WELFARE AND CURRENT APPROACHES IN FARM ANIMALS

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PREFACE

The concept of animal welfare refers to the quality of life of the animal. Welfare in farm animals is the state of being in harmony with the environment of the animal, being able to adapt to the environment in which it lives without any pain or discomfort and being healthy. The determination and assessment of animal welfare is a multi-dimensional and multi-criteria approach. Welfare assessment at farm level can be used as an advisory tool by farmers, as a source of information for management and as a component of quality assurance schemes for consumers. Nowadays, consumers have a high interest in animal production conditions and related animal welfare standards due to the positive public health implications of the effects on the health and production of animals. Changes in animal production in recent years, increasing food demand in parallel with population growth, lead to changes in production systems and increased integrated production activities. In addition to the increase in production, changes in environmental conditions, herd management, nutrition, biotechnological and environmental conditions have been inevitable. In these changes, animals are exposed to many stress factors. Animals try to cope with the difficulties they face with various reactions. Monitoring, measurement and evaluation of these changes are necessary to ensure the continuity of productivity in animals.

This book is composed of studies aiming to develop new approaches in the field of welfare in farm animals and evaluating sustainable solutions to the problems encountered from an academic perspective.

We would like to thank all our academicians who contributed to the book "Welfare and Current Approaches in Farm Animals", our valuable scientists who carry out research in this field and contribute to our book with their professional experience and support, and Iksad Publishing House employees who supported and contributed during the publishing phase.

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CHAPTER 1

ETHICS AND ANIMAL WELFARE IN ANIMAL EXPERIMENTATION

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1. INTRODUCTION

The adventure of humans using animals for experimentation, which started with Hippocrates' anatomy studies on animals in the 5th century, continues today with scientists using animals only for scientific purposes within the framework of ethical and welfare rules. Among the usage areas of experimental animals are vaccine, toxin, and antioxidant production and development, testing and standardization of biological substances, research, education, and practical studies in the fields of health, cosmetics, and defense industry.

There are also many studies that have developed since the beginning of the 20th century and show the importance of experimental animals (Table 1).The development of diphtheria antiserum by Von Behring, experiments on tuberculosis and anthrax pathogens by Koch, studies of the typhus pathogen by Nicolle, and the development of yellow fever and polio vaccines by Theiler, Enders, and Welter can be cited as examples of the use of animals for the production of vaccines, toxins, and antioxidants.With the studies carried out to understand the anatomy and physiology, the structural function and chemical properties of the cell, how the immune and central nervous systems work, the effects of antibiotics used against bacterial infections, and how organ transplants should be performed. In addition, the discovery and development of diagnostic methods, such as computed tomography, which has an important place today, have been provided using experimental animals.

Table 1. Contribution of animal experiments to the world of science in the 20th century.

Year	Scientist	Experimental animal	Research
1901	Von Behring	Guinea pig	Development of antiserum of diphtheria
1902	Ross	Pigeon	Understanding of life cyle of malaria
1903	Pavlov	Dog	Responses of animal
1905	Koch	Cow, sheep	Researching for patagen of the charbon and tuberculosis
1906	Golgi, Cajal	Dog, horse	Understanding of central nervous system
1910	Kossel	Bird	Development of cell chemistry knowledge

1912	Carrel	Dog	Surgical studies with blood vessels
1919	Bordet	Guinea pig horse, rabbit	Understanding of function of immune system
1922	Hill	Frog	Consuming of oxygen on muscle
1924	Einthoven	Dog	Development of electrocardiograph (ECG)
1928	Nicolle	Monkey, pig, mouse	Investigation of pathogen of typhus
1932	Sherrington, Adrian	Cat, dog	Function of the neurons
1936	Dale, Loewi	Cat, bird, frog	Chemical tranmission of nerve impulses
1943	Dam, Daisy	Rat, dog, mouse	Investigation of vitamin K
1945	Fleming, Chain, Florey	Mouse	Effects of penicillin on the bacterial infection
1949	Hess, Moniz	Cat	Functional structure of brain
1951	Theiler	Monkey, Mouse	Development of the yellow fever vaccine
1952	Waksman	Guinea pig	Discovery of the streptomycin
1954	Enders, Weller	Monkey, Mouse	Development of poliomyelitis vaccine
1966	Rous,Huggins	Rat, rabbit, chiken	Treatment of cancer with hormones
1968	Halley, Khorana	Rat	Interpretation of genetic coding
1973	Von Frish, Lorenz	Bee, bird	Communal orders in animals
1974	De Duve, Palade, Claude	Chiken, guinea pig, rat	Regulation of cells function and structure
1979	Cormack, Homsfield	Pig	Development of computer-assisted tomography
1986	Levi-Montalcini, Cohen	Mouse, snake, chiken	Discovery of nerve growth factor
1990	Murray, Thomas	Dog	Methods of organ transplant
1991	Neher, Sakman	Frog	Chemical communication between cells
1996	Doherty, Zinkernagel	Mouse	Detection of infected cells by the immune system

The use of animals in research for the benefit of humanity has elicited a wide range of reactions from individuals. First, it was believed that there was no use in studying animals because they were so different from humans. Experiments that cannot be done on humans should not be done on animals, according to a second line of reasoning, which holds that if there are similarities between humans and animals, then experiments that cannot be done on humans should not be done on animals either. As a result, a dilemma evolved in the use of animals for experimental purposes. Considering this complicated scenario, the use of experimental animals has been redesigned and moved to a more humanitarian dimension, with the benefit of humanity in mind. Regulations and legislation have been enacted on both the national and international levels in order to safeguard animals and guarantee that they are only used in circumstances that are essential and appropriate.

These regulations aim to observe the rules set for ethics and welfare in animal experiments. It is aimed at balancing the rights and welfare of animals with scientific progress. Although each country has its own legal regulations, the general principle is to protect animals and take into account the requirements of their use.

The issue of animal testing remains an area of constant ethical debate and regulatory review. In the future, efforts to develop better protection methods and alternative test methods will also continue. Thus, both scientific progress and the rights of animals will be respected.

Animal experiments, which are an important part of scientific research, come together as a result of the protection of animals' emotions and happiness with animal rights. In this chapter, we are going to go on an adventure to investigate the morality and welfare concerns that are associated with animal testing.

2. EXPERIMENTAL USE OF ANIMALS THROUGH THE YEARS

Throughout recorded history, humans have relied on various animals for a variety of purposes, starting with feeding and progressing to transportation and economic gain. Hippokrates's work, *Corpus Hippocraticum*, which he produced in the fifth century, has historical records of the first experimental animal (Olsson et al., 2003). Aristotle's *Historia Animalium* has several interesting observations about the study of animal anatomy. Galen's understanding of the physiological function of the internal organs of dogs, monkeys, and pigs provides the earliest evidence of the use of animals in research (Conner, 2017). In addition to the requirement for the use of animals in toxicological and hygiene investigations, Claude Bernard, the "father of physiology," also noted that animal experiments should be conducted only from a physiological perspective (Hajar, 2011).

It's common knowledge that historically, experimental animals have been agricultural animals selected at random. This explains why it seemed like similar experiments at the time yielded varied outcomes. Environmental aspects, including as the breeding environment, nourishment, and housing of the animals to be used in research, have begun to be standardized in an effort to remove this problem.

Animals were supposed to be emotionless for a long time. The primary distinction between humans and animals has been stated as a lack of consciousness. Although the Cartesian concept that animals cannot experience pain was widely held until Jeremy Bentham's "An Introduction to the Principles of Moral Life" was published in 1789, this position was eventually disproved. According to Bentham, what matters morally is whether animals can suffer pain, not whether they can speak or whether they can consciously examine things. An additional issue was that anesthetics had not yet been discovered at the time of these discussions. The animals used in the experiments suffered tremendously in agony because anesthetics were not administered. The initial steps were taken to carry out the death of animals under anaesthesia after the discovery of anaesthesia. The 'Victoria Street Society' and 'Frances Power Cobbe' organisations were founded in 1875, and as a result of their efforts, the 'Royal Commission' was formed in England, and the ethical law known as 'The Humane Treatment of Animals Act' was established. Within the regulations of the law, it was decided that experiments on live animals could only be conducted under the supervision of the Minister of Government, under anaesthetic, and for the purpose of valuable scientific research. Following the ruling, multiple associations were formed in the United States and Europe, and because of their efforts, international agreements were reached and legislation on the issue were implemented in a number of nations (Altuğ, 2009). The suggestions on animals to be used in experimental studies in WMS Russell and RL Burch's 1959 book "The Principles of Humane Experimental Tecnique" form the basis of today's laws. Russell and Burch's goal is to ensure that animal experiments are carried out in accordance with specified guidelines. The 3R rule, which is still in use today, is the most important of their recommendations in the book they manufactured. The concepts of 'Replacement, Refientment, and Reduction' were proposed in accordance with this approach by considering how the inhumane features of animal studies could be abolished or reduced (Tannenbaum and Bennett., 2015)

In accordance to these events, in 1978, Paris published the "Universal Declaration of Animal Rights," which consists of fourteen articles. The Declaration evolved to include a clause declaring the use of animals in scientific research. "It is contrary to animal rights to conduct experiments that cause physical or psychological suffering to animals; this applies to all types of experiments, whether medical, scientific, commercial, or otherwise," states Article 8 of the Declaration (URL 1).

The "Council of International Organisations for Medical Sciences (CIOMS)" research on animal ethics from 1982 is also notable for advancing the cause of animal rights protection. The collaboration between COIMS and the World Health Organization continued. The fundamental objective of the research is to limit the necessity of animal testing and to stop testing on animals altogether when it's not absolutely essential. The research led to the publication of the "Animal Experiments Ethics Law" in 1984, which consists of eleven articles (Uzel, 1994).

A regulation governing the use of experimental animals was enacted in 1986 and published as Council Directives under the number 86/609/EEC (Council of Europe, 1986). A comprehensive legal regulation was made on the use of experimental animals in 2010 with the publication of the "Council Directive on the Protection of Animals Used for Scientific Purposes" with the publication number 2010/63/EU, which was amended in 2003 with the publication of the Directive 2003/65/EC (European Commision, 2010). In 2012, the council issued directive 2012/707/EU (Commision Implementing Decision, 2012), then in 2014, the council issued directive 2014/11/EU (Commission Implementing Decision, 2014), continuing the regulations.

In conclusion, different countries have endeavoured to handle animal experiments both scientifically and ethically by the enactment of various regulations and legislation in light of the experiences and ethical understanding obtained over the years. There are some fundamental similarities between regulations and laws. These include the ability to conduct experimental studies within the framework of the 3R rule, the acceptance of the necessity of using experimental animals, and the control of essential rights like housing during animal experiments by certain organizations.

3. CONCEPTS AT THE BASIS OF ANIMAL TESTING

The French word éthique comes from the Greek word ethos, which means "character," and its meaning is the science of moral behavior (URL 2). Studies in social life and the scientific area are conducted within the framework of moral conditions, and the concept of ethics is universally acknowledged.

Ethical questions arise when animal testing is considered. The proposed hypothesis of the experimental investigation must be put up before any animal experiments can be conducted in an ethical manner. In animal experiments, 'researchers' use 'experimental animals' under supervision of 'animal experimentation ethics committees' to gather evidence to support of the hypothesis (Ergün, 2010).

3. 1. Experimental Animals

Animals used in scientific experiments today must be non-human vertebrates, and this includes live cephalopods, mammals in their final third of normal foetal development, and free-living or reproducing larval forms. Animals used in scientific experiments can be broken down into two categories. Mice, rats, hamsters, rabbits, zebrafish, guinea pigs, and monkeys all fall under the category of "laboratory animals" (Hickman et al., 2017). Horses, goats, sheep, cattle, and pigs (Government gazette, 2011) are all examples of animals that are commonly kept as "livestock". Animals for use in experiments are chosen according to predetermined standards called "experimental animal model selection criteria," which vary from one study to the next.

Animals are used in experiments for three primary reasons nowadays (Ergün, 2010).

1. The testing of potentially harmful or poisonous items and chemicals,
2. The development of pharmaceutical and other medical products,
3. The development of research in the basic sciences.

Before deciding on an animal to use in experiments, it's important to do some background reading on the topic at hand. It is important to look into alternate approaches that can be used in the experimental study that will be conducted during the selection process. If there are no acceptable alternative method for using an animal within the experiment, then one should choose an animal for the purpose of research. Knowing the animal's family, species, genus, and lineage, among other systematic, microbiological, and genetic traits, allows for more informed choices when selecting experimental animals. It's important to decide based on how well the animal model resembles the human population (Henry et al., 2002). Because of their rapid weight growth and short life cycle, certain strains of mice are often used as model organisms in research on diabetic disease, which has implications for the study of obesity. However, due to their short lifespan, they are not favoured as model organisms for studies of chronic toxicity (Kaya and Çevik, 2011).

Scientists were able to use more and more animals in experiments without running into ethical issues until the 1970s, but after widespread opposition and the introduction of new regulations, the number of animals used in experiments dropped precipitously in the early 1980s (Figure 1).

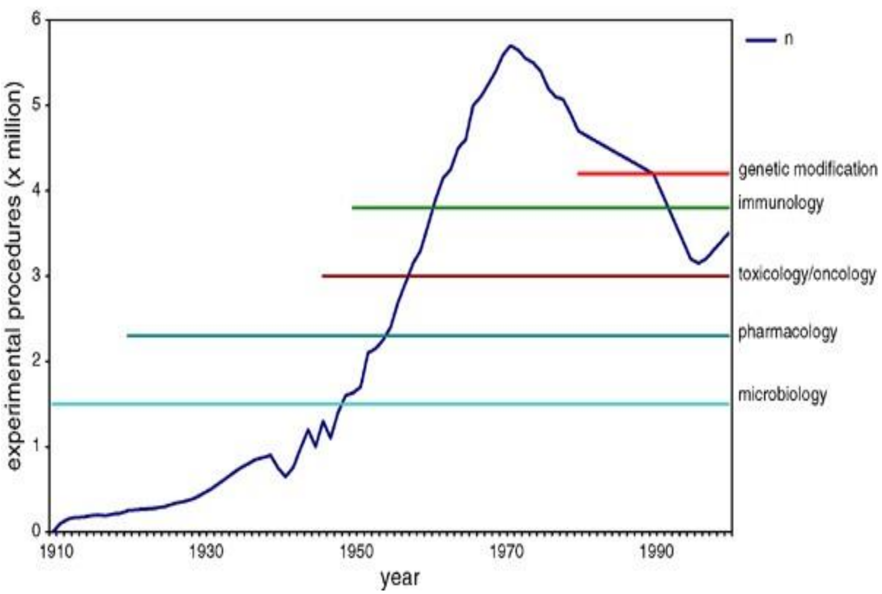

Figure 1. The sheer amount of animal testing during historical (Baumans, 2004a).

Despite this decline, the importance of animal experimentation was shown by the fact that approximately 85% of the Nobel Prizes in Physiology and Medicine in 1996-2001 involved animal experiments (Griender et al., 2003). The discovery of endothelium-derived relaxing factor in rabbit aorta contributed to the 1998 Nobel Prize being shared equally by Robert Furchgott, Louis Ignarro, and Ferid Murad. The work relied on animal research. Researchers had identified this substance as nitric oxide, which is now understood to play a critical role in the cardiovascular system as a vasodilator (Smith, 1998; Furchgott, 1999).

In conclusion, the use of experimental animals has a long and illustrious history that dates back to Hippocrates in the fifth century and continues right up to the present day. In order to further the study of physiology, biochemistry, pharmacology, microbiology, immunology, pathology, and other biomedical disciplines, the use of animals in experiments is unavoidable. To better understand the physiopathology of disease, researchers are increasingly simulating human conditions in animals and studying their diagnosis and therapy.

3. 2. Researchers

The scientific method requires a team of people led by an individual with accountability for their work. Nothing has changed in this regard in experiments using live animals. Certain requirements must be met by the researcher for them to be considered a responsible one. A person must meet these requirements in order to be eligible to earn a certificate (Government gazette, 2006), and they include membership in a specific occupational group, possession of a bachelor's degree, participation in certificate programs set within the framework of various regulations and organized by ethical committees. Certificate programs educate students on the various types of experimental animals, their physiological and biochemical characteristics, relevant laws and regulations, ethical principles, and practical skills such animal care, injection, blood collection, anaesthesia, and euthanasia. Also, in the certificate programs envisioned for farm animals, a veterinarian is required. This veterinarian also needs to be certified to work with experimental animals. As a result, it is possible for scientists who want to work with experimental animals to participate in certificate programs, and to use experimental animals as a result of their success.

3. 3. The Authorized Committees

Various ethics committees provide assessments of the project's scientific and ethical merits, as well as reviews of the researcher and the institutions funding the project. These ethics committees perform essentially the same function worldwide, but their names could be different. "Institutional Animal Care and Use Committees" in the United States, the "Ethics Committees for Animal Experimentation" in Europe, and the "Animal Experimentation Center Ethics Committee" in Turkiye are just a few examples. Committee members should be elected in a transparent process and have the ability to speak independently. The committees' role as supervisory mechanisms necessitates that they have a deep familiarity with the 3R rule, that they employ supervisory mechanisms in order to bring the rule into effect, and that they work in line with the law (Ergün, 2010).

3. 4. Experimental Animal Legislation in Turkiye

In Turkiye, the control mechanisms of experiments using experimental animals were established after the European Union standards on the subject were determined. In 2004, the Animal Protection Law No. 5199 was enacted by the Ministry of Environment and Forestry. Article 9 of this law defines how animal experiments should be carried out (Government gazette, 2004b). In the absence of another method of study in the experimental study to be carried out, it is appropriate to use experimental animals after conditions such as care, housing, and protection under appropriate conditions are provided if permission is obtained from ethics committees. Physical conditions such as feeding, caring for, housing, and breeding experimental animals are determined by the regulations issued by the Ministry of Agriculture and Rural Affairs. After the publication of the 'Regulation on the Procedures and Principles of the Establishment, Operation, Supervision, and Procedures and Principles of the Establishment, Operation, Supervision, and Procedures and Principles of the Experimental Animals Used for Experimental and Other Scientific Purposes, the 'Regulation on the Working and Procedural Principles of the Ethics Committees for Animal Experiments' was published by the Ministry of Environment in 2006, entered into force, and the use of animals was legally secured (Government gazette, 2004a).

The purpose of the Regulation on the Working and Procedural Principles of Animal Experimentation Ethics Committees is to ensure the establishment and working principles of the Central Ethics Committee for Animal Experiments and Local Ethics Committees for Animal Experiments in order to determine the ethical conditions of the methods planned to be used in scientific studies and to examine research proposals. Within the scope of the Regulation, the Central Ethics Committee was established for the first time in Turkiye. The Central Ethics Committee for Animal Experiments (HADMEK) consists of 21 members from non-governmental organizations working to protect animal rights, such as the Ministry of Health, the Association of Veterinary Doctors, medical faculties, and the Scientific and Technological Research Council of Turkiye. Determining the ethical rules for the use of experimental animals by the ethics committee, ensuring that local ethics committees comply with the regulations, evaluating the training programs carried out by local ethics committees and the equivalence of the certificates given to the trainees at the end of the trainings, and evaluating the objections to the decisions of local ethics committees are among the duties of the central ethics committees. Thanks to the Regulation, obligatory for scientists who want to work with experimental animals to attend experimental animal courses, obtain a certificate, and have their studies approved by the ethics committee (Uludağ, 2019).

In Turkiye, the regulation published in 2006 was reorganized between 2011 and 2014, and two regulations were published to update the regulations. The regulation published in 2011 was prepared by the Ministry of Food, Agriculture, and Livestock on December 13, 2011, taking into account the provisions of the European Union Directive 2010/63/EC. The purpose of the regulation is to ensure animal welfare and safety, such as feeding, housing, care, and production of animals to be used in experiments, the determination of post-experimental killing methods, the qualifications of the researcher, and the evaluation of the protocols to be used (Government gazette, 2011).

On February 15, 2014, the Ministry of Forestry and Water Affairs issued a regulation in parallel with the Animal Rights Law No. 5199 and Directive 2010/63/EU. The regulation aims to determine the protocols and materials to be used in activities such as scientific studies, training, and certification programs using experimental animals within the framework of ethical rules, the establishment and control of the work of central and local ethics committees, the submission of the protocols of the experimental study in which animals will be used, the examination of research and study proposals, and the recording and auditing of the protocols of each procedure performed. In addition, the regulation provided for the establishment of local ethics committees (HADYEK) and the determination of their working principles (Uludağ, 2019).

HADYEK can be established by higher education boards and public and private institutions that have received permission from the Ministry of Food, Agriculture and Livestock and prioritize animal welfare. The study protocols to be carried out with experimental animals are left to the permission and control of HADYEK in line with the regulation published in 2014 (Government gazette, 2014). Therefore, whether the researcher involved in the experimental study has a certificate or not and the suitability of the laboratory environment for the production, housing, and transport of experimental animals are controlled by HADYEK. HADYEK carries out its activities in line with various principles. Some of these principles are mentioned below (Balkan and Balkan, 2013).

1. To ensure the prevention of malpractices that may be carried out against experimental animals,

2. To control the one-off use of experimental studies that may cause pain, stress or suffering,

3. To ensure that painful experiments are performed on animals in certificate programs, congresses, seminars, and experiments carried out for educational purposes,

4. Ensuring that scientifically reliable results are obtained with the minimum number of animals and in a way that causes the least stress to the animals,

5. Ensuring that animal welfare principles are applied throughout the experimental study,

6. Ensuring that animals are cared for by trained personnel under appropriate conditions,

7. Administering anesthesia to experimental animals during painful procedures and ensuring the use of painkillers,

8. Ensuring that humane killing methods are used, and that euthanasia is carried out under the control of a veterinarian, especially after surgical

procedures, because the animal is exposed to too much pain and this situation cannot be corrected,

9. To prevent the use of experimental animals if alternative methods can be used experimentally and to prevent the repetition of experiments that have already been performed and have information in the literature,

10. At the end of the experimental work, if the animals continue to live, ensuring a healthy living environment,

11. If a heavy and long-term experimental study is to be carried out, first ensure that the experimental study is carried out after the approval decision given by the local ethics committee within the framework of ethical principles.

Terms of conclusion, the strict supervision of the use of animals in experimental studies by HADMEK, HADYEK through laws and regulations leads to both the humane behaviour of researchers and the use and protection of animals when necessary.

4. GUIDELINES FOR SCIENTIFIC STUDIES ON ANIMALS

Insatiable curiosity has driven scientists to conduct research that span centuries and will continue to do so in the future. Many areas of medicine, including physiology, psychology, and immunology, have advanced thanks to the use of non-human animals in experimental studies. From the point of view of ethics, the use of experimental animals for the benefit of humanity is a violation of animal rights and has created great chaos. The rejection of the Cartesian view by Jeremy Bentham was the first step, followed by the publication of the Declaration of Animal Rights and the implementation of laws on the use of experimental animals. Basic principles guiding the use of experimental animals today can be traced back to a set of rules proposed by Russell and Burch during the process of establishing regulations. Known as the "3R rule," this guideline outlines the standards that must be met whenever animals are used in research (Altun and Keskin, 2020). 3R stands for Replacement, Reduction, and Refinement, respectively. Recently, Responsibility (Lee et al., 2020) and Rehabilitation (Parija and Mandal, 2013) have been included among the principles. Because of this, the rule that used to be known as the 3R rule has now been renamed the 5R rule (Figure 2).

Figure 2. The 5R rules use in animal experiments.

4. 1. Replacement

As defined by Russell and Burch in "The Principles of Humane Experimental Technique," Replacement is "the use of non-sentient materials that can replace the methods using live vertebrates in place of consciousness" (Kolar, 2006). Today, this expression is still relevant. This idea provides support for the replacement of non-living resources, such as cell, tissue, and organ cultures, for live animals in scientific research (Kolar, 2006). Especially in trainings such as experimental animal use certificate, visuals, films or artificial experimental animals could be preferred (Altun and Keskin, 2020). During the experiment, alternative methods may be used, but it is possible that the results will not be as accurate. Similarities between animal and human physiology and pathology allow for more accurate results to be obtained when organ systems are studied together (Oral and Çakar, 2005). This is why animal experiments are still being conducted in several branches of science.

4. 2. Reduction

According to Russell and Burch, the definition of "reduction" is "reducing the number of animals used to obtain information to a certain extent and sensitivity" (Koral, 2006). Based on these criteria, researchers should minimize the number of animals used in experiments while maximizing the quality of the results obtained. For this reason, in accordance with the intended research, it is necessary to do a literature review first. It is preferable not to conduct the intended experimental investigation if the existence of similar studies is established and the results of the similar studies are significant. If the results of a similar study don't amount to much and the goal of the study is to find a remedy, then an experimental investigation should be conducted (Ergün, 2010). First, physical and chemical properties like the type, breed, and age of the animal to be used in the experiment and the variables to be used in the experimental study could be determined if the absence of similar studies is determined by the literature review. Statistical analysis can be used to determine how many animals should be employed in the experiment to achieve statistical significance. It is important to aim for a statistically significant outcome when determining the number of animals in the control and study groups. The use of animals in research would be pointless if it didn't result in a statistically significant outcome (Tüfek and Özkan,2018).

Likewise, choosing a research strategy is equally crucial. The importance of conducting preliminary research cannot be overestimated. Prior to testing on a large number of animals (Balkan andBalkan 2013), it is important to identify potential issues that may arise if a new methodology or chemical substance is employed in the study. Adding the findings of experimental investigations to the literature or making them available to other researchers and institutions will also aid in reducing the number of animals used in experiments.

Furthermore, the availability of seasoned researchers with the credentials to use animals in experiments is another factor that can help lessen animal suffering. This way, experts can make use of animals in experiments instead of inexperienced people, reducing animal suffering and unnecessary death (Oral and Çakar, 2005).

4. 3. Refinement

The third and final R rule proposed by Russell and Burch is called "refinement," and it refers to "a reduction in the severity of inhumane procedures applied to animals that need to be used" (Kolar, 2006). The primary objective of the refining rule is to improve the health and well-being of animals. It is clear that the procedures that are going to be utilized in the experiment must be carried out in a way that causes the animals as little discomfort as possible and does not involve any cruel treatment if the comfort of the animals that are going to be used in the studies is going to be maintained from birth until death (Ergün, 2010). As a result, it can be directed at enhancing efficiency by minimizing the disadvantages of the procedures to be utilized in the experimental phase (Pereira et al., 2015). The potential problems that could arise during the experiments and the solutions to those problems are discussed below:

1. At the end of animal experiments, the licensing of the use of chemical substances can be carried out. The dose calculations of these toxicological studies should be calculated very well. Otherwise, serious health problems may be caused in animals (Tüfek and Özkan,2018).

2. During the use of animals in experiments, the fact that animals also suffer should not be forgotten. Considering the fact that methods that cause pain and suffering in humans cause pain and suffering in animals in the same way, animals should be monitored after the procedures, and if the pain they suffer is greater than anticipated, veterinarians should be consulted, and their treatment should be provided. In addition, it is prohibited to perform more than one painful application on the same animal at the same time or in succession. Even if it is for educational purposes, experiments in which animals will feel pain and suffering should not be performed (Tan and Çobanoğlu, 2013).

3. Before surgical procedures, anaesthesia must be performed, and antibiotic and analgesic applications must be performed afterwards. Asepsis/ antisepsis, and surgical rules should be followed during surgical procedures. In particular, it should be ensured that the most appropriate surgical method is applied without damaging the tissues, and it should be ensured that the materials used are less likely to cause inflammation. At the end of the procedure, the vital signs of the animal should be controlled, the post-op process should be

comfortable, and the animal should be awakened with the least amount of pain (Okur, 2016).

4. At the end of the experiments, the lives of animals that are constantly suffering and in pain and whose recovery is not possible at the end of veterinary control should be terminated under humane conditions in a respectful manner. The most crucial factor to consider when deciding on a technique of killing is that the animal loses awareness quickly, followed by respiration, cardiac arrest, and loss of brain functioning (Tüfek and Özkan,2018). It should not be forgotten that animals should not be agitated before euthanasia.

In physical and chemical euthanasia (Table 2), chemical euthanasia is the administration of high doses of anaesthetic by invasive or inhalation routes. The physical euthanasia method is used when experimental data are affected. At the end of euthanasia, it must be confirmed that the animal is dead. For this purpose, it must be ensured that the circulation have stopped, that brain death has occurred, or that rigor mortis has begun (Government gazette, 2011).

Table 2. Methods of killing animals (Government gazette, 2011).

Animals Methods/ Descriptions	**Fish**	**Amphibious**	**Reptile**	**Poultry**	**Rodents**	**Rabbits**	**Cat, Dog, Weasel, and Fox**	**Evolved Mammal**
Overdose of anaesthesia	1	1	1	1	1	1	1	1
Taser	-	-	2	-	-	-	-	-
Carbon Dioxide	-	-	-	-	3	-	-	-
Neck dislocation	-	-	-	4	5	6	-	-
Concussion / Hard blow	-	-	-	7	8	9	10	-
Decapitation	-	-	-	11	12	-	-	-
Electroshock	13	13	-	13	-	13	13	13
Inert gas (N_2, Ar)	-	-	-	-	-	-	-	14
Shooting with a rifle, gun	-	-	15	-	-	-	16	15

Terms of application

1. If necessary, it is used by giving a tranquilliser beforehand.
2. For use in large reptiles only.
3. To be used only in rodents in the 'gradual-fill' stage after the neonatal stage and not in foetuses and newborns
4. It is only used in poultry under 1 kg. Poultry over 250 g are given tranquillisers.
5. Used only in rodents under 1 kg. Rodents over 150 g are given tranquillisers.
6. Used only in rabbits under 1 kg. Rabbits over 150 g are given a tranquilliser.
7. Used only in poultry under 5 kg.
8. Used only in rodents under 1 kg.
9. Used only in rabbits under 1 kg.
10. Used only in newborns.
11. Used only in poultry weighing less than 250 g.
12. Only used when other methods are not possible.
13. It is applied with special equipment.
14. Used only on pigs.
15. Used only by experienced snipers under field conditions.
16. Used only by experienced snipers under field conditions when other methods are not possible.

4. 4. Responsibility

While the 3R rule continues to be applied during the use of experimental animals, the Responsibility rule was added by the Bank in 1995 (Davies et al., 2018). This rule indicates that animals used in experiments should not be regarded only as material but should be aware of their responsibility and act accordingly. It is known that scientists have a responsibility to contribute to the literature with every study they conduct. In addition, it is a fact that researchers who use experimental animals in their studies have different responsibilities, and there are some rules that these researchers must comply with as specified in the legislation. The main purpose of these rules is to protect the rights of experimental animals and to ensure the reliability of the data to be obtained as a result of the studies through laws, regulations, directives, and guidelines. Thus, studies can be carried out at high standards for science, and as a result, the results of original scientific studies are included in the literature (Tüfek and Özkan, 2018).

It should be ensured that the planned scientific study is carried out within the framework of ethical rules. Especially the part where the application of ethical rules is most necessary is the part where the experiment is terminated. Animals may need to be killed at the end of the experiment for various reasons. In order to prevent them from suffering during their death, the rules in the accepted and published regulations should be followed, and the appropriate killing technique should be used. As can be seen, the implementation of ethical rules is framed within the scope of regulations (Altun and Keskin, 2020).

In conclusion, the concept of responsibility should be explained as the responsibility of not only researchers but also regulators, supervisors, ethics committees, and journal editors (everyone who contributes to the use of animals in experiments) (Davies et al., 2018).

4. 5. Rehabilitation

As a result of experimental studies, the rehabilitation rule refers to the situation of restoring animals to health if possible. The 'Committee for the Control and Supervision of Experiments on Animals' (CCSEA) (Parija and Mandal, 2013), which was established in India in 1960 and works to prevent cruelty to animals, published a guide covering the rehabilitation of large animals after the experiment in 2020. According to this guideline, large animals are defined as rodents and animals higher on the phylogenetic tree. Rehabilitation is defined as the alleviation of suffering, such as pain, stress due to physical and psychological traumas that animals bred/raised for experimental purposes, subjected to experimentation, kept in shelters for experimental purposes, and the survival of animals in an environment different from the laboratory environment until their natural death without being used in experimental studies (Government of India, 2020).

5. ALTERNATIVE METHODS

In accordance with established ethical guidelines, animals are used in scientific experiments. It is the responsibility of ethical committees to ensure that non-animal alternatives are used whenever possible in experimental experiments. Today, a wide variety of alternatives are employed. Microarray and omics technologies, computer models, and data banks are only a few examples of alternatives to traditional methodologies (Erkekoğlu et al., 2011; Mustaq et al., 2018).

5. 1. In Vitro Methods

In vitro methods are dynamic systems used to determine the effects of drug therapy and chemical substances on living organisms by imitating living organisms (Erkekoğlu et al., 2011). In vitro methods include cell, tissue, and organ cultures.

Cell / Tissue / Organ Culture

The use of cultural methods is preferred in line with the objectives of the study. The use of these methods is among the important alternatives to reducing the use of experimental animals. In particular, cells taken from various tissues of animals or humans can be used in suitable environments for months. Studies on healthy or diseased cells enable the understanding of biochemical and physiological cell properties and metabolisms, the mechanisms of drugs on a cellular basis, and cytotoxicity studies (Segeritz and Vallier, 2017). In tissue culture, interactions between cells may be observed, and in organ cultures, the organization between tissues, growth of organs, and differentiation of their functions are observed (Walymouth, 1996).

5. 2. Computer Modelling

In the context of computer simulations, the phrase "in silico" refers to the process of carrying out the investigation using virtual environments created on computers. Nowadays, in silico research not only helps cut costs but also decreases the number of times animals are used in scientific experiments. The precision and reliability of the input data is a crucial factor in the success of computational models. At the same time, the results of computer-aided studies that use inaccurate data can lead to the formation of incorrect conclusions.

Toxicology investigations of chemicals and pharmaceuticals, physicochemical molecular interactions, and the identification of previously unknown biological pathways have all benefited from the application of in silico models in recent years (Erkekoğlu et al., 2011; Mustaq et al., 2018).

5. 3. Omics Techniques

The word "omics" originates from the Latin word for "body" (ome). "Whole" in this context refers to the findings of scientific investigations of biological data. The integrity of molecules is symbolized by omics technologies (Horgan and Kenny, 2011). Genomics refers to the study of genomes; transcriptomics to that of messenger RNA; proteomics to that of proteins; and metabolomics to that of metabolites (Figure 3).

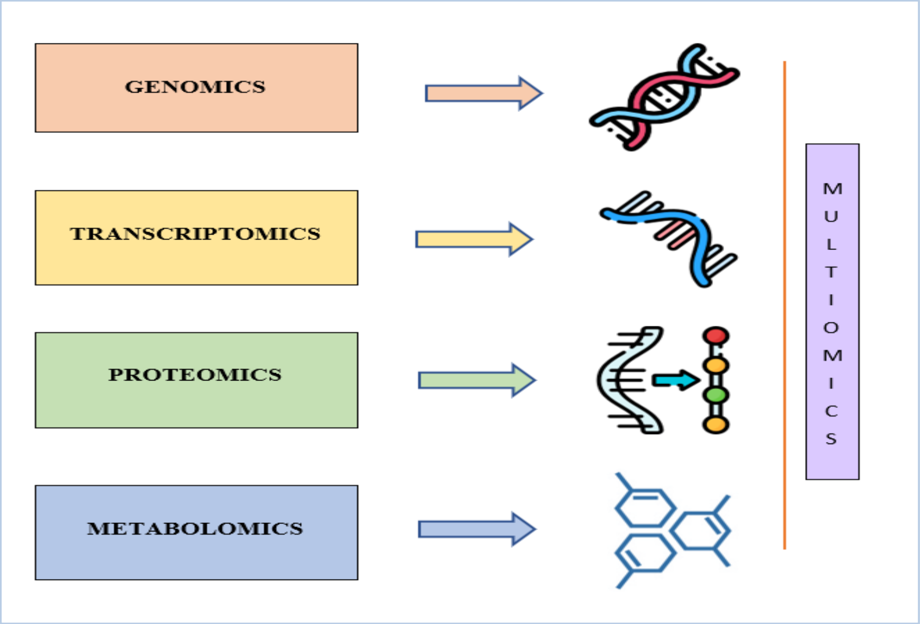

Figure 3. The varieties of omic technology.

Genomic research elucidates fundamental questions about how the DNA of living things is structured and how it is put to use. Transcriptomic research involves the comprehensive examination of all mRNAs produced during a certain time period. Transcriptomic analyses shed light on the molecular mechanisms underlying cell growth and differentiation.

All proteins created by the genome in the organism can be characterized in terms of their structure and function thanks to proteomic research. Protein synthesis can occur at varying speeds amongst cells and under different physiological conditions. As a result, proteomic studies present a higher level of complexity than genomic ones. Proteomic investigations identify the pathways in which proteins are engaged and how they operate in these pathways.

On the other side, metabolomic research attempts to uncover the metabolic by-products within a cell. Metabolics include substances including amino acids, vitamins, carbohydrates, lipids, minerals, and nucleic acids that can be generated and incorporated into the body. Changes in the metabolomic structure of the organism occur, especially in cases of sickness, and these changes are both long-lasting and measurable. Disease diagnostics increasingly rely on metabolomic techniques (Horgan and Kenny, 2011; Budak and Dönmez, 2012; Yaman, 2015).

6. WELFARE

Today, when animal welfare and rights are frequently on the agenda, the use of animals in experimental studies for scientific purposes is a very difficult and sensitive issue. For this reason, the use of experimental animals in many countries is restricted by laws and regulations that include strict and precise rules (Schwindaman, 1994; Hartung, 2010; Özen, 2017; MacArthur Clark and Sun, 2020).Ensuring the welfare of the experimental animal by the researchers is important in terms of compliance with the laws of the country where the study is carried out and ethical work, as well as being directly related to the scientific efficiency of the outputs of the study.Therefore, the protection, care, welfare, and post-experimental status of animals used in experimental and scientific studies are priority issues for the researcher.

6. 1. History Of Animal Welfare

Throughout human history, animal and human relations have progressed in quite different ways. Animals, which were considered only as food at first, were later used in transport. Human beings, who moved from hunter-gathering to settled life and engaged in agriculture, started to domesticate the animals they needed for protection, food, clothing, etc. The prohibition of dissection of human beings and the filling of this gap with animals have brought animal-human relations to a different level. As a result, with the development of medical science, the concept of experimental animals has entered our agenda. Throughout all these processes, philosophers have periodically observed animal-human relations from different angles. Anthropocentrism, which considers animals as living machines at the disposal of humans, and Descartes, one of the proponents of this idea, argue that compared to humans, animals do not have awareness and therefore do not suffer (Kopnina et al., 2018). Physiocentrism, on the other hand, recognizes that animals can also feel pain and therefore should be treated with more compassion (Marder, 2014). These two different approaches have influenced scientists in different periods and guided scientific studies.

According to the dictionary definition, "welfare" is defined as happiness, well-being, and living a good life. The concept of welfare for humans is also used for the state of physical and mental health. The welfare mentioned for animals is not different. Basically, animal welfare defines the quality of life of animals in their environment and the state of good physical and mental health (Fidan, 2012).

Apart from the definitions made in the past, today, physiological parameters such as heart rate, cortisol, and endorphin levels, which determine the levels of regulatory and defense activities of the animal against the conditions it is in, are included in the concept of welfare (Altınçekiç and Koyuncu, 2010). In other words, animal welfare can be defined as ensuring that laboratory, farm, wild, and pet animals are free from pain and stress and have a happy, healthy, and good living condition during their nutrition, shelter, care, breeding, transport, treatment, and use for scientific purposes.

In the historical process, the first movement related to the rights to life and protection of animals was organized by the 'Animal Protection League' in England in 1822 (Appleby et al., 2004). The first animal welfare-related step taken by the European Union was realized with the signing of the 'Treaty of Rome' in 1957. In 1964, Rutz Harrison published the book Mechanized Animals. The content of the book criticizes the system in which farm animals were bred to increase their productivity. Thanks to this book, the Brambell Committee was established in 1965, and the first definition of animal welfare was made. In addition, the commission presented the declaration, defined as the five fundamental freedoms. One of the most important steps taken internationally for animal rights and welfare is the Declaration of Animal

Rights, which was announced in 1978 (Yaşar and Yerlikaya, 2004; Atasoy, 2011).

In 1993, the 'Farm Animal Welfare Committee' was established. The committee defined the freedoms that should be given to animals. Within the concept of freedom determined by the Committee, animals should be able to maintain their lives in appropriate housing conditions, eliminate conditions that will affect their psychological health such as fear and stress, ensure that their nutrition is balanced and regular, provide suitable conditions for the housing of animals living in groups, and ensure that animals of the same species are housed in the same area. Directive 98/58/EC on the Protection of Farm Animals was published by the European Union in 1998. Subsequently, the Treaty of Amsterdam, which entered into force in 1999 with the amendment and development of the Treaty of Rome and the published directives, contained the first legal obligations regarding animal welfare, and animals were recognized as emotional creatures for the first time (Fidan, 2012). Even in the modern era, nations still retain the ability to make regulations through publishing a variety of regulations (Table 3).

Table 3. Chronological information on animal welfare legislation in Europe, European Union and Turkiye (Sert and Uzmay, 2017).

Situation in Europe	**Situation in the EU**	**Situation in Turkiye**
1911-Animal Protection Law	**1974-** Law on the Slaughter of Animals	**2004-**Animal Protection Law
1951- Establishment of the Animal Welfare Institute	**1976-** Law on the Protection of Farm Animals	**2004-**Organic Agriculture Law
1957- Treaty of Rome	**1977-** Law on Animal Transport	**2010-** Veterinary Services, Plant Health, Food and Feed Law
1964- Ruth Harrison: Animal Machinery and Brambell Report	**1988-** Law on Laying Hens	**2011-** Regulation on Welfare and Protection of Animals during Transport
1972- Animal Protection Law	**1991-** Regulation on Transport Times and Animal Densities during Transports	**2014-** Regulation on the Protection of Calves
1974- Animal Slaughter Act	**1991-** Law on Calves and Pigs	-

1978- Universal Declaration of Animal Rights	**1993-** Law on the Protection of Animals during Slaughter	-
1996- Animal Welfare in Transport	**1998-** Farm Animal Protection Act	-
1997- Animal Protection and Welfare	**1998-** Amsterdam Treaty	-

7. WELFARE OF EXPERIMENTAL ANIMALS

Like every living thing, experimental animals have needs. When these needs arise, certain psychological and physiological mechanisms are triggered in the animal's body to respond. If the response to the need is not sufficient, the physiological and psychological stability of the animal is disrupted, and a lack of motivation occurs. As a result, animal welfare shifts in a negative direction. Animal welfare is also an indicator of the animal's resistance to changing environmental conditions. The welfare of the animal that cannot resist the conditions gradually decreases. Events such as pain, disease, damage to the body are other factors that reduce animal welfare.

Another concept that should be mentioned together with welfare is well-being. Well-being is a state that is not continuous and allows coping with environmental conditions for a short period of time. Well-being sometimes occurs in order to ensure welfare. An animal undergoing surgical intervention due to disease has impaired well-being, but the main purpose of this procedure is to provide animal welfare by treating the disease. Animal welfare is related to well-being and health. Therefore, both concepts are considered when assessing welfare.

7. 1. Assesing Animal Welfare

It is very difficult to understand the welfare of experimental animals as they do not have the chance to express their problems and wishes (Mason and Mendi, 1993). Welfare and well-being are not just about good health, but also about the psychological state of the animal. While it is possible to determine the health status objectively, subjective opinions may be involved in the evaluation of the psychological state. Therefore, a complete definition or evaluation of well-being cannot be made. However, it is possible to evaluate the situation with the following questions (Dawkins, 2003):

1) Is the animal healthy?

2) Does the animal have what it wants?

With the answers to these questions, the state of animal welfare and the direction in which it is moving can be determined.

7. 2. Use Of Experimental Animal

There are two important criteria for the use of experimental animals in scientific research:

1) It has been determined that results cannot be obtained by alternative methods (cell culture, computer modeling, etc.) before the use of experimental animals in the research, and the use of experimental animals has become mandatory.

2) The benefit to be obtained by using the experimental animal is superior to the suffering or even killing of the animal.

Meeting these criteria does not mean that the welfare of the experimental animal and the minimization of its discomfort are ignored. On the contrary, it brings with it the legal and ethical supervision of these two concepts (Baumans, 2004b). Only by ensuring the welfare of the experimental animal can we talk about the accuracy and precision of the data obtained as a result of the experiment. The welfare of experimental animals encompasses five fundamental freedoms that have become essential for animals in other conditions but are also applicable to experimental animals (Brambell, 1965). These are:

1) Freedom from thirst, hunger, and malnutrition: The experimental animal cannot be dehydrated or starved. It should be fed a balanced diet unless the experiment requires it.

2) Freedom from disturbance: The animal should be kept away from any situation that may affect its welfare. Housing should be organized according to the specific needs of the animal. Social animals should be housed in specific groups, in a certain number of shelters.

3) Freedom from pain, injury and disease: The health of the experimental animal should be monitored and protected from possible diseases. It is the duty of the researcher and the staff responsible for care to take preventive decisions for this. If the experimental study requires a surgical procedure, unless otherwise stated, the pain and suffering of the animal after the operation should

be minimized. Injuries caused by biting or scratching of animals living together should also be treated as soon as possible.

4) The state of expressing normal behavior: Housing and environmental conditions should be arranged so that the experimental animal can exhibit its natural movements and feel comfortable.

5) Freedom from stress and fear: In order to prevent the stress and fear that the animal will be exposed to during the experimental procedures, the environment should be prepared and experienced personnel who are experts in their field should perform the procedures.

The characteristics of the facilities where the production, housing, and care of experimental animals are provided are determined by the relevant authority of each country's laws and regulations. Accordingly, the entire facility plan is expected to be in accordance with these instructions, from the sections that the facility should have to where the offices should be located. In addition, all equipment (cages designed according to species, litter materials, feeds, materials to be used for cleaning, etc.) that may be required during care, housing, and experimental phases should be available in the facility and ready for use by expert facility personnel (Smith et al., 2018).

The conditions of the environment where experimental animals are kept should be in conditions that can ensure animal welfare. Accordingly, the ambient temperature should be kept at an optimum level for each species. Good ventilation ensures the circulation of fresh air and eliminates animal-induced heat in the environment. Lighting should be adjusted to create a light-dark phase in rooms without windows that do not see the outside. Avoid excessive humidity and noise to avoid stress for the animals.

The welfare of the experimental animal depends on different and important conditions such as housing, care, and the ability to express itself under stressful conditions. Although these animals are confined in species-specific designated places, they want to react in the same way as if they were living in the same conditions as their free relatives (Olsson and Dahlborn, 2002). For this reason, the environment in which the experimental animal lives should be designed in such a way that it can perform activities such as sleeping, feeding, research, exploring, exploring, nesting, social relationships, and hiding when necessary, against stress conditions.

Housing experimental animals in an environment with relatively simple control is actually a factor that reduces welfare. The restriction of their housing environment and food intake causes changes in the behavior and physiology of these animals. These changes also affect the life span and quality of the animal (Baumans, 2004b). For example, some species, such as rabbits, which are highly sensitive to predators in their natural habitat, want to hide to protect themselves as a result of an unfamiliar stimulus. If there is no opportunity to do so in their environment, they try to escape, bite or remain immobilized (Holgate, 2010).

One of the ways to increase the physical and psychological welfare of experimental animals is to enrich the animal's shelter in a species-specific way. In this way, the animal, which must be kept in its shelter, is given the opportunity to react to different environmental stimuli as if it were in its natural environment (Novak and Suomi, 1988; André et al., 2018).

In shelters that are easily predictable and easy to control, it is natural for animals to become bored and show aggressive behavior. To prevent this, nesting materials such as tubes and tissue paper should be placed inside the shelter to arouse curiosity (Kostomitsopoulos et al., 2017; Leidinger et al., 2019).

Social relationships have an important place in the welfare of experimental animals. Animals should be allowed to socialize as long as it does not disrupt the experimental planning. In this way, it is also possible to form groups and repeat the same movements as a group (Kappel et al., 2017).

7. 3. Housing Systems According To Species Needs

7.3.1. Rodents

Rodents such as mice, hamsters, rats and gerbils can sleep, hide from external stimuli, gather as a group or reproduce in the habitat they create using nesting material (Patterson-Kane, 1999; Baumans, 2005; Kirchner et al., 2012). Therefore, the material to be used in the cage should be usable for these purposes.

7.3.2. Mice

The welfare of the mice can be determined by the nest building in the cage. If the number of nests decreases, the mice have a problem. Mice are very sensitive and will become aggressive if they can't find suitable material. This directly affects their learning and memory skills. They generally prefer tissue paper as a material (Leidinger et al., 2019). At the same time, it has been observed that different materials that arouse curiosity or reward (tubes, gnawing sticks) increase the level of well-being (Baumans, 2005).

7.3.3. Rats

As they are natural prey animals, they are highly sensitive to external stimuli. For this reason, they hide during the day and become active at night. They are social animals. However, if they have not learned to build a nest from their mother, they will chew and eat even if there is material in the environment (Hutchinson et al., 2005). They prefer materials that can be chewed and nest boxes that are not exposed to light.

7.3.4. Guinea pigs

Guinea pigs, which are social animals like mice and rats, cannot build nests. However, they can live in nests built by other animals. Straw is sufficient as a nest substrate. As they are timid animals, there should be places where they can hide in their habitat. Females should be kept in groups and males in pairs if possible (Kaiser et al., 2010).

7.3.5. Hamsters

Except for mating, they prefer to live alone. To keep them in groups, socially compatible individuals should be brought together. They can build nests and even dig them. A hiding place, rough nesting material and different objects for gnawing should be kept in the cage.

7.3.6. Rabbits

The height of the cage should be increased to ensure that they can perform their natural movements such as standing on two legs and jumping in the cage. Instead of confining the rabbits in individual cages, the cages should be connected to each other to provide a social communication environment.

Roughage and chewing sticks should be available in the cage environment (Kostomitsopoulos et al., 2017). In addition, by elevating an area in the cage, the rabbit is provided with a retreat area.

7.3.7. Dogs

They should be housed in social groups of compatible individuals. Since chewing is an important activity in dogs, chew toys made of durable materials should be available in the cage. Since dogs, like rabbits, want to dominate their surroundings, a platform in the cage can fulfill both this desire and the need for a place to play and rest (Baumans and Van Loo, 2013).

7.3.8. Cats

Thanks to their high sense of smell and sight, they avoid physical confrontation or hide. Cats like to live alone, but they can also live in pairs in a group. Like rabbits and dogs, cats have a desire to dominate their environment. For this reason, it is preferable to have a platform with resting and observation places at different heights in the cage (Stella and Croney, 2016). Cats' instinct to avoid conflict also requires a hiding place in the cage.

7.3.9. Mini pigs

They are social and curious animals. It is possible for them to live in groups. Keeping only males together during the mating season can cause injuries. The shelter should be supported with plenty of hay and dry grass. Curiosity can be satisfied with toys that can be taken as a reward (Holtz, 2010).

7.3.10. Geese

Geese are among the first poultry domesticated by humans. They are widely regarded as the birds with the highest levels of intelligence. Their memories are incredibly strong; they do not forget what they have lived through, the people and animals they faced (Weiß et al., 2013). They usually gather in groups known as herds and are able to live harmoniously with a variety of different species. Traditionally, geese spend their evenings in shelters and their days in meadows, grassland, and wetlands (Sarı et al., 2021).

7.3.11. Sheep

Sheep are known as social livestock for farming and were among the first species that humans domesticated. Common behavioral traits include a strong mother-child attachment between the offspring and the mother, staying with the herd, getting to know each other in the herd, being vigilant and careful all the time, and spontaneous mating (Keeling et al., 2001). Sheep have been identified as ruminant creatures. For this reason, they have a heat-producing rumen and are not affected by low temperatures. Even though the temperature in their living spaces is low, they should be provided with a shelter that will prevent them from being affected by rain, snow, and mud. In addition, air circulation must be provided to eliminate moisture and infection problems (Arney, 2009).

7. 4. Livestock Welfare

The branch of science that studies the attitudes and behaviors of animals in their natural habitats is known as ethology. The part of ethology based on observing the natural behavior of farm animals is called applied ethology. Applied ethology not only observes individual attitudes and behaviors but also examines the behavior of animals in groups or herds (Bueno-Guerra, 2021). With the domestication of animals, changes have occurred in their behavior due to the nature of domestication, care, and feeding (Valeriy, 2014). In addition, the fact that the amount of food the animal can eat and the amount of water it can drink have been measured causes stress in the animal (D' Eat et al., 2010) Stress is an event that directly affects the welfare level negatively. In this case, the effect of emotional state changes on welfare is also observed (Swaisgood, 2007).

Since the determination of animal welfare does not only depend on the animal's physical condition, the psychological state of the animal also gains importance. The ability of the animal to respond to environmental conditions and stimuli in the most natural way depends on the enrichment of the environment in which it lives (Spinka, 2012). In this way, the farm animal will feel itself in its natural environment, and abnormal behaviors that may occur if it does not feel itself in its natural environment will be prevented. Every animal that can feel itself in its natural environment and exhibit its natural behaviors will have the opportunity to move more and will have a healthier body. In this way, the life span will also be extended (Rutherford et al., 2004). Determining the welfare of farm animals requires a combination of different methods and approaches. Animal welfare can be predicted by controlling animal behavior according to these practices (Fraser, 2009).

Human-animal interaction, which is accepted as one of the environmental conditions, is another factor affecting animal welfare. This situation is directly related to the animal's perspective on humans. Accordingly, the animal may perceive the human as a friend or as a creature that will harm itself. The stress and fear that may occur will cause a decrease in animal welfare and productivity (Mota-Rojas et al., 2020). As a result of the decrease in welfare, animal deaths, a decrease in fertility, and abnormal behaviors may be encountered. Socialization of the animal with humans increases the welfare level and contributes to an increase in productivity and the physical and mental health of the animals (Brake and Hopster, 2006).

Ignoring the welfare of farm animals and going to intensive breeding causes abnormal behaviors in animals. Considering the welfare of social animals such as farm animals will both contribute to the breeders' economic well-being and increase the well-being of the animals raised.

8. CONCLUSION

Throughout the human history, animals have been used for various purposes. With the use of animals in scientific studies, many ethical debates and problems have arisen. In order to solve these problems, many national and international regulations have been put into effect. In order to eliminate these problems, it may be aimed at preventing the use of experimental animals in experimental studies, but today, although there are many alternative methods, it is inevitable to use animals in some experiments. Therefore, the fact that animals are used in experiments in many disciplines is undeniable. Today, rules and regulations are constantly updated in order to improve the living conditions of the subjects, prevent the animals from suffering when the experiment is terminated, and ensure the sustainability of the scientific work.

Although animal rights try to protect animals, they cannot prevent the use of animals in experimental studies. In order to reduce the use of experimental animals, it is ensured that animals are used within the framework of ethical and welfare rules. The most important issue that scientists should pay attention to is ensuring the welfare of animals by acting in accordance with the regulations and laws mentioned in the use of experimental animals and applying these rules by internalizing them.

REFERENCES

André V, Gau C, Scheideler A, Aguilar-Pimentel JA, Amarie OV, Becker L, et al. (2018). Laboratory mouse housing conditions can be improved using common environmental enrichment without compromising data. PLoS Biol 16(4): e2005019.

Arney, D. R. (2009). Sheep behaviour, needs, housing and care. Scandinavian Journal of Laboratory Animal Science, 36(1), 69-73.

Atasoy, F. (2011). Hayvan refahının tanımı, önemi ve yetiştiricilikte refahın değerlendirilmesi. Anadolu Üniversitesi Yayını, (2332), 108.

Altınçekiç, Ş. Ö., and Koyuncu, M. (2010). Nakil koşullarının hayvan refahı üzerine etkileri. Hayvansal Üretim, 51(1).

Altuğ T. (2009). Hayvan Deneylerinde Etik. Sağlık Bilimlerinde Süreli Yayıncılık, 53-68.

Altun, A., and Keskin, İ. (2020). Hayvan çalışmalarında uygun model seçim kuralları ve etik durum. Sakarya Tıp Dergisi, 10(2), 359-364.

Appleby, MC., Mench, JA., and Hughes, BO. (2004). Poultry behaviour and welfare. Trowbridge: Cromwell Press, pp.118-208.

Balkan, A., and Balkan, M. (2013). Legal requirements involving ethics in animal research, laboratory standardisation, and animal care. Türk Toraks Dergisi/Turkish Thoracic Journal, 14(Supplement 2), 6-9.

Baumans, V. (2004a). Use of animals in experimental research: an ethical dilemma? Gene Ther 11 (Suppl 1), S64–S66.

Baumans, V. (2004b). Methods for Evaluation of Laboratory Animal Well-being. Alternatives to Laboratory Animals. 32(1_suppl):161-162.

Baumans, V. (2005). Environmental Enrichment for Laboratory Rodents and Rabbits: Requirements of Rodents, Rabbits, and Research, ILAR Journal. 46(2): 162–170.

Baumans, V., and Van Loo, P. (2013). How to improve housing conditions of laboratory animals: The possibilities of environmental refinement. The Veterinary Journal, 195(1), 24–32.

Bracke, M. B. M., and Hopster, H. (2006). Assessing the Importance of Natural Behavior for Animal Welfare. Journal of Agricultural and Environmental Ethics, 19(1), 77–89.

Brambell Committee (1965). – Report of the Technical Committee to enquire into the welfare of animals kept under intensive livestock husbandry systems. Command paper 2836. Her Majesty’s Stationary Office, London.

Brydges, N. M., Leach, M. J., Nicol, K., Wright, R. N., and Bateson, M. (2011). Environmental enrichment induces optimistic cognitive bias in rats. Animal Behaviour, 81(1), 169–175.

Bueno-Guerra, N. (2021). Where Is Ethology Heading? An Invitation for Collective Metadisciplinary Discussion. Animals, 11, 2520.

Budak, Ş. Ö., and Dönmez, S. (2012). Gıda Biliminde Yeni Omik Teknolojileri. Gıda, 37(3), 173-179.

Commission Implementing Decision, (2012). 2012/707/EU of 14 November 2012 establishing a common format for the submission of the information pursuant to Directive 2010/63/EU of the European Parliament and of the Council on the protection of laboratory animals used for scientific purposes (OJ L 320, 17.11.2012, p. 33).

Commission Implementing Decision, (2014). correcting Annex II to Implementing Decision 2012/707/EU establishing a common format for the submission of the information pursuant to Directive 2010/63/EU of the European Parliament and of the Council on the protection of animals used for scientific purposes (2014/11/EU).

Conner, Annastasia (2017). Galen’s Analogy: Animal Experimentation and Anatomy in the Second Century C.E. Anthós: Vol. 8: Iss. 1, Article 9.

Council of Europe (1986). European Convention for the Protection of Vertebrate Animals used for Experimental and Other Scientific Purposes, ETS No. 123, 3 pp. Strasbourg, France: Council of Europe.

Davies, G., Greenhough, B., Hobson-West, P., and Kirk, R. G. W. (2018). Science, Culture, and Care in Laboratory Animal Research. Science, Technology, and Human Values, 43(4), 603–621.

Dawkins, M. S. (2003). Behaviour as a tool in the assessment of animal welfare. Zoology. 106: 383-387.

D’Eath, R., Conington, J., Lawrence, A., Olsson, I., and Sand∅e, P. (2010). Breeding for behavioural change in farm animals: practical, economic and ethical considerations. Animal Welfare, 19(S1), 17–27.

Ergün, Y. (2010). Hayvan deneylerinde etik. Arşiv Kaynak Tarama Dergisi, 19(4), 220-235.

Erkekoglu, P., Giray, B. K., and Basaran, N. (2011). 3R principle and alternative toxicity testing methods. Fabad J Pharm Sci, 36(1), 101-17.

European Commission. (2010). Directive 2010/63/EU of the European Parliament and of the Council of 22 September 2010 on the protection of animals used for scientific purposes. Off. J. Eur. Union, 50, 33-79.

Fraser, D. (2009). Animal behaviour, animal welfare and the scientific study of affect. Applied Animal Behaviour Science, 118(3–4), 108–117.

Fidan, E. D. (2012). Türkiye'de çiftlik hayvanları ile ilgili refah uygulamaları. Animal Health Production and Hygiene, 1(1), 39-46.

Furchgott R. F. (1999). Endothelium-Derived Relaxing Factor: Discovery, Early Studies, and Identifcation as Nitric Oxide (Nobel Lecture). Angewandte Chemie (International ed. in English), 38(13-14), 1870–1880.

Government of India Ministry of Fisheries, Animal Husbandry and Dairying Department of Animal Husbandry and Dairying, (2020). Guidelines of CPCSEA for Reuse/Rehabilitation of Large Animals post experimentation.

Grieder FB, Strandberg JD. in Hau J, Van Hoosier Jr GL. (2003). The Contribution of Laboratory Animals to Medical Progress-Past, Present, and Future. In: Hau J, Van Hoosier Jr GL, Handbook of Laboratory Animal Science. Volume I Essential Principles and Practices 2nd ed. USA CRC PRESS; p. 1-13.

Hajar R. (2011). Animal testing and medicine. Heart views: the official journal of the Gulf Heart Association, 12(1), 42.

Hartung, T. (2010). Comparative analysis of the revised Directive 2010/6106/EU for the protection of laboratory animals with its predecessor 86/609/EEEEC – a t4 report", ALTEX - Alternatives to animal experimentation, 27(4), pp. 285–303.

Henry J. Baker, J. Russell Lindsey. (2002). Research in Laboratory Animal and Comparative Medicine. In: James G. Fox, Lynn C. Anderson, Franklin M. Loew, Fred W (ed). Laboratory Animal Medicine. Academic Press. Amsterdam, Netherlands, 2nd ed., pp 1228-1237.

Hickman, D. L., Johnson, J., Vemulapalli, T. H., Crisler, J. R., and Shepherd, R. (2017). Commonly used animal models. Principles of animal research for graduate and undergraduate students, 117.

Holgate, B. (2010). Planning, Design and Construction of Efficient Animal Facilities. In The UFAW Handbook on the Care and Management of Laboratory and Other Research Animals (eds R. Hubrecht and J. Kirkwood).

Holtz, W., 2010. Pigs and mini pigs. In: UFAW Handbook on the Care and Management of Laboratory Animals, Eighth Ed. Wiley-Blackwell, Oxford, UK, pp. 473–494.

Horgan, R. P., and Kenny, L. C. (2011). "Omic" technologies: genomics, transcriptomics, proteomics and metabolomics. The Obstetrician and Gynaecologist, 13(3), 189–195.

Hutchinson, E., Avery, A., and VandeWoude, S. (2005). Environmental Enrichment for Laboratory Rodents. ILAR Journal, 46(2), 148–161.

Kaiser, S., Krueger, C., Sachser, N. (2010). The guinea pig. In: UFAW Handbook on the Care and Management of Laboratory Animals, Eighth Ed. Wiley-Blackwell, Oxford, UK, pp. 380–398.

Kappel, S., Hawkins, P., Mendl, M. T. (2017). To Group or Not to Group? Good Practice for Housing Male Laboratory Mice. Animals 2017, 7, 88.

Kaya, M. and Çevik, A. (2011). Hayvan deneylerinde planlanma ve model seçimi. Deneysel Tıp Araştırma Enstitüsü Dergisi, 1 (2), 36-39.

Keeling, L. J., and Gonyou, H. W. (Eds.). (2001). Social behaviour in farm animals. CABI publishing, pp. 211-238.

Kirchner J, Hackbarth H, Stelzer HD, Tsai P-P. (2012). Preferences of group-housed female mice regarding structure of softwood bedding. Laboratory Animals. 46(2):95-100.

Kolar, R. (2006). Animal experimentation. Sci Eng Ethics 12, 111–122.

Kopnina, H., Washington, H., Taylor, B. et al. (2018). Anthropocentrism: More than Just a Misunderstood Problem. J Agric Environ Ethics 31, 109–127.

Kostomitsopoulos, N., Serafetinidou, M., Katsarou, A., Voyazaki, C., Dontas, I. (2017). Evaluation of an environmental enrichment device used for laboratory rabbits. Journal of the Hellenic Veterinary Medical Society, 66(1), 41–47.

Lee, K.H., Lee, D.W. and Kang, B.C. (2020). The ‘R’ principles in laboratory animal experiments. Lab Anim Res 36, 45.

Leidinger, C. S., Thöne-Reineke, C., Baumgart, N., Baumgart, J. (2019). Environmental enrichment prevents pup mortality in laboratory mice. Laboratory Animals. 53(1):53-62.

MacArthur Clark, JA, Sun, D. (2020). Guidelines for the ethical review of laboratory animal welfare People’s Republic of China National Standard GB/T 35892-2018 [Issued 6 February 2018 Effective from 1 September 2018]. Animal Model Exp Med. 3: 103– 113.

Mandal, J., and Parija, S. C. (2013). Ethics of involving animals in research. Tropical parasitology, 3(1), 4–6.

Marder, M. (2014). For a Phytocentrism to Come. Environmental Philosophy, 11(2), 237–252.

Mason, G., and Mendi, M. (1993). Why is There no Simple Way of Measuring Animal Welfare? Animal Welfare, 2(4), 301–319.

Mota-Rojas, D., Broom, D. M., Orihuela, A., Velarde, A., Napolitano, F., and Alonso-Spilsbury, M. (2020). Effects of human-animal relationship on animal productivity and welfare. Journal of Animal Behaviour and Biometeorology, 8(3), 196–205.

Mushtaq, S., Daş, Y. K., and Aksoy, A. (2018). Alternative methods to animal experiments. Türkiye Klinikleri. Tip Bilimleri Dergisi, 38(2), 161-170.

Newberry, R. C. (1995). Environmental enrichment: Increasing the biological relevance of captive environments. Applied Animal Behaviour Science 44, 229–243.

Novak, M. A., and Suomi, S. J. (1988). Psychological well-being of primates in captivity. American Psychologist, 43(10), 765–773.

Okur, H. (2016). Deneysel araştırma yöntemleri. Çocuk Cerrahisi Dergisi, 30(Ek sayı 1), 7-11

Olsson, I. A. S., Dahlborn, K. (2002). Improving housing conditions for laboratory mice: a review of “environmental enrichment.” Laboratory Animals. 36(3):243-270.

Olsson AS, Robinson P, Pritchett K, et al. (2003). Animal Research Ethics. In: Hau J, Van Hoosier Jr GL. Handbook of Laboratory Animal Science. Volume I Essential Principles and Practices 2nd ed. Usa Crc Press, 13-31.

Oral M, Çakar S. (2005). Deneysel hayvan çalışmalarında etik prensipler. Anestezi Dergisi, 13 (2): 75-82.

Özen, A. (2017). Türkiye'de hayvan refahı mevzuatına tarihsel bir bakış. Kafkas Üniversitesi Veteriner Fakültesi Dergisi. Veteriner Fakültesi Dergisi.

Parija, S., and Mandal, J. (2013). Ethics of involving animals in research. Tropical Parasitology, 3(1), 4.

Patterson-Kane, E. G. (1999). Assessing and Enriching the Cage Environment of Laboratory Rats (Version 1). Open Access Te Herenga Waka-Victoria University of Wellington.

Pereira S, Tettamanti, M. Ahimsa (2015). And Alternatives - The Concept Of The 4th R. Th e CPCSEA in India. Altex., 22(1), 3-6

Government gazette. (2004a). Deneysel ve Diğer Bilimsel Amaçlar İçin Kullanılan Deney Hayvanlarının Korunması, Deney Hayvanlarının Üretim Yerleri İle Deney Yapacak Olan Laboratuvarların Kuruluş, Çalışma, Denetleme, Usul ve Esaslarına Dair Yönetmelik. Tarih: 16 Mayıs 2004, Government gazette Sayı: 25464.

Government gazette. (2004b). 5199 sayılı Hayvanları Koruma Kanunu., Kanun no:5199. Tarih: 01 Temmuz 2004. Government gazette Sayısı: 25509.

Government gazette, (2011) Deneysel Ve Diğer Bilimsel Amaçlar İçin Kullanilan Hayvanlarin Refah Ve Korunmasina Dair Yönetmelik. Tarih: 13 Aralık 2011, Government gazette Sayısı:28141.

Government gazette, (2014). Hayvan Deneyleri Etik Kurullarının Çalışma Usul ve Esaslarına Dair Yönetmelik. Tarih: 15 Şubat 2014, Government gazette Sayısı: 28914.

Rutherford, K., Haskell, M., Glasbey, C., Jones, R., and Lawrence, A. (2004). Fractal analysis of animal behaviour as an indicator of animal welfare. Animal Welfare, 13(S1), S99–S103.

Sarı, M., Boz, M. A., and Saatcı, M. (2021). Current Breeding Techniques in Goose Breeding: A Review: Techniques in Goose Breeding. International Journal of Poultry-Ornamental Birds Science and Technology, 2(1), 11-16.

Schwindaman, D. (1994). Federal regulation of experimental animal use in the United States of America. Revue Scientifique et Technique (International Office of Epizootics), 13(1), 247–260.

Segeritz, C.-P., and Vallier, L. (2017). Cell Culture. Basic Science Methods for Clinical Researchers, 151–172.

Sert, H., and Uzmay, A. (2017). Dünya'da hayvan refahı uygulamalarının ekonomik ve sürdürülebilirlik açısından değerlendirilmesi. Adnan Menderes Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 4(4), 263-276.

Spinka, M. (2012). Social dimension of emotions and its implication for animal welfare. Appl. Anim. Behav. Sci. 138: 170-181.

Smith, A. J., Clutton, R. E., Lilley, E., Hansen, K. E. A., Brattelid, T. (2018). PREPARE: guidelines for planning animal research and testing. Laboratory Animals. 52(2):135-141.

Smith, O. (1998). Nobel Prize for NO research. Nat Med 4, 1215.

Stella, J. L., and Croney, C. C. (2016). Environmental Aspects of Domestic Cat Care and Management: Implications for Cat Welfare. The Scientific World Journal, 2016, 1–7.

Stokes, W. S. (2004). Selecting Appropriate Animal Models and Experimental Designs for Endocrine Disruptor Research and Testing Studies. ILAR Journal, 45(4), 387–393.

Swaisgood, R. R. (2007). Current status and future directions of applied behavioral research for animal welfare and conservation. Appl. Anim. Behav. Sci. 102: 139-162.

Tan, D., and Çobanoğlu, N. (2013). Hukuki ve Etik Boyutuyla Türkiye'de Hayvan Deneyleri. Türkiye Klinikleri Tıp Etiği Dergisi, 21(1), 24-37.

Tannenbaum, J., and Bennett, B. T. (2015). Russell and Burch's 3Rs then and now: the need for clarity in definition and purpose. Journal of the American Association for Laboratory Animal Science: JAALAS, 54(2), 120–132.

Tarım Orman, 'Deney Hayvanları Birimi,' https://vetkontrol.tarimorman.gov.tr/merkez/Menu/94/DeneyHayvanlari-Birimi. [Retrieved: 29.02.2023]

Tüfek, H., and Özkan, Ö. (2018). 4R rule in laboratory animal science. Commagene J Biol, 21(1), 55-60.

Uludağ, Ö. (2019). Hayvan deneyi çalışmalarında etik kuralların tarihçesi ve önemi. Adıyaman Üniversitesi Sağlık Bilimleri Dergisi, 5(1), 1401-1413.

URL-1.https://www.pau.edu.tr/dcuam/tr/sayfa/hayvan-haklari-evrensel-bildirgesi [Retrieved: 02.04.2023]

URL-2. https://www.etimolojiturkce.com/kelime/etik [Retrieved: 22.03.2023]

Uzel İ. (1994). Hayvan Deneyleri Etik Yasası. T Klin Tıbbi Etik; 2: 75-79

Valeriy, G. (2014). Domestication and Genome Evolution. International Journal of Genetics and Genomics, 2(4), 47. https://doi.org/10.11648/j.ijgg.20140204.11

Waymouth, C. (1966). Cell, tissue and organ culture. Biology of the Laboratory Mouse, 435-510.

Weiß, B. M., and Scheiber, I. B. (2013). Long-term memory of hierarchical relationships in free-living greylag geese. Animal cognition, 16(1), 91-97.

Yaman Ö. (2015). Hekimlikte Metabolomik Çalışmalara Genel Bir Bakış. Bahri Dağdaş Hayvancılık Araştırma Dergisi, 3(1), 33-46.

Yaşar, A., and Yerlikaya, H. (2004). Hayvan gönenci-veteriner hekimliği ilişkisi ve Avrupa Birliğindeki yasal düzenlemeler üzerine bir araştırma. Veteriner Bilimleri Dergisi. Eurasian Journal of Veterinary Sciences, 20(4), 17-24.

CHAPTER 2

LEGAL REGULATIONS ON ANIMAL WELFARE

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1. INTRODUCTION

The need for natural resources and food products of animal origin is increasing, depending on the increase in the world population. For this reason, the application of industrial animal breeding techniques is also increasing. In industrial production, especially in the last century, various legal arrangements have been made to improve animal welfare and prevent animals from experiencing stress-induced biological, physiological, and emotional problems. Many countries have started to make legal regulations due to the use of methods that do not comply with animal welfare in activities such as obtaining food from animals in industrial production and using them as a means of entertainment (Menteş Güler and Osmanağaoğlu, 2009). In addition, some countries have added animal rights sanctions to their constitutions (Uran Murphy, 2019). Various scientific studies are carried out to increase efficiency in animal welfare studies, taking into account legal regulations. Various scientific studies are carried out to increase efficiency in animal welfare studies, considering legal regulations. Care is taken to ensure that these studies are practices that consider scientific ethics and animal welfare.

In societies with increasing welfare and education levels, movements to adopt domesticated animals and defend animal rights are becoming widespread. In many countries, studies are carried out to increase public awareness so that animals are not used in experimental studies. For example, the World Organization for Animal Health has put forward specific standards to improve animal welfare and protect animal rights (Garcia, 2017). All countries are expected to implement and legalize these standards. However, only some countries meet the criteria, excluding developed countries and predominantly European countries. Despite this, in recent years, necessary steps have been taken to in0crease animal welfare in underdeveloped and developing countries with no adequate legal regulation or scientific studies on animal rights. It is significant to protect farm animals, domestic animals, and wild animals, to make legal arrangements that will increase the welfare of animals in all countries, and to protect the natural balance and sustainable life. The issue of which standards should include animal welfare and rights is also very important.

2. ANIMAL WELFARE AND ANIMAL RIGHTS

Animal welfare can be defined as the examination of scientific practices and legal regulations as a whole, which are put forward to prevent inappropriate methods used to obtain more efficiency from animals and to avoid using animals as a means of entertainment (Şanlı, 2018). Meeting animals' physiological and behavioural requirements and leading a stress-free life is an essential animal welfare condition. The concept of animal welfare is defined as ensuring that animals live in ideal conditions, away from suffering, malnutrition, and housing conditions, and that they are able to exhibit their natural behaviour (Arslan and Related, 2022). There is a need for legal regulations and sanctions to ensure and sustain animal welfare. Laws and regulations are prepared to recognize that animals have rights and to ensure that these rights are legally binding.

While determining the scope of animal rights, important factors such as protecting animals, not mistreating them, respecting their lives, living in accordance with their natural life and killing without suffering when necessary, transportation in appropriate conditions, meeting nutritional needs, and preventing animal abuse should be taken into account (Neumann, 2012; Phillips and Kluss, 2018; Arslan and İlgili, 2022).

People's thoughts about animal rights and therefore animal welfare have changed and developed over the centuries. Philosophers such as Aristotle, Descartes, and Kant claimed that animals could be used for the benefit of humanity because they do not suffer and do not have a will like humans; philosophers such as Arthur Schopenhauer and Jeremy Bentham stated that animals could suffer; J. Locke pointed out that it is immoral to torture animals; and Darwin argued that animals have feelings and behaviours unique to them, just like humans. In the 1700s-1800s, the idea of using animals as an experimental tool was adopted to achieve developments in the medical field (Yaşar and Yerlikaya, 2004). With the Industrial Revolution, the increase in industrial production led to the use of animals for experiments and the adoption of cruel and unethical practices to increase the yield of animal products. However, since the 19th century, it has been thought that the treatment of animals is wrong and that they have the right to life. It can be said that the term "bioethics," which was introduced soon, contributed significantly to the development of this understanding (Akbulut and Çobanoğlu, 2020). Bioethics is a concept introduced by V.R. Potter in 1970. It can be defined as a concept that covers all current and future people and living things and works on legal, scientific, and philosophical studies about living things within biological and ethical rules (Potter, 1970). Adopting bioethics has helped us understand that other living things, like humans, must have their own unique requirements and living conditions.

Since animal welfare and rights are directly related issues, their development progresses in parallel. Giving legal rights to animals necessitates the improvement of animal welfare, as it introduces sanctions.

3. HISTORICAL DEVELOPMENT OF LEGAL REGULATIONS FOR ANIMAL WELFARE

The invention of writing enabled people to record their relationships with animals. The first written legal sources including animals in known history are given in the Ur-Nammu Laws (2100 BC), Lipit-Ishtar (1925 BC), Eshnunna Laws (1920 BC), and Hammurabi Laws (1728 BC) (Wise, 1995, p.477). These laws include regulations on how people will seek their rights in the event that animals are bought and sold as goods and stolen or killed.

In time, the perspective towards animals has developed, and it has been thought that animals have habitats and rights as living things. In 1640, a legal arrangement was made by the British colony (Massachusetts) in America to prevent cruelty to animals (Francione, 1993). The first regulation for the protection of animals and their rights, as adopted by many countries, was established in 1822 by the "Animal Protection Association" in the United Kingdom under the leadership of R. Martin, "An Act to prevent the cruel and improper Treatment of Cattle" (Appleby et al., 2004; Robertson, 2015). This regulation mainly contains statements for the prevention of cruelty to farm animals. Then, with the "Grammont Law" published in France in 1850, it became legal regulation to punish those who abuse animals for the first time (Santana and Oliveira, 2006). Laws were enacted in Austria in 1855 to prevent cruelty to pets, in Portugal in 1886 to punish those who injure and torture animals, in Germany in 1871 to prevent animal torture, and in Hungary in 1873 to punish those who torture animals (Santana, 2006; Uran Murphy, 2019).

The world wars in the first half of the 20th century, as with almost every other issue, caused the studies to improve animal welfare and rights to be neglected. The only significant development in this period was the "Animal Protection Law" enacted in Europe in 1911 (Sert and Uzmay, 2017).

4. DEVELOPMENT OF ANIMAL RIGHTS IN THE RECENT

After the wars, the first comprehensive legal regulation on animal welfare was introduced by the European Community in 1957 with the Treaty of Rome. Then, in 1965, R. Brambell published the "Report of the Technical Committee on the Welfare of Animals Kept Under Intensive Livestock Keeping" to improve the welfare of farm animals in the United Kingdom (Brambell, 1964). In 1978, the "Universal Declaration of Animal Rights" was announced to the whole world by UNESCO and it was stated that it was an obligation for animals to have rights. Also in 1978, the "European Convention on the Protection of Farm Animals" was signed by the European Union (Yaşar and Yerlikaya, 2004). In 1979, in the United Kingdom, the "Welfare of Farm Animals" report was presented, which stated five areas of freedom to improve animal welfare, such as not leaving animals hungry or without food, providing suitable shelter, protection from pain and disease, and freedom from fear and stress (Arslan & Related, 2022). In 1988, the regulation on the "Protection of Animals Used for Experimental and Scientific Purposes" published by the European Commission made positive contributions to the improvement of animal rights. Many scientists have contributed to the emergence of these regulations, which can be seen as a milestone in the development of animal welfare and rights. In 1975, Australian philosopher P. Singer, in his book "Animal Liberation", stated that animals are beings that need to be protected and that animal rights are an important ethical issue (Singer, 2005). In addition, other scientists Scruton and Hursthouse stated that when regulating people's relations with animals, it is necessary to act in accordance with animal nature and treat animals in accordance with ethical values (Scruton, 2006; Hursthouse, 2006; Zeybek et al., 2021).

Although there were superficial legal regulations on issues such as providing ideal living conditions for all animals and avoiding torture until the

1980s, more detailed legal regulations have started to be made for the needs of animal species since the 1990s.

It is known that since the 1990s, animal welfare has been stripped of its conceptual structure and accepted as science by scientists such as Broom, Duncan, and Dawkins (Broom, 2011). Also, in recent years, the number of countries that contribute to legal regulations, in addition to the work of scientists to increase animal welfare, has been growing.

Table 1. Countries that have animal rights clauses in their laws (Sinmez, 2022)

Countries	Law Clauses	Law Contents
Germany	Article 20a	The state protects animals by law and judicial decisions for the benefit of future generations.
Avusturia	Article 11/1(8)	Animals are protected within the framework of legal provisions.
Brazil	Article 24(4), 225(8)	Sanctions will be applied to prevent animal abuse and extinction.
Gambia	Article 254(1)-e, 254(4)-b	The state imposes legal sanctions to improve the welfare of animals and to prevent and protect animal abuse.
India	Article 48, 48A, 51A(g)	It includes laws specifically to prevent the killing and torture of cattle and wild animals.
Switzerland	Article 78,79,80,120(2)	Protection of wild and endangered animals, animal welfare improvement, and genetic diversity protection are protected by law.
İzland	Article 36	The prevention of animal cruelty and the protection of endangered animals are guaranteed by law.
Libya	Article 190	Protecting land and sea creatures is under the state's guarantee.
Malaysia	Article 73, 74	Protection of wild animals and natural life and prevention of exploitation of animals is prohibited.
Mexico	Article 122 (5)-1	The authority to protect animals is given to legal representatives.
Egypt	Article 30, 45	The protection of endangered animals and livestock and the prevention of torture of animals are protected by the constitution.
Papua New Guinea	Article 4	The state makes legal arrangements to protect all animals.

Table 2. Countries Whose Laws Contain Provisions For The Protection of Animals (Sinmez, 2022)

Andora	Article 31	Protecting animals and the natural environment is one of the constitution's requirements.
Angola	Article 39	The Constitution is obliged to protect animal species and ecology.
Azerbaijan	Article 39/(4)	The state's responsibility is to protect animal species and natural balance.
Bahrain	Article 9	Protecting animals in their natural life area is the state's responsibility.
Bangladesh	Article 18A	The state is responsible for conserving forests, biodiversity, and wild animals.
China	Article 9	The state must protect rare and endemic animals.
Croatia	Article 52	The law guarantees the protection activities of animals, forests, and the environment.
Cuba	Article 27	The protection of animals and the natural environment is the responsibility of the state and the public.
Ecuador	Article 14	Conservation of animals and biodiversity is the responsibility of the state.
Guatemala	Article 97	The state is responsible for the protection of animals and the protection of natural life.
Guyana	Article 36	The protection of animals and natural life is the responsibility of the state.
Haiti	Article 253, 257	Sanctions and penalties for protecting animals and the natural environment are the state's responsibility.
Hungary	Article 1(1)	The state and the public have to protect animal species.
Ivory Coasts	Article 40	Responsibility for the protection of animal species belongs to the state.
Kosovo	Article 52	Conservation of animal species is the responsibility of the state.
Kyrgyzstan	Article 12(5), 48(3)	Animals and the natural environment must be protected and guaranteed by the state.
Lithuania	Article 54	Wildlife and its conservation are the responsibility of the state. The penalty for killing an animal is imprisonment.

Table 2. Countries Whose Laws Contain Provisions For The Protection of Animals (Sinmez, 2022) (Continued)

Macedonia	Article 56	The state must protect animal species.
Mauritania	Article 57	The protection of animal species is the duty of the state.
Mongolia	Article 6	Protecting animals and the natural environment is the people's and the state's duty.
Nepal	Article 51(5)	The protection of animals and natural life is the responsibility of the state.
Nigeria	Article 20	The state is responsible for the protection of forests and wildlife.
Panama	Article 296	Care should be taken to protect animals and other species.
Serbia	Article 97(9)	The state is responsible for the protection of animal species.
Slovakia	Article 44(4)	Conservation of wild animals and their biodiversity is the responsibility of the state.
Sweden	Article 2	The protection of animals and the prevention of violence against animals are guaranteed by law.
The Dominician Republic	Article 16,66	Protecting wild animals and ecological balance is the state's responsibility.
Turkmenistan	Article 14	The protection of animals is the responsibility of the state.
U. Arab Emirates	Article 121	The protection of animals is the responsibility of the state.
Uganda	Article 27	Conservation of animal species and biodiversity is the responsibility of the state.
Uzbekistan	Article 55	The state is responsible for the protection of animals.
Yemen	Article 40,379,382,383	It is the state's responsibility to protect aquatic life, biodiversity, and migratory birds and to prevent overfishing.

As specific examples of efforts related to animal rights and welfare, one can mention the "Egg and Poultry Marketing Standards" introduced by the European Union in 1990, "European Symposium on Poultry Welfare" held between 1989 and 1993, the "Transport of Animals During Transport" Treaty among EU member states in 1996, the "Protocol on the Protection and Welfare of Animals," also known as the Amsterdam Treaty of 1997, the "Farm Animal Welfare Act" enacted in 1998, regulations concerning the "Protection of

Animals for Slaughter" from 1988, and the "Regulation on Animals in Zoos" issued in 1999. (Rowan et al., 1999; Yaşar and Yerlikaya, 2004; Yaşar, 2005; Antalyalı, 2007). Apart from this, arrangements have been made in the existing legal regulations of the Treaty of Rome, signed in 1957, to improve the welfare of animals over the years. In 1991 and 1997, the "Commission Decision on the Conservation of Calves" was published by the European Union, and in 1999, the Commission decision containing the regulations on the protection of farm animals was published (Yaşar and Yerlikaya, 2004). Thanks to technological developments, new studies to increase animal welfare also cause the welfare improvement criteria to be updated. Additionally, the welfare of animals in transport conditions needs to be improved in recent years, when global trade and the need for reliable animal-derived food have increased. Since the legal regulations on these issues need to be improved and expanded, many legal restrictions have been made in recent years.

5. CURRENT LEGAL REGULATIONS ON ANIMAL WELFARE AND ANIMAL RIGHTS IN THE WORLD

In recent years, with the increase in global trade and the demand for reliable animal-derived food products, there has been a growing need to improve the welfare of animals during transport. Many legal measures have been implemented to address this and other aspects of animal welfare. For instance, the "Regulation on the Protection of Animals during Transport" issued in 1995 and the "Law on the Protection of Animals during International Transport" published in 2004 play a crucial role in ensuring that animals are treated humanely during transport (Yaşar and Yerlikaya, 2004).

OIE is an international organization that conducts international activities dedicated to safeguarding the health and welfare of animals. In 2002, they introduced regulations aimed at setting global standards for animal welfare, taking into account the essential needs of animals (Escobar et al., 2018).

Moreover, the enactment of a law in Germany in 2002, which recognized equal rights for animals and humans spurred increased awareness in other countries. Austria, for instance, initiated legal studies to protect animals, following regulations similar to those in Germany (Natrass, 2004; Uran Murphy, 2019). While many countries have general legal regulations pertaining to all animals, some nations have implemented specific rules to enhance the welfare and rights of farm animals.

For instance, in England, regulations have been implemented to improve farm animal welfare, including provisions for suitable shelter, adequate nutrition and water, stress reduction, and environments that allow animals to exhibit natural behaviours (Kaplan and Boztepe, 2011; Fidan, 2012). In Australia, a key player in the global livestock industry, mandatory rules are enforced in all states to enhance animal welfare. Penalties, including fines and legal sanctions, are applied in cases of animal cruelty and non-compliance with welfare standards (Morton et al., 2020).

In New Zealand, the "Animal Welfare Law" has been enacted to protect domestic and stray animals, as well as experimental and farm animals (Zeybek et al., 2021). In 2004, Italy and Sweden implemented laws that punish animal cruelty with imprisonment and fines. Similarly, Lithuania in 2010 and Hungary in 2012 passed penal laws that impose fines and imprisonment for acts that cause suffering and ill-treatment of animals, negatively affecting animal welfare.

Turkey is another country actively developing animal rights and welfare within a legal framework. The "Animal Protection Law" enacted in Turkey in 2004 serves as the legal foundation for all scientific and legal efforts to improve animal welfare and protect animals (Official gazette[1], 2004). Furthermore, The "Regulation on Health Conditions and Protection Against Diseases of Aquatic Animals" published by the EU Commission in 2006 and 2008 has announced significant decisions regarding the health and welfare improvement of fish and other marine organisms (Sağlam, 2017)." In 2010, several states including Louisiana, Nebraska, Iowa, and Alaska enacted laws classifying animal fighting, torture, and killing as criminal offenses, while in the same year, Nebraska introduced legislation imposing criminal penalties for the torture of horses and farm animals (Wisch, 2011).

6. HISTORICAL DEVELOPMENT OF ANIMAL RIGHTS FOR ANIMAL WELFARE IN TÜRKİYE

The first studies on protecting animals on Turkish land were included in the Bursa İhtisap Law enacted during the Ottoman Empire. In this law, If animals are injured, it is stated that measures should be taken to improve them and to prevent excessive load carrying as draft animals (Güler and Osmanağaoğlu, 2009). Moreover, in the "Regulations on the Streets" issued in 1859, slaughtering of animals outside the slaughterhouses and improper slaughtering of old animals were prohibited (Ergin, 1995; Güler and Osmanağaoğlu, 2009). In the period of the Turkish Republic, the "Animal Breeding Law," published in 1926, was the first important development in which modern Turkiye legally recognized animal rights (Official gazette, 1926). Until the 1990s, while the practices on animal welfare and rights in Turkiye were based on the old law and the penal code, the legislation published by the European community on animal welfare and rights was implemented in the process of harmonization with the European Union.

Legislations implemented by Turkiye by European Union standards to increase animal welfare:

• 15 June 1989 and under issue number 20081 "European Convention for the Protection of Animals during International Transport",

• 15 September 2000 and numbered 24171"Communiqué on the Licensing and Inspection Procedures and Principles of Animal Markets"

• 22 July 2003 and under issue number 25176 "Law on the Ratification of the European Convention for the Protection of Pet Animals,"

• 5th March 2004 and numbered 25393 "Regulation on the Establishment, Operation and Inspection Procedures and Principles of Livestock Enterprises" and "Draft Regulation on Procedures and Principles on Qualifications of Inspection Personnel, Audit and Monitoring"

• 1st July 2004, and numbered 25509 "Animal Protection Law",

• 12 May 2006 and numbered 26166 "Implementation Regulation on the Protection of Animals"

• 13 December 2011 and numbered 28141 "Regulation on the Welfare and Protection of Animals Used for Experimental and Other Scientific Purposes",

• 23 December 2011 and under issue number 28151 "Regulation on the Welfare of Farm Animals",

• 22 November 2014 and under issue number 29183 "Regulation on General Provisions Concerning the Welfare of Farm Animals",

• 8 July 2019 and under issue number 30825 "Regulation on Amendments to the Regulation on the Welfare and Protection of Animals Used for Experimental and Other Scientific Purposes” (Official Gazette, 1989; Official Gazette, 2000; Official Gazette, 2003; Official Gazette, 2004a; Official Gazette, 2004b; Official Gazette, 2006; Official Gazette, 2011a; Official Gazette, 2011b; Official Gazette, 2014a; Official Gazette, 2019). Ethical committees for the use of animals in scientific studies began to be established in Turkiye in 1998 (Yaşar and Yerlikaya, 2004; Arslan and İlgili, 2022). No article in the current Turkish constitution directly protects animal rights and welfare. The lack of articles is a significant deficiency in the Turkish legal system (Uyumaz, 2016). However, "Animal Protection Law No. 5199" was enacted in 2004 to protect animals in Turkiye (Official Gazette, 2004). The essential headings of the animal protection law are:

All animals are born equal and have the right to live in accordance with the provisions of this law,

• The lives of stray animals should be supported just like owned ones,

• Necessary measures should be taken to protect, watch over, care for animals and keep them away from ill-treatment,

• Killing or slaughtering animals other than the animals allowed for hunting and production as slaughter animals on private production farms within the framework of Law No. 4915, and wild animals subject to trade for meat needs, and putting them on the market, is prohibited,

• To operate on the animals when they are sick, pregnant, and who have completed 2/3 of the gestation period, and to keep them in inappropriate conditions,

• Torturing animals." prohibited (Official Gazette, 2004).

Right after the enactment of the animal protection law in 2005, scientists for animal welfare areas in Turkiye came together. They organized the 1st Animal Welfare and Veterinarian Education Conference on animal welfare (Yaşar and İzmirli, 2006). Then, in 2006, "Implementation Regulation on the Protection of Animals" and "The Veterinary Services, Plant Health, Food and Feed Law No. 5996" came into effect in 2010 to better implement the animal protection law (Official Gazette, 2006; Official Gazette, 2010). Law No. 5996 is an explanatory and binding law on what needs to be done to improve animal welfare. Based on Law No. 5996, "Regulation on Welfare of Farm Animals" was issued in 2011 (Official Gazette, 2011). Within the framework of harmonization with the European Union and taking into account the Animal

Protection Law enacted in 2004, the "Regulation for the Welfare and Protection of Livestock and Animal Products During the Transport of Livestock and Animal Products in the Country" was published in 2011 (Fidan, 2012). According to this regulation, it has been explained what the conditions should be for the animals to be transported to the point they need to reach by providing welfare conditions healthily and safely. In 2014, the most updated version of the "Regulation on Minimum Standards for the Protection of Calves" and "General Provisions on the Welfare of Farm Animals," numbered 29183, was published (Official Gazette, 2014a; Official Gazette, 2014b). The last update regarding the protection and development of animal welfare and rights in Turkiye is the making of a new update in 2019 in the "Regulation on the Welfare and Protection of Animals Used for Experimental and Other Scientific Purposes," published in 2011.

7. CONCLUSION

This book chapter aims to reveal the developments in animal welfare and animal rights in the world and Turkiye from the past to the present. Improving animal welfare and granting rights to animals the improvement of rights is guaranteed by legal regulations such as constitutions, laws, regulations, and directives in many developed and developing countries. It is seen that the actual legal rules and regulations on animal rights started about a century ago but developed with the contribution of many countries in the last seventy years. Adopting standard legal provisions on animal rights, especially in European Community countries, has accelerated animal welfare and rights progress. Although there are provisions on animal rights in the constitutions of some European countries, there are many areas for improvement in the legal regulations of many other countries.

The initiatives of the World Organization for Animal Rights on animal welfare improvement and rights have been a turning point in animal rights. Animal rights committee decisions of the European Community have contributed to making legal regulations on animal rights in countries such as Turkiye, which are in the process of membership, and EU member states. Legal rules on animal rights accelerated within the scope of EU membership negotiations in Turkiye and gained momentum in the early 2000s. However, the fact that there are still no provisions directly protecting animal rights in the

Turkish constitution and that the existing regulations are insufficient to protect animals and increase their welfare is an issue that must be reconsidered.

While studies to improve the welfare of many animals are carried out, although they are not sufficient, it is a fact that the health and welfare of aquatic products are not as cared for as other living creatures. In the literature, the number of studies and laws directly on improving aquaculture welfare in countries' policies or regulations is relatively low. Considering the size of the world's water area, the diversity of lake and sea creatures, and its importance in obtaining economically high value-added products, there is a need for much study and legal regulation on the welfare and health of aquaculture.

It is necessary to enact laws protecting all animals by keeping them away from cruelty and ill-treatment directly, without leaving any room for interpretation, and penal sanctions should be regulated in a deterrent manner. It is necessary to increase the regulations to improve the welfare of farm animals subject to industrial production and to increase legal sanctions on the welfare and protection of animal species according to their vital needs. Furthermore, it is more beneficial and important to make more awareness-raising activities on animal welfare conditions and rights in all countries, especially in developing, underdeveloped and developed countries, to defend and improve animal rights within the legal framework.

REFERENCES

Akbulut, O. and Çobanoğlu, N. (2020). The legislation about animal protection in Turkish law and the legal status of animals according to them. Journal of Süleyman Demirel University Institute of Social Sciences, 36(1): 1-37.

Appleby, M.C., Mench, J.A. and Hughes, B. O. (2004). Poultry behaviour and welfare. Trowbridge, Cromwell Press, pp.118-208.

Arslan, M. and İlgili, Ö. (2022). Post-graduate theses including the bioethical aspects of animal rights and welfare concepts in Türkiye: A qualitative research. Journal of The Turkish Veterinary Medical Society 93(2): 133-150.

Antalyalı, A.A. (2007). Avrupa Birliği ve Türkiye'de hayvan refahı uygulamaları (Animal welfare practices in the European Union and Turkey). AB Uzmanlık Tezi, Tarım ve Köyişleri Bakanlığı Dış İlişkiler e Avrupa Birliği Koordinasyon Daire Başkanlığı.

Brambell Report (1964). Report of the Technical Committee to enquire into the welfare of animals kept under intensive livestock husbandry systems. Her Majesty's Stationery Office, London, UK.

Broom, D.M. (2011). A History of Animal Welfare Science. Acta Biotheor, 59, 21-137.

Ergin, O.N. (1995). Mecelle-i Umûr-i Belediyye, Vol 4, Büyükşehir Belediyesi Kültür İşleri Daire Başkanlığı yayınları, İstanbul, Turkiye.

Escobar, L. S., Jara, W. H., Nizam, Q. N., and Plavšić, B. (2018). The perspective of the world organisation for animal health. In Advances in Agricultural Animal Welfare (pp. 169-182). Woodhead Publishing.

Fidan, E.D. (2012). Welfare Applicati ons Related to Livestocks in Turkey. Animal Health, Production and Hygiene, 1: 39 – 46.

Francione, G. L. (1993). Animals, property and legal welfarism: unnecessary suffering and the humane treatment of animals. Rutgers L. Rev., 46, 721.

Gürler, A.M., Osmanağaoğlu, Ş. (2009). History of Animal Protection Law in Turkey. Kafkas University, Faculty of Veterinary Medicine, 15(3), 325-330.

Garcia, R. (2017). One Welfare': a framework to support the implementation of OIE animal welfare standards. Bull. OIE, 2017, 3-8.

Horton, C. (2016). Sentencing for Animal Cruelty in England and Wales. [Online] Available at: Cruelty-Report.pdf (bdch.org.uk) (Accessed:13.07.2023).

Jose De Santana, H. (2006). Abolicionismo Animal. (PhD Thesis). Federal University of Pernambuco

Kaplan, S. and Boztepe, S. (2011). Çiftlik hayvanlarında refah. Konya Ticaret Borsası Yayını (Welfare of farm animals. Konya Commodity Exchange Publication), Adım Press, Konya, Turkiye.

In the Official Gazette of Turkiye (Resmî Gazete), (1926). The "Islah-ı Hayvanat Kanunu" (Animal Breeding Law) was published on 29 June 1926 under issue number 25602.

In the Official Gazette of Turkiye (Resmî Gazete), (1989). The "Hayvanların Uluslararası Nakil Sırasında Korunmasına Dair Avrupa Sözleşmesi" (European Convention for the Protection of Animals during International Transport"), was published on 15 June 1989 and under issue number 20081.

In the Official Gazette of Turkiye (Resmî Gazete) (2000). The "Hayvan Pazarlarının Ruhsatlandırılma ve Denetleme Usul ve Esasları Hakkında Tebliğ" (Communiqué on the Licensing and Inspection Procedures and Principles of Animal Markets) was published on 15 September 2000 and under issue number 24171. [Online] Available at: https://www.resmigazete.gov.tr/eskiler/2000/09/20000915.htm (Accessed: 13.07.2023).

In the Official Gazette of Turkiye (Resmî Gazete), (2003). The "Ev Hayvanlarının Korunmasına Dair Avrupa Sözleşmesinin Onaylanmasının Uygun Bulunduğu Hakkında Kanun" ("Law on the Ratification of the European Convention for the Protection of Pet Animals" was published on 22 July 2003 and under issue number 25176 [Online] Available at: https://www.resmigazete.gov.tr/eskiler/2003/07/20030722.htm. (Accessed 13.07.2023).

In the Official Gazette of Turkiye (Resmî Gazete), (2004a). The "Hayvancılık İşletmelerinin Kuruluş, Çalışma, Denetleme Usul ve Esaslarına Dair Yönetmelik" ile "Denetim Elemanlarının Nitelikleri, Denetim ve İzlemeye İlişkin Usul ve Esaslar Yönetmeliği Taslağı" (Regulation on the Establishment, Operation and Inspection Procedures and Principles of Livestock Enterprises" and "Draft Regulation on Procedures and Principles on Qualifications of Inspection Personnel, Audit and Monitoring) was published on 5th March 2004 and under issue number 25393. (Accessed 13.07.2023).

In the Official Gazette of Turkiye (Resmî Gazete), (2004b). The "5199 Sayılı Hayvanları Koruma Kanunu" (Animal Protection Law) was published on 1st July 2004 under issue number 25509. [Online] Available at: https://www.mevzuat.gov.tr/mevzuatmetin/1.5.5199-20100611.pdf. (Accessed 12.07.2023).

In the Official Gazette of Turkiye (Resmî Gazete), (2006). The "Hayvanların Korunmasına Dair Uygulama Yönetmeliği" (Implementation Regulation on the Protection of Animals) was published on 12 May 2006 and under issue number 26166. [Online] Available at: https://www.resmigazete.gov.tr/eskiler/2006/05/20060512.htm. (Accessed 13.07.2023).

In the Official Gazette of Turkiye (Resmî Gazete), (2010). The "Veteriner Hizmetleri, Bitki Sağlığı, Gıda Ve Yem Kanunu" (Veterinary Services, Plant Health, Food and Feed Law) was published on 11 June 2010 and under issue number 27610 [Online] Available at: https://www.mevzuat.gov.tr/mevzuatmetin/1.5.5996.pdf. (Accessed 13.07.2023).

In the Official Gazette of Turkiye (Resmî Gazete), (2011a). The "Deneysel ve Diğer Bilimsel Amaçlar İçin Kullanılan Hayvanların Refah ve Korunmasına Dair Yönetmelik" (egulation on the Welfare and Protection of Animals Used for Experimental and Other Scientific Purposes) was published on 13 December 2011 under issue number 28141. [Online] Available at: https://www.resmigazete.gov.tr/eskiler/2011/12/20111213-4.htm. (Accessed 29.09.2023).

In the Official Gazette of Turkiye (Resmî Gazete), (2011b). The "Çiftlik Hayvanlarının Refahına İlişkin Yönetmelik" (Regulation on the Welfare of Farm Animals) was published on 23 November 2011 under issue number 28151. [Online] Available at:

https://www.resmigazete.gov.tr/eskiler/2011/12/20111223-3.htm. (Accessed 13.07.2023).

In the Official Gazette of Turkiye (Resmî Gazete), (2014a). The "Çiftlik Hayvanlarinin Refahina İlişkin Genel Hükümler Hakkinda Yönetmelik" (Regulation on General Provisions Concerning the Welfare of Farm Animals) was published on 22 November 2014 under issue number 29183. [Online]. Available at: https://www.resmigazete.gov.tr/eskiler/2014/11/20141122-6.htm (Accessed 13.07.2023).

In the Official Gazette of Turkiye (Resmî Gazete), (2014b). The "Buzağilarin Korunmasi İle İlgili Asgari Standartlara İlişkin Yönetmelik" (Minimum for calf protection regulation on standards) was published on 22 November 2014 under issue 29183. [Online] Available at: https://www.resmigazete.gov.tr/eskiler/2014/11/20141122-5.htm (Accessed 13.07.2023).

In the Official Gazette of Turkiye (Resmî Gazete), (2019). The "Deneysel ve Diğer Bilimsel Amaçlar için Kullanılan Hayvanların Refah ve Korunmasına Dair Yönetmelikte Değişiklik Yapılmasına Dair Yönetmelik" (Regulation on Amendments to the Regulation on the Welfare and Protection of Animals Used for Experimental and Other Scientific Purposes) was published on 8 July 2019 under issue number 30825. [Online] Available at: https://www.resmigazete.gov.tr/eskiler/2019/07/20190708M1-24.htm. (Accessed 13.07.2023).

Menteş Güler, A. and Osmanağaoğlu, Ş. (2009). History of Animal Protection Law in Turkey. Journal of Faculty of Medicine, Kafkas University, 15(3): 325-330.

Morton, R., Hebart, M. L., and Whittaker, A. L. (2020). Explaining the gap between the ambitious goals and practical reality of animal welfare law enforcement: A review of the enforcement gap in Australia. Animals, 10(3), 482.

Nattrass, K.M. (2004). Und die tiere constitutional protection for Germany's animals. Anim Law, 10, 283-312.

Neumann, J.M. (2012). The universal declaration of animal rights or the creation of a new equilibrium between species. Animal Law Review, 91: 91-109.

Phillips, C.J.C. and Kluss, K. (2018). Animal welfare and animal rights. Scanes, C.G., Toukhsati, S.R. editors. Animals and human society. 1st ed. Amsterdam: Academic Press. Elsevier Inc, 483-497.

Potter, V. R. (1970). Bioethics, the science of survival. Perspectives in biology and medicine, 14(1), 127-153.

Robertson, I. A. (2015). Animals, welfare and the law: Fundamental principles for critical assessment. Routledge, London and Newyork.

Rowan, A.N. (1997). The Concept of Animal Welfare and Animal Suffering, In: Animal Alternatives, Welfare and Ethics. Eds: L.F.M. van Zuphten and M. Balls. pp.157-168. Published: Elsevier Science B.V., Amsterdam.

Sağlam, N. (2017). Fisheries engineering and European Unıon legıslatıons related to fısh health, Turkish Journal of Aquatic Sciences, 32 (2):120-128.

Santana, L. R., and Oliveira, T. P. (2006). Guarda responsável e dignidade dos animais. Revista Brasileira de Direito Animal, 1,1.

Sert, H. and Uzmay, A. (2017). Assessment of Economical Aspects and Sustainability of Global Animal Welfare Practices. Adnan Menderes Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 4(4): 263-276.

Sinmez, Ç.Ç. (2022). The current constitutional position of animal rights in the world and Türkiye, Harran University Journal of The Faculty of Veterinary Medicine, 11(1):51-57.

Şanlı, R. (2018). Küçükbaş Hayvan Nakillerinde Hayvan Refahı. 1st International Symposium on Silvopastoral Systems and Nomadic Societies in Mediterranean Countries, Ekim 22-24, Isparta, 341-347.

Tosun, M. and Yalvaç, K. (1989). Sümer, Babil, Asur Kanunları ve Ammi Şaduqa Fermanı. 2. Baskı, Türk Tarih Kurumu Basımevi, Ankara, 1989.

Uran Murphy, P. (2019). Animal protection in the constitutional framework. The Journal of Academic Social Science, 7(88):252-275.

Uyumaz, A. (2016): Animal rights as a legal problematic in the light of actual developments in Turkey. Gazi University Faculty of Law Review, 20 (3): 133-184.

Wisch, R.F. (2011). Animal- Related Laws Enacted or Amended in 2010. Michigan State University College of Law, Michigan, USA.

Wise, S.M. (1995). The legal thinghood of nonhuman animals. Boston College Environmental Affairs Law Review, 23,471-547.

Yaşar, A. and İzmirli, S. (2006). Legal Arrangernents related to Anirnal Welfare in Turkey. Journal of Veterinary Sciences 22(3-4):51-56.

Yaşar, A. and Yerlikaya, H. (2004). A research on relation of animal welfare to veterinary medicine and regulations in European Union, Journal of Veterinary Sciences, 20(4): 17-24.

Yaşar, A. (2005). Tarihsel bir bakış açısıyla hayvan gönenci: Veteriner Hekimliği etiği, Hayvan kullanım etiği, hayvan gönenci ve Veteriner Hekimliği ilişkisi (Animal welfare from a historical perspective: Veterinary ethics, Animal use ethics, the relationship between animal welfare and Veterinary Medicine). Türkiye'de birinci sınıf hayvan refahı ve Veteriner Hekimliği Eğitimi Konferansı Bildirileri Kitabı, Pozitif Matbaacılık, Ankara (Proceedings of the First Class Animal Welfare and Veterinary Education Conference in Turkey, Pozitif Matbaacılık, Ankara).

Zeybek, O, Keser, A. and Yıldırım, Y. (2021). Animal Rights and Wildlife Crossings. Academia Journal of Nature and Human Sciences, 7(1): 84-104.

CHAPTER 3

THE USE OF NEW GENERATION TECHNOLOGIES IN DETERMINING ANIMAL WELFARE AND BEHAVIORS IN CATTLE (*Bos taurus*), DOMESTIC SHEEP (*Ovis aries*) AND POULTRY

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1. INTRODUCTION

Recently, the number of modern production systems has increased with the acceleration of the intensification process in livestock. This process has changed consumer's perceptions of food quality. Consumers often associate food quality with the nature of the products, their safety, and the welfare of the animal from which they are produced. Therefore, animal welfare is the primary factor for consumers and producers in determining food quality (Napolitano et al., 2019). Previously, animal welfare on farms was associated with problems such as hunger, thirst, injury and disease. However, recently the definition of animal welfare has been expanded to provide the animal's physical and mental health, as well as feeding and living spaces where it can exhibit its species-specific normal behaviors. In summary, the assessment of animal welfare consists of four basic principles: feeding, barning, health status and behavior (Islam et al., 2020). Therefore, careful and systematic monitoring of the welfare and comfort of farm animals in their growing conditions is important in terms of improving all management practices offered to them and increasing the quality of the products produced. These developments in the dairy and meat industry have also changed the perspectives of farmers and scholars on modern production systems. Thus, researchers have focused on integrating new-generation technologies into modern livestock farming systems to monitor animal behavior and welfare, as well as product quality.

In the 21st century, with the acceleration of modern technological developments, the use of farm automation and digital applications has increased significantly in cattle and small ruminant herds raised in both intensive and extensive conditions (Post et al., 2020). These developments are the result of a series of changes in the dairy and meat industry globally. Firstly, yield traits have been improved by the successful selection practices in farm animals. Hence, the dairy and meat industry is concentrated in terms of productivity per animal (Lovarelli et al., 2020). This situation adversely affected their reproductive performance, milk quantity and quality, immune, metabolic and health conditions and thus there has been increased interest in Precision Livestock Farming (PLF) (Okuyucu et al., 2023). Secondly, the increase in herd size on farms has highlighted the need to support breeders with digital decision support systems and ensure the welfare of farm animals (Post et al., 2020). In addition, the increasing use of modern livestock production systems around the world is another factor that causes the widespread use of farm automation and digital applications. In modern livestock production systems, animals are kept in social isolation indoors or in small closed areas. This social isolation causes an array change in the environment-, animal-, and both-based welfare criteria, including their udder hygiene, body condition, nutritional status, physical, physiological status, behaviors and temperament traits. To increase sustainable production and address these issues, PLF provides good opportunities to continuously monitor and manage individual productivity, nutritional sensitivity, various behavioral and physiological indicators, and health issues, rather than traditional group-level management of animals (Lovarelli et al., 2020; Lee and Seo, 2021; Džermeikaitė, et al., 2023). In addition, individual monitoring through direct observation of farm personnel and/or video recordings is time consuming and labor, and is impractical on large-herd farms. Therefore, wearable wireless biosensor systems have been used for individual animal tracking. Since the 1980s, researchers have focused on the improvements of these systems (Rutten et al., 2013; Herlin et al., 2021). Such technologies are effective for breeders and stockperson to track and manage animals more intensively, quickly and easily than usual. In addition, these systems contribute significantly to increasing productivity and improving animal welfare with less environmental impact (Herlin et al., 2021). In this context, obtaining reliable data to understand and predict the nutritional, health, welfare status and production of farm animals such as cattle, water buffalos, sheep and goats depends on combining animals' management practices with the use of sensors and technology. The interest in this subject has contributed to the examination of new technological approaches for integrating these systems into modern livestock production systems from a broad perspective. Therefore, the definition and evaluation of farm automation and digital applications used in modern livestock production systems are of primary importance for sustainable production.

2. WHAT IS PRECISION LIVESTOCK FARMING?

The term 'digitalization' is a broad concept that includes various trends and innovations. This term includes modern information technology based on sensor technology and electronic data, and is often known as 'Precision Livestock Farming' PLF in the dairy and meat industry. PLF is defined as management systems that collect large and important data by providing continuous automatic monitoring (real-time) and control of important management indicators such as behavior, health, welfare, nutritional status and reproductive performance of farm animals. Thanks to modern information technologies, data is collected and produced, which is calculated and analyzed by algorithms to produce information regarding the relevant management indicators mentioned above (Figure 2). These algorithms allow breeders and stockpersons to be supported by digital decision support systems (Kleen, and Guatteo, 2023). In this context, PLF provides significant advantages for farm personnel compared to traditional methods;

- Instant availability and processing of data
- Integration of data from a variety of different sources
- Instant notification of key points of interest in any negative situation on the farm
- Accelerating and facilitating the decision-making process of farm personnel
- Supporting the decision-making process with automatic (a system that includes components such as sensors, algorithms, applications and interfaces, Figure 1)

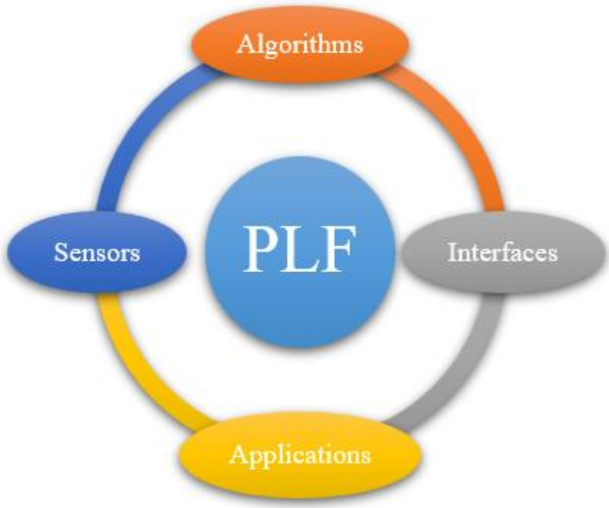

Figure 1. Elements of precision livestock farming (Adapted from Kleen and Guatteo, 2023)

It is possible to examine the systematic working stages of PLF systems at 4-levels (Rutten et al., 2013; Kleen, and Guatteo, 2023).

Level I- Sensor Technique: Collection of measured and/or recorded biological and physical data via sensors.

Level II- Data Interpretation: The interpretation of the sensor data by defining the variations and changes is completed by the created algorithms.

Level III- Integration of Information: Integration and monitoring of data from different sources is completed.

Level IV- Decision Making: According to the systematic results, the decision-making or decision-support process is completed.

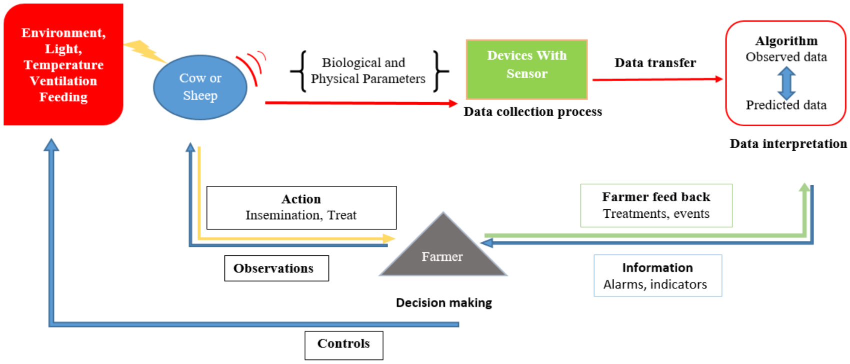

Figure 2. Overview of the working principle of the PLF system (Adapted from Kleen and Guatteo, 2023)

3. DIGITAL TECHNOLOGIES TO CONTROL ANIMAL MOVEMENTS OUTDOORS AND INDOORS

New generation technologies have mostly been developed to be integrated into rearing systems (indoor systems) under intensive conditions. However, recently, with the acceleration of the development of the infrastructure for data transfer, it allows the use of these digital systems in pasture-based rearing systems (grazing animals such as sheep and goats). Animal species raised in both intensive (in barns or indoors) and extensive conditions (pasture-based) animal behavior and welfare are controlled thanks to many digital technologies such as sensor technologies, camera technologies, positioning technologies, moving animals with drones and virtual fences (Table 1; Herlin et al., 2021).

Table 1. New generation technologies used to evaluate the health status of farm animals and some animal welfare criteria (Adapted from Neethirajan, 2020; Van Erp-van der Kooij and Rutter, 2020; Džermeikaitė et al., 2023)

Elements of PLF	Measurement	Information
Accelerometer	Activity	Oestrus, Health, Lameness, Onset of calving
Temperature Sensor	Body temperature	Health
pH Sensor	Rumen pH, Body temperature	Rumen acidosis
Weighing device	Weight	Growth
Tri-axial accelerometers, Pedometers	Feeding behavior Grazing and ruminating times Activity Laying time Walking behavior	Lameness
Pressure Sensor	Leg pressure	Lameness
Milking robots	Milk analyzes (fat and protein content and EC)	Ketosis Mastitis Acidosis
Vision (Camera and drone)	Face recognition Body Condition Score Body weight Behaviour Activity	Health, Identification, Stress Nutrition Production
Positioning	Locomotion Behaviour	Health, stress, Reproduction

3. 1. Sensor Technologies

Sensor technologies allow continuous measurement of physical, physiological or behavioral indicators of farm animals, as well as changes in herd management. Moreover, it controls the sequence of events in the animal's natural habitat or pasture-based rearing conditions and constantly produces detailed data about the animal's health and welfare conditions. Many of the parameters in the environment where a dairy cow and/or a group of animals are raised are monitored by biosensors, and the biosensor systems may vary according to type and mounting location. Sensor technologies can be classified in two different ways: animal-based and non-animal-based.

3. 1. 1. Animal-based sensors

These sensors are generally attached to anatomical areas where reliable data transfer can be achieved and in a way that does not disturb the animal when attached. Ear tags, collars, leg bands on the animal, as well as internal (Reticulo-Rumen) boluses and implants applied to the animal are such sensors. The usage area of each may differ according to the above-mentioned type and mounting location.

Wearable sensors on the animal's ear, neck and leg: Because they are mounted in different ways on the ear, neck and leg areas of the cow, sheep or goat, these are defined as Ear Tag, Leg Tag, Halter Type and Neck Collar. These sensors are generally used to control the health status of animals as well as temperature stress and estrus cycle conditions by transferring body temperature data to herd management systems. These sensors work on similar principles. However, recently most commercial products such as neck collar sensors and leg tag sensors are equipped with triaxial accelerometer sensors (pedometers) and microphone sensors. In this way, it can also control feeding behaviors (feeding times and/or frequency and rumination time) and some activity levels of the animals (the animal's number of step, standing time, lying time etc.). Data obtained from neck collar sensors and leg tags sensors are used with automatic milking systems. Therefore, the neck collar sensors is the most commonly used sensor system on dairy farms, followed by the leg tag sensors system. Nowadays, these sensor systems that can be integrated into herd management systems are produced by many commercial companies.

Moreover, determining feeding behaviors, grazing routes in the pastures, animal movements and estimating herbage intake is possible with devices recording individual immobility, pressure exposure, temperature, and various stress factors with a high-tech global positioning system, saving data and self-charging with solar energy (Akdağ and Ocak, 2019). These devices have technologies that are attached to animals in some way (ear tag, neck collar) from the primitive to the most technological and direct information from the satellite to the electronic environment (Figure 3,4).

Reticulo-Rumen Bolus Sensors: Reticulo-Rumen Boluses are sensor technologies that allow monitoring of rumen temperature and pH parameters of farm animals. These sensor technologies can be effectively used to control changes in the physiological state of the animal by constantly monitoring rumen temperature and pH parameters. The components of rumen bolus systems usually consist of a battery, temperature sensor, pH sensor, accelerometer and a transmitter for data transfer. These sensor systems are placed orally into the animal by a veterinarian. The animal's reticulo-rumen also remains throughout its life.

Apart from all these sensor technologies listed above, there are also tail and vagina mounted sensors based on similar operating principles. This type of sensors is designed to determine the calving time without any observation. Tail-mounted sensors take into account changes in the animal's tail movements depending on the frequency of labor contractions, while vagina-mounted sensors generate data on decreasing body temperature prior to calving.

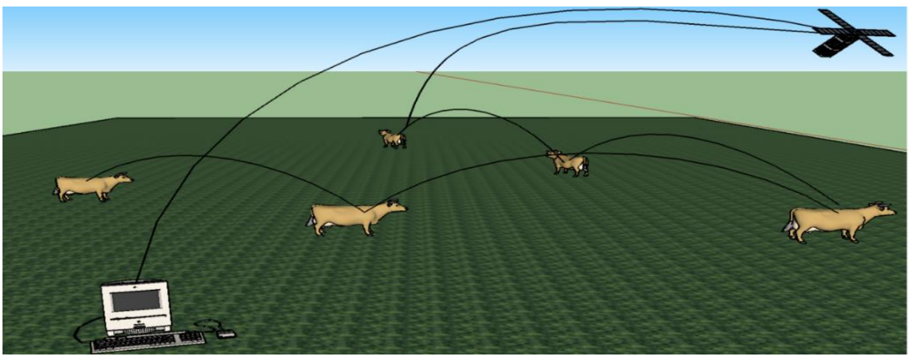

Figure 3. Wireless sensor network (Akdağ and Ocak, 2019)

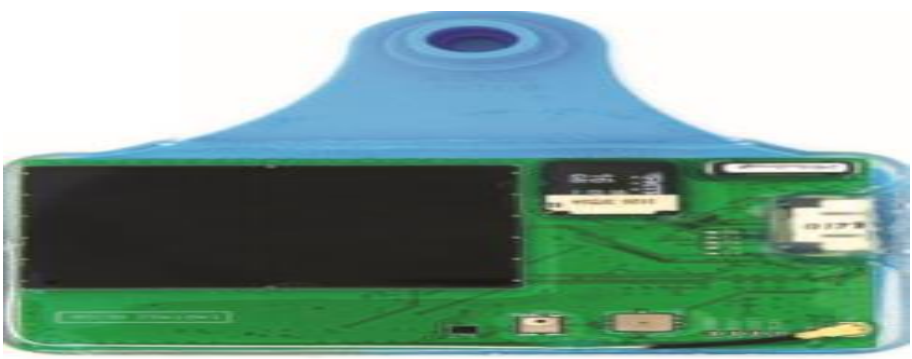

Figure 4. A device used as a wearable technology in wireless sensor networks (Greenwood et al., 2014)

3. 1. 2. Non-animal-based sensors

These are biosensors that can be positioned in the animal's environment and collect data both on-line and off-line; for example: TIR (Thermal Infrared) Sensors, automatic feeding systems, automatic scales and milking robots (Figure 5).

Figure 5. Milking robots and automatic feeding systems (Anonymous, 2023)

Sensors of different types of sensor technology have been mounted on milking robots developed in the 1990s. For example; In robotic milking systems, thanks to the sensors mounted between the milking parlor and the entrance door of the system, they read the electronic earrings attached to the neck or leg and milking procedures start according to the cow's status information. Additionally, sensors are used to automatically remove the teat cup. During milking, if the milk flow does not occur at a fixed time, the teat cups are removed by the robot. (Demir and Öztürk, 2010).

3. 2. Camera and Drones Technologies

Cameras that provide images or video can be used for large-scale surveillance by mounting on drones both indoors and outdoors. Camera technology is often used indoors to detect standing and lying behavior, as well as the social interactions of animals. In addition, drones equipped with cameras have recently been widely used in pasture studies, as well as in the identification and counting of farm animals (cattle, sheeps and goats) raised under extensive conditions. Therefore, it is becoming common to herd sheep, goats and cattle with drones in large herds based on large pastures. However, several authors argue that some aspects of this system still need improvement (Herlin et al., 2021). The accuracy and magnitude of data collected by drones are related to the size of the observed area and the resolution of the camera mounted on the drone, as well as the ability of the system to detect the object. In this regard, it is important to develop drones equipped with cameras or sensors that can detect objects with high resolution in the dark of night and in adverse climatic conditions and environmental with dense vegetation. Also, continuous monitoring of animal welfare criteria in pasture-based production systems is essential for profitable production. Therefore, it is a primary necessity to develop systems that can constantly monitor animal welfare criteria (behavior, health, nutritional status) and to mount these systems on drones.

Another camera and imaging system is Infrared thermography (IRT). IRT technology both measures the temperature in different parts of the animal's body and displays temperature changes in color with videos or photographs. Thermal videos or photographs are interpreted according to the color scale (hot areas are seen in white or red, while cold areas are seen in black or blue). This technology is a reliable method used in the diagnosis and evaluation of conditions such as infection, lameness and mastitis in horses, sheep and cattle, depending on the increase or decrease in the surface temperature of the skin (Džermeikaitė et al., 2023). Similarly, this technology is also used to detect physiological changes caused by heat or cold stress on animals. Since IRF technologies, which are an important part of PLF provide important opportunities for monitoring animal health and welfare, technologies that can be applied to these systems should be developed.

3. 3. Positioning Technologies

Radio Frequency Identification (RFID) and Global Positioning Systems (GPS) are new generation technologies used to determine animal behavior in intensive and extensive production systems. Components of the RFID system; it consists of a reader, a transponder (tag) and a software that converts the obtained data into useful information. Due to the short range of RFID technology, its use outdoors is limited. In this regard, GPS technologies are used more in outdoor and pasture-based production systems compared to RFID technologies. GPS monitoring is a technology that produces data via radio signals coming from special satellites at a specific positioning moment. By attaching a collar with a positioning receiver (GPS) to farm animals in the pasture, the movements and behaviors of sheep, goats and cattle grazing in the pasture can be monitored. Apart from these, it also enables the examination of changes in group movements and/or behavior of sheep depending on the quality of the pastures where they graze (Herlin et al., 2021).

Vegetation changes can serve as a critic parameter for estimating and/or determining the herbage intake of grazing ruminants. The accuracy of these differences can be subject to discussion, but it still holds potential for estimation/calculation as an indirect herbage intake determination methods. Remote sensing is a technology used for determining vegetation changes. Vegetation maps can be created by using satellite images. Some mathematical transformations and statistical approaches are utilized to obtain more meaningful information from satellite images (Genç et al., 2010). Principal Component Analysis and Tasseled Cap transformations have been used for the classification of vegetation (Genç et al., 2005; Chen and Rao, 2008). The Normalized Difference Vegetation Index (NDVI) is usually used to assess plant density in pastures or agricultural fields (Richard and Jia, 1999). Moreover, NDVI can be a tool for quantitative measures of relative vegetation density (Seaquist et al., 2003). If it becomes possible to estimate vegetation quantities by using NDVI as a remote sensing method, it could be applied to estimate the herbage intake of herds.

4. NEW GENERATION TECHNOLOGIES MONITORING POULTRY WELFARE

Recently, it is essential to take animal welfare into consideration to meet the demands of consumers who prefer poultry products and to ensure the sustainability of commercial production. However, it is often difficult to ensure and assess high welfare levels in large-scale facilities, to detect potential welfare risks and to control or minimize their effects. Current advances in technology offer new possibilities every day for real-time automatic monitoring of the welfare and health of commercial poultry. In this section, the latest technological measurement methods, especially in determining the welfare of broiler chickens and laying hens, will be discussed.

4. 1. Sensors and Monitoring Systems

The use of sensors and monitoring systems in livestock farms is a new generation of technological instruments aimed at reducing management costs and improving animal health, welfare and productivity (Ruiz-Garcia et al., 2009). As sensing and imaging technology becomes increasingly affordable and less complex, it is expected to find wider use in animal welfare (Sassi et al., 2016). Some of the new generation of technologies for detecting and improving poultry welfare are summarized in Table 2.

Table 2. New generation sensor technologies monitoring poultry welfare (Adapted from Corkery et al., 2013; Sassi et al., 2016; Li et al., 2020)

Technology	Applications	Reference
Video imaging technology	Monitoring hatching time and behavioral tests in broilers	Løtvedt and Jensen (2014)
Automatic camera monitoring system	Activity and lameness detection in broilers	Aydın et al. (2010) Aydın et al. (2013) Aydın et al. (2015)
	Monitoring chicken flock behavior to detect early warning of infection by human pathogen Campylobacter	Colles et al. (2016)
	Early warning of footpad dermatitis and hock burn in broiler chicken	Dawkins et al. (2017)
3D computer vision	Body weight prediction in broilers	Mortensen et al. (2016)
	Automated tracking and behavior quantification of laying hens	Nakarmi et al. (2014)
	Behavioral quantification of individually caged poultry	Leroy et al. (2006)
A machine vision system	Early detection and prediction of sick broilers	Okinda et al. (2019) Zhuang et al. (2018) Zhuang and Zhang (2019)
	Identifying broiler breeder behavior	Pereira et al. (2013)
	Monitoring floor distribution in broilers	Guo et al. (2020)
	Evaluating beak and head motion of broiler chickens during feeding	Mehdizadeh et al. (2015)
	Body weight prediction in broilers	Amraei et al. (2018)
Sensoring technology	Detecting laying performances and behaviors of hens by nest usage sensor	Zaninelli et al. (2018)
Sound technology	Feed intake in laying hens	Bright (2008)
	Determination of feather pecking in laying hens	Zimmerman et al. (2000)
	Stress detection by environmental temperature variation and fear	Pereira et al. (2014)

Skeletal disorders and contact dermatitis are particularly important problems that negatively affect the welfare of modern broiler chickens (De Jong et al., 2012). The integration of new generation technologies in this field, together with effective management practices, may contribute to the welfare of broilers in the short future. Dawkins et al. (2017) suggested that it is possible to predict footpad dermatitis and hock burn at slaughter, even in young birds, before external signs appear, with the help of an inexpensive camera system that monitors the movements of broiler chickens throughout their lives. Løtvedt and Jensen (2014) effectively observed the behavior of laying hybrid chicks between the ages of 3 and 8 weeks with a camera surveillance system.

Aydin et al. (2014) developed a system for real-time detection of feed intake in broiler chickens. In this study, it was aimed to determine the instantaneous feed intake of broilers by using pecking sounds. For this purpose, a voice recognition algorithm was developed to detect the pecking sounds of broiler chickens and the relationship between pecking sounds and feed intake of broilers was examined. Since the correlation between pecking sound and feed intake was found very high (R2=0.99), the results showed that the pecking sound detection method could be used as an effective tool to monitor feed intake of broiler chickens (Aydın et al., 2015).

Studies using image processing technologies to detect lameness and sick chickens have been conducted in large modern broiler chicken houses (Aydın et al. 2010, 2013 and 2015). Aydin et al. (2010) developed a fully automatic analysis tool using image processing technique that can determine the lameness levels of broiler chickens. Studies have shown that automatic camera monitoring has high potential in detecting activity levels associated with lameness in broilers. Aydin et al. (2013) in another study determined the activity and sitting levels of broiler chickens, as well as their space usage, with the help of a color algorithm. As a result of the study, a success rate of 83% was achieved and a significant relationship was found between the number of sitting and gait scores of the chickens. Additionally, a negative relationship was determined between the chickens' resistance to sitting and their walking scores. Aydin et al. (2015) reported that the automatic monitoring system they developed had a high potential in detecting lameness problems in broiler chickens.

Kashiha et al. (2013) developed a new system that uses cameras and image processing software to detect problems in broiler chicken houses. This study results showed that problems occurring in the chicken house could be detected with 95% success. Mortensen et al. (2016) developed a fully automatic 3D camera-based weighing system for broilers and tested it in a commercial broiler house containing 48,000 broilers (Ross 308) during the last 20 days of the rearing period under commercial conditions.

Video recording and manual video analysis are the most common practices used to determine behavior in laying hens. However, these methods are very time consuming and error prone. Nakarmi et al. (2014) developed a new method for automatically measuring specific behaviors of hens housed at the group level, such as locomotion, perching, feeding, drinking, and nest building. To identify and track individual birds in the group, a state-of-the-art with a state-of-the-art time-of-flight (ToF) of light-based 3D vision camera and overhead image processing techniques were used with the help of a passive radio frequency identification (RFID) system. Each hen was tagged with an RFID transponder attached to its leg. This system may allow more effective assessment of the impact of housing and/or management factors or health status on bird behavior.

5. CONCLUSION

The primary task of PLF is to produce reliable data by utilizing new generation technologies such as sensors, camera drones and positioning technologies and to enable this data to be examined through intelligent software systems. Therefore, PLF creates a decision mechanism for the farmer to improve animal health and welfare as well as increase productivity and efficiency. Additionally, PLF provides early diagnosis by examining the disease indicators (biological, physiological and physical indicators) of animals in real time. This system allows for more effective individual animal health management in large-sized herds. Moreover, Remote sensing must be integrated to GPS systems for individual herbage intake estimation potential. Consequently, new technologies for estimating herbage intake of grazing animals need more studies to be integrated grassland production systems. PLF technologies can provide added value to animal husbandry in terms of increased animal welfare, reduced environmental impact and long-term sustainability. One of the purposes of installing technological devices on an animal farm is to detect potential abnormal situations effectively and early. However, it is clear that further studies are needed to prove the consistency of new generation technologies in animal husbandry aimed at reducing costs by increasing welfare and finding wider commercial use.

REFERENCES

Akdağ, A., Ocak, N. (2019). Herbage intake determination methods. Scientific Papers: Animal Science and Biotechnologies, 52(1).

Amraei, S., Mehdizadeh, S. A., Nääs, I. D. A. (2018). Development of a transfer function for weight prediction of live broiler chicken using machine vision. Engenharia Agrícola, 38: 776-782.

Anonymous, (2023). Milking robots and automatic feeding systems https://www.lely.com/tr/ (Access date: 01.07.2023).

Aydin, A., Bahr, C., Berckmans, D. (2015). A real-time monitoring tool to automatically measure the feed intakes of multiple broiler chickens by sound analysis. Computers and Electronics in Agriculture, 114: 1-6.

Aydin, A., Bahr, C., Viazzi, S., Exadaktylos, V. Berckmans, D. (2014). A novel method to automatically measure the feed intake of broiler chickens by sound technology. Computers and Electronics in Agr., 101: 17-23.

Aydin, A., Cangar, O., Eren Ozcan, S., Bahr, C., Berckmans, D. (2010). Application of a fully automatic analysis tool to assess the activity of broiler chickens with different gait scores. Computers and Electronics in Agriculture, 73: 194-199.

Aydin, A., Pluk A., Leroy T., Berckmans D., Bahr C. (2013). Automatic Identification Of Activity And Spatial Use Of Broiler Chickens With Different Gait Scores. Transactions of the ASABE, 56: 1123-1132.

Ben Sassi, N., Averós, X., Estevez, I. (2016). Technology and poultry welfare. Animals, 6(10), 62.

Bright, A. (2008). Vocalisations and acoustic parameters of flock noise from feather pecking and non-feather pecking laying flocks. British Poultry Science, 49(3): 241-249.

Chen, S., Rao, P. (2008). Land degradation monitoring using multi-temporal Landsat TM/ETM data in a transition zone between grassland and cropland of Northeast China. International Journal of Remote Sensing, 29(7): 2055-2073.

Colles, F. M., Cain, R. J., Nickson, T., Smith, A. L., Roberts, S. J., Maiden, M. C., Lunn, D., Dawkins, M. S. (2016). Monitoring chicken flock behaviour provides early warning of infection by human pathogen

Campylobacter. Proceedings of the Royal Society B: Biological Sciences, 283(1822): 20152323.

Corkery, G., Ward, S., Kenny, C., Hemmingway, P. (2013). Incorporating smart sensing technologies into the poultry industry. Journal of World's Poultry Research, 3(4): 106-128.

Dawkins, M. S., Roberts, S. J., Cain, R. J., Nickson, T., Donnelly, C. A. (2017). Early warning of footpad dermatitis and hockburn in broiler chicken flocks using optical flow, bodyweight and water consumption. Veterinary Record, 180(20): 499-499.

De Jong, I., Berg, C., Butterworth, A., Estevéz, I. (2012). Scientific report updating the EFSA opinions on the welfare of broilers and broiler breeders. EFSA Supporting Publications, 9(6).

Demir, B., Öztürk, İ. (2010). Robotic Milking Systems. Alınteri, 19(B): 21-27.

Džermeikaitė, K., Bačėninaitė, D., Antanaitis, R. (2023). Innovations in Cattle Farming: Application of Innovative Technologies and Sensors in the Diagnosis of Diseases. Animals, *13*(5), 780.

Genç, L., Kavdır, D., Turhan, H., Genç, H., Kavdır, Y. (2005). Bitkisel Üretim ve Uzaktan Algılama. Harran Üniversitesi Ziraat Fak. Derg., 9(4): 1-9

Genç, L., Saçan, M., Turhan, H., Aşar, B. (2010). Determination of Land Cover using Landsat TM Imagery. Journal of Agricultural Sci., 16: 213-224.

Greenwood, P. L., Valencia, P., Overs, L., Paull, D. R., Purvis, I. W. (2014). New ways of measuring intake, efficiency and behaviour of grazing livestock. Animal Production Science, 54: 1796–1804.

Guo, Y., Chai, L., Aggrey, S. E., Oladeinde, A., Johnson, J., Zock, G. (2020). A machine vision-based method for monitoring broiler chicken floor distribution. Sensors, 20(11), 3179.

Herlin, A., Brunberg, E., Hultgren, J., Högberg, N., Rydberg, A., Skarin, A. (2021). Animal welfare implications of digital tools for monitoring and management of cattle and sheep on pasture. Animals, 11(3), 829.

Islam, M. A., Sharma, A., Ahsan, S., Mazumdar, S., Rudra, K. C., Phillips, C. J. (2020). Welfare assessment of dairy cows in small farms in Bangladesh. Animals, 10(3), 394.

Kashiha, M., Pluk, A., Bahr, C., Vranken, E., Berckmans, D. (2013). Development of an early warning system for a broiler house using computer vision. Biosystems Eng., 116: 36–45.

Kleen, J. L., Guatteo, R. (2023). Precision Livestock Farming: What Does It Contain and What Are the Perspectives? Animals, 13(5), 779.

Lee, M., Seo, S. (2021). Wearable wireless biosensor technology for monitoring cattle: A review. Animals, 11(10): 2779.

Leroy, T., Vranken, E., Van Brecht, A., Struelens, E., Sonck, B., Berckmans, D. (2006). A computer vision method for on-line behavioral quantification of individually caged poultry. Transactions of the ASABE, 49(3): 795-802.

Li, N., Ren, Z., Li, D., Zeng, L. (2020). Automated techniques for monitoring the behaviour and welfare of broilers and laying hens: towards the goal of precision livestock farming. Animal, 14(3): 617-625.

Løtvedt, P., Jensen, P. (2014). Effects of hatching time on behavior and weight development of chickens. PloS one, 9(7), e103040.

Lovarelli, D., Bacenetti, J., Guarino, M. (2020). A review on dairy cattle farming: Is precision livestock farming the compromise for an environmental, economic and social sustainable production? Journal of Cleaner Production, 262, 121409.

Mehdizadeh, S. A., Neves, D. P., Tscharke, M., Nääs, I. A., Banhazi, T. M. (2015). Image analysis method to evaluate beak and head motion of broiler chickens during feeding. Computers and Electronics in Agriculture, 114: 88-95.

Mortensen, A. K., Lisouski, P., Ahrendt, P. (2016). Weight prediction of broiler chickens using 3D computer vision. Computers and Electronics in Agriculture, 123: 319-326.

Nakarmi, A. D., Tang, L., Xin, H. (2014). Automated tracking and behavior quantification of laying hens using 3D computer vision and radio frequency identification technologies. Transactions of the ASABE, 57(5): 1455-1472.

Napolitano, F., Serrapica, F., Braghieri, A., Masucci, F., Sabia, E., De Rosa, G. (2019). Human-animal interactions in dairy buffalo farms. Animals, 9(5), 246.

Neethirajan, S. (2020). Transforming the adaptation physiology of farm animals through sensors. Animals, 10(9): 1512.

Okinda, C., Lu, M., Liu, L., Nyalala, I., Muneri, C., Wang, J., Zhang, H., Shen, M. (2019). A machine vision system for early detection and prediction of sick birds: A broiler chicken model. Biosystems Engineering, 188: 229-242.

Okuyucu, I. C., Akdağ, A., Erdem, H., Ocak, N. (2023). Physiological and physical responses of dairy cattle to heat stress. Black Sea Journal of Agriculture, 6(1): 95-103.

Pereira, D. F., Miyamoto, B. C., Maia, G. D., Sales, G. T., Magalhães, M. M., Gates, R. S. (2013). Machine vision to identify broiler breeder behavior. Computers and Electronics in Agriculture, 99: 194-199.

Pereira, E. M., Nääs, I. D. A., Garcia, R. G. (2014). Identification of acoustic parameters for broiler welfare estimate. Engenharia Agrícola, 34: 413-421.

Post, C., Rietz, C., Büscher, W., Müller, U. (2020). Using sensor data to detect lameness and mastitis treatment events in dairy cows: A comparison of classification models. Sensors, 20(14): 3863.

Richards J. A., Jia, X. (1999). Remote Sensing Digital Image Analysis: An Introduction, 3rd edn Sydney: Springer Verlag.

Ruiz-Garcia, L., Lunadei, L., Barreiro, P., Robla, J. I. (2009). A review of wireless sensor technologies and applications in agriculture and food industry: state of the art and current trends. Sensors, 9(6): 4728-4750.

Rutten, C. J., Velthuis, A. G. J., Steeneveld, W., Hogeveen, H. (2013). Invited review: Sensors to support health management on dairy farms. Journal of Dairy Science, 96(4): 1928-1952.

Seaquist, J. W., Olsson, L., Ardö, J. (2003). A remote sensing-based primary production model for grassland biomes. Ecological Modelling, 169: 131-155.

Van Erp-van der Kooij, E., Rutter, S. M. (2020). Using precision farming to improve animal welfare. CAB Rev. Perspect. Agric. Vet. Sci. Nutr. Nat. Resour, 15: 1-10.

Zaninelli, M., Redaelli, V., Luzi, F., Mitchell, M., Bontempo, V., Cattaneo, D., Dell'Orta, V., Savoini, G. (2018). Development of a machine vision method for the monitoring of laying hens and detection of multiple nest occupations. Sensors, 18(1), 132.

Zhuang, X., Bi, M., Guo, J., Wu, S., Zhang, T. (2018). Development of an early warning algorithm to detect sick broilers. Computers and Electronics in Agriculture, 144: 102-113.

Zhuang, X., Zhang, T. (2019). Detection of sick broilers by digital image processing and deep learning. Biosystems Engineering, 179: 106-116.

CHAPTER 4

GENETICS AND WELFARE OF FARM ANIMALS

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1. INTRODUCTION

Welfare defines the state in which a person or animal is healthy, happy and safe (Wehmeier, 2005). In other words, animal welfare can be described as the requirement of environmental conditions in which animals can fully express their natural behavior (Akunal and Koknaroglu, 2021). In this regard, the physical health and psychological well-being of the animals should be considered regarding welfare. However, today's increasing intensive production to meet people's food needs restricts the natural life of animals and causes welfare problems.

Since domestication of livestock began approximately 9,000 years ago, humans have intentionally or unwittingly selected animals suitable for food production for a variety of reasons (Simm et al., 1996). Domestication is the process of genetically modifying a population of animals through selection (Hale, 1962). Domestic animals have been able to take advantage of the extra resources made available by humans, leading to altered selection pressures and possibly altered behavior (Hale, 1962; Price 1998).

During domestication, selection was largely based on subjective assessments of the animals' merits. Thanks to genetic selection and improvements in management systems, the production volume of poultry and livestock has almost tripled in the last 100 years (Grandin and Deesing, 2022). For example, the age at slaughter in broilers has been shortened by approximately one day each year, largely because of genetic selection for higher live weight (Havenstein et al. 1994). Adult broilers reach more than four times the body mass of their wild ancestor, the red junglefowl (*Gallus gallus*) (Jackson and Diamond, 1996). On the other hand, milk production in dairy cows and feed preservation efficiency have increased, which is accompanied by critical changes in reproductive physiology compared with the unselected wild type (Foxcroft, 2012).

The science of genetics has shown that it affects livestock primarily through genetic selection and technologies. In parallel with the development of molecular technology, more information is being gained every day about the genetic basis of traits such as yield and defects in livestock. Genetic science undoubtedly plays an important role in efforts to improve livestock yields. In particular, the discovery of DNA structure in the 1950s and the development of the polymerase chain (PC), as well as later advances in sequencing technology

(Barlett and Stirling, 2003), have expanded our knowledge about DNA content in farm animals.

Genetic selection has significantly increased yields in most livestock species such as dairy cows, poultry, pigs and sheep. In addition to the benefits of genetic selection, it is also known to cause a number of health, reproductive and metabolic problems that negatively impact animal welfare. Intensification of animal production may also impact the frequency and severity of disease (Lean et al., 2008; Ridler, 2008). Therefore, concerns about animal life have been raised for centuries, with concerns about farm animal welfare since the 1960s (Dwyer et al., 2008). The effects of genetic selection on productivity and animal welfare are primarily observed in dairy farms and the poultry sector. Therefore, the effects of genetic selection on these two species are discussed in this section. In addition, gene editing technologies that enable surgical interventions at the DNA level are briefly discussed, and the connection of this technology to breeding and animal welfare is mentioned.

2. EFFECTS OF GENETIC SELECTION ON ANIMAL WELFARE

Genetic selection has significantly improved the yield of livestock. Although the desired increase in yield has been achieved through genetic selection in many farm animals, the effects of genetic selection on welfare are still being studied. It is worth mentioning here that it is not easy to directly determine the effects of genetic selection on welfare. Genes often have pleortpic effects, meaning that one gene can influence the expression of several traits at the same time, even if the traits appear to have nothing to do with each other. Therefore, a gene affecting a production trait can be inherited together with another gene affecting a welfare trait. This means that selection has the potential to lead to desirable and undesirable genetic changes or to have unexpected consequences for animal welfare (Hocking, 2014). On the other hand, both in terms of production efficiency and environmental adaptation, artificial and natural selection can result in sweeps of selection that increase the frequency of recessive alleles, and this negatively affects fitness, which is defined as any trait that affects survivability and reproduction (Hocking, 2014).

The use of the selection index in livestock is almost as old as the art of animal breeding. In practice, many factors influence an animal's performance

(Hazel, 1943). Therefore, to achieve the maximum economic benefit in livestock, animal breeding programs use a selection index developed based on the economic value of each trait. The selection index may include one or more traits, such as heritability, genetic correlations, and economic values of each trait. However, if a selection index contains more traits, the genetic progress in selection decreases. Furthermore, it is not easy to combine health and welfare traits such as fitness in a breeding program because they are usually measured differently and have low heritability and uncertain economic values (Hocking, 2014). The positive effects of genetic selection on livestock species, especially cattle and poultry, as well as their effects on animal welfare are discussed using examples.

Domestication and selection have dramatically shaped the characteristics of species for thousands of years since their emergence. Conventional and genetic selection studies have undoubtedly contributed to improving performance or desirable traits in animals. Broiler chickens and dairy cows provide a clear example of increased productivity. In addition to the desired consequences of genetic selection, which aims at high profits, negative side effects are also recognizable. As a result of the selection of genetically superior individuals to increase production, animals are at greater risk in terms of behavioral, physiological, and immunity (Rauw et al., 1998). One reason for this risk could be that genetic selection leads to the loss of homeostatic balance in animals, leading to the development of pathologies and consequently to compromised animal welfare (Rauw et al., 1998).

Genetic selection has greatly increased the production of livestock species, particularly dairy cattle and chicken breeds. In addition to genetic selection, many factors such as environmental influences, breeding strategies, traditional selection studies, and modern molecular techniques have also led to this increase in animal production. Chicken breeds in particular are more affected by genetic selection because of their short generation. Therefore, the focus here is mainly on examples of poultry and dairy species.

Over the last century, the range of traits considered for genetic selection in dairy cattle herds has expanded to satisfy the needs of industry and society. In this context, the genetic selection for important characteristics has contributed to the growth and development of dairy farms. From the 1930s until the 1970s, the main goal of selection was to increase milk production (Miglior et al., 2017), and this purpose has maintained its continuity. Milk yield per cow has more than doubled over the past five decades with the help of genetic selection studies and the use of modern technology. A clear example of this increase can be shown in dairy cattle breeds in Canada throughout the time (Figure 1) (Brito et al., 2021).

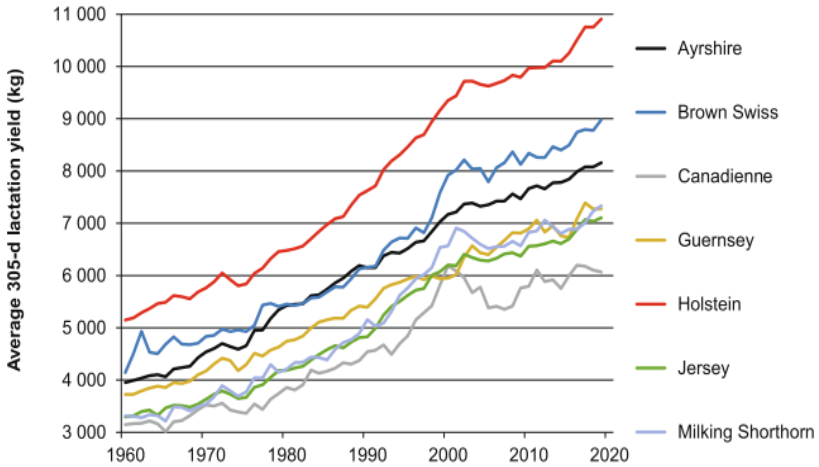

Figure 1. Lactation milk yields of dairy cattle breeds in Canada.

In many developed or emerging countries, such as the United States and China, milk production has increased and the number of farms and cows has decreased, corresponding to an increase in milk production (Brito et al., 2021). In fact, in addition to genetic selection studies, feeding practices, herd management, and the use of reproductive technologies have also contributed to this increase (Brito et al., 2021).

Increased animal production has led to health problems and reduced reproductive capacity, which in turn has led to reduced animal welfare (Brito et al., 2021; Oltenacu and Algers, 2005) because of negative genetic responses to traits such as fertility, health, etc. (Brito et al., 2021). In fact, it can be expected that the intensive selection will lead to deterioration in fertility and animal health. For many years, selective pressure has also reduced life expectancy and disease resistance, indicating poor dairy cow welfare. Unfortunately, the genetic selection is now increasingly seen as increasing farm profits at the expense of animal welfare (Oltenacu and Algers, 2005).

A significant increase in the number of genotyped dairy cows has enabled the identification of various recessive diseases. Most cattle diseases, such as Detilleux, depend on a variety of genetic traits (Morris et al., 2007; Weller et al., 2016). Potentially harmful interactions between genetic traits should be considered; In the past, applied genetic selection studies for traits such as milk production have led to animal welfare problems such as Weaver syndrome in Brown Swiss cattle (Hoeschele & Meinert, 1990). This syndrome, also called bovine progressive degenerative myeloencephalopathy, is a neurodegenerative disease characterized by progressive hindlimb weakness and ataxia (Baird et al., 1988; Kunz et al., 2016).

There is extensive research into the negative effects of selection on the welfare of dairy cows. Cow welfare and production profitability are important issues in sustainable animal husbandry programs. Among the determinants affecting production and profitability, fertility ranks first. Therefore, fertility is deemed a highly significant economic characteristic in animal husbandry. A decline in fertility increases the involuntary killing of animals. Therefore, fertility can be considered a welfare attribute (van Marle-Köster and Visser, 2021). Along with intensive selection, reproductive performance has declined in many countries, partly because of an unfavorable genetic relationship (Berlund, 2008). The use of artificial insemination (AI) has also led to a decline in fertility as a result of increased inbreeding in the dairy industry (Weigel, 2001). AI exerts its impact on fertility by decreasing animal welfare by increasing inbreeding. Similarly, the use of AI and intensive selection in the pig industry has led to an increase in harmful alles and embryo death caused by deadly mutations (Derks, 2019).

Similar welfare problems were also observed in poultry (Maudlin, 1995). Genetic selection has dramatically increased chickens’ ability to gain weight. The broiler production age decreased from 16 weeks to 47-48 days from 1925 to 2022, representing a 30% increase in growth rate (National Chicken Council, 2022). On the other hand, the egg production has also increased. The ancestors of today’s chickens laid approximately 25 eggs per year. Modern laying hens produce 310 eggs in 2010, while was 325 eggs per year in 2015 (Preisinger, 2018).

Genetic selection in broilers has focused on growth rate and feed efficiency over the past 60 years, which has led to significant welfare problems resulting in mortality (Hartcher et al., 2020).

Most rapid growth rate problems are leg disorders, bone deformation causing leg weakness, and cardiovascular diseases resulting in mortality by sudden death syndrome (Julian, 1998; Bradshaw et al., 2002; Siddiqui et al., 2009). The percentage of mortality in 2.98 kg (6.56 lb) broilers are 5.3% (National Chicken Council, 2022).

Beef and sheep are mainly raised in extensive systems, with breeding goals geared toward growth traits. In sheep farming, the number of lambs per birth is an important factor in profitability. However, the increased number of lambs per ewe has likely resulted in lower lamb survival rates, and increasing litter size may result in a pre-weaning mortality rate (Morel et al., 2018), which results in reduced animal welfare.

Livestock farming takes into account the production traits that bring the highest profit (Miglior et al., 2017). However, this bias was accompanied by a decline in other traits, mainly related to reproduction and welfare. Several variables influence the complex relationship between welfare and reproductive characteristics. For example, high levels of stress in animals are associated with reduced fertility (Ritter et al., 2019). A decline in fertility leads to an increase in involuntary culling of animals; Therefore, it is a reasonable conclusion that fertility can be accepted as a welfare trait (van Marle-Köster and Visser, 2021).

Dairy cow fertility is associated with lameness, which is linked with pain and stress that have a negative impact as a response to the reproductive cycle (Fitzgerald et al., 2012). Lameness has become an important production disease in livestock and affects many livestock species (Nalon and Stevenson, 2019). Lameness also occurs in all systems and has been ranked by the European Commission on welfare of dairy cows as one of the top three challenges to sheep welfare. In broilers, due to genetic selection for fast growth, many chickens suffer from painful leg disorders that lead to welfare problems (Knowles et al., 2008).

Some mutations have significant effects on the animal's growth rate and muscles. One of these, myostatin, is extensively studied in livestock because of its effects on growth traits (Georges, 2010). Myostatin is a well-studied locus that has been linked to a variety of quantitative and qualitative carcass and meat qualities in double muscle cattle (Ceccobelli et al., 2022). There are both advantages and disadvantages to using this gene in breeding studies. Inactivation of the myostatin (MSTN) gene increases skeletal muscle weight while decreasing fertility, dystocia, and calf survival (Arthur, 1995; Greger, 2011). This result gives cause for concern in terms of animal welfare.

3. SELECTION FOR IMPROVING ANIMAL WELFARE

Welfare traits vary among animals because of their complex genetic and environmental dependencies. These traits tend to be genetically complex and are influenced by numerous genes, each of which makes a small contribution. It is possible to reduce the frequency of a harmful allele affecting animal welfare in a selective population. However, it is extremely difficult to remove completely (Lush, 1945). Although known carrier individuals can be removed from the population, it is more frequent in practice to avoid carrier-to-carrier matings because carrier sires have high genetic value for economically relevant traits (Cole et al., 2016).

The heritability of welfare-related traits shows a significant variation although the influence of genotype on the expression of traits is typically less pronounced than that of environmental factors. Since the early 1980s, there has been increased awareness of welfare problems observed in animals and research into how to solve them (Moss, 1980; Curtis and Striclin, 1991). Studies have demonstrated that it is possible to eliminate undesirable welfare behaviors such as feather pecking in laying hens when selection pressure is placed on this trait (Kjaer et al., 2001). Feather pecking can result in important mortality rates, particularly in large flocks in non-cage systems (Rodenburg et al., 2004). Traditional family selection based on livability and feather condition in group cages has resulted in feather pecking (Icken et al., 2017).

The use of molecular genetics may hold promise for improving animal welfare. However, because of complex genetic and environmental dependencies, it is usually difficult to determine the genetic background of a situation that negatively impacts animal welfare. Lineage differences in feather pecking and cannibalism, as well as traits that may be linked to feather pecking, suggest that there is a genetic basis for these behavioral characteristics (Jones et al., 1995). Feather pecking is a heritable trait and exhibits moderate heritability that can be altered by selection (Kjaer and Sørensen, 1997;

Rodenburg et al., 2003). In the study by Ellen et al. (2007), it was observed that birds selected for low mortality traits in group housing were less anxious than unselected control lines. On the other hand, Bennewits et al. (2014) indicated that feather pecking might result in an unfavorable correlated selection response, reducing the egg production.

The survival of commercial laying hens is a crucial trait. Bird survival is greatly affected by feather pecking. To improve survival time, it is important to use quantitative genetic methods that consider both the direct and indirect genetic effects (Ellen and Bjma, 2019). It was found that within the total heritable variation, the direct genetic effects accounted for 13%–64%, whereas the indirect genetic effects accounted for 36%–87%, and both effects together accounted for 36–87% of the phonotypic variation in survival time (Ellen and Bijma, 2019). Ellen et al. (2007) theoretically showed that the response to selection can be improved by considering both direct and indirect genetic effects. Muir (1996) also showed that the group selection reduced mortality in the selected line from 68% in generation 2 to 9% in generation 6.

Selection based on the performance of animals is often practiced by commercial breeders. Selection for individual performance can simultaneously lead to the selection of undesirable behavioral traits, such as feather plucking and cannibalism, because these traits are absent in separately housed birds (Rodenburg et al., 2008). For feather pecking, an important welfare issue in egg production, it is not yet possible to define a genetic background (Wysocki et al., 2010). Until now, a large number of genetic loci have been mapped for feather pecking (Flint, 2003; Wysocki et al., 2010). Biscarini et al. (2010) found a link between the gene for the serotonin receptor HTR2C and feather damage. This association was significant in a population of nine purebred selection lines. Feather pecking in laying hens can apparently be controlled by modulating their serotonergic system through genetic selection (van Hierden et al. 2004), as there was a connection between the genes involved in the serotonergic system and feather pecking. It can be caused by endogenous and environmental factors. Despite the large number and variety of experiments carried out in recent years, it is still not possible to define a genetic background for feather pecking.

In the dairy industry, mastitis is one of the major problems affecting animal welfare and needs to be recognized as an important animal welfare issue (van Hierden et al. 2004; Rainard et al., 2016). Susceptibility to mastitis was associated with a rapid genetic increase in milk production, and genetic selection for mastitis resistance should be considered. To achieve a genetic improvement in mastitis resistance, the somatic cell score is used as an indicator trait (Shook and Schutz, 1994). The success of indirect selection depends on the high genetic correlation between the two traits. Somatic cell score has a heritability of approximately 10%, and the genetic correlation between somatic cell score and clinical mastitis is approximately 0.6–0.8 (Shook and Schutz, 1994). Therefore, using the somatic cell score in selection is a worthwhile approach. Selecting lower somatic cell counts is consistent with the goal of maximizing genetic improvement for overall economic benefit and should be incorporated into breeding programs (Shook and Schutz, 1994). Resistance to mastitis is extremely polygenic in that a large number of genes have only minor effects, making selection based on individual genes ineffective (Oget et al., 2019). On the other hand, in both dairy sheep and dairy cows, attempts are being made to determine molecular markers that can be used to determine genetically resistant animals to mastitis (Oget et al., 2019; Khan et al., 2022). There are many factors that play a role in the development of mastitis. These include animals (lactation stage, age, etc.), genetics (breed and line, etc.), and environmental factors (herd management and pathogenic species, etc.) (Oget et al., 2019). Therefore, further research is needed to understand the genetic mechanism of this disease.

The rising world temperature is another important factor that has a negative impact on animal welfare. Fluctuations in climatic variables (temperature, humidity and solar radiation) adversely affect livestock growth, reproduction, and production. Heat stress, for example, is a source of enormous financial losses for animal production worldwide and leads to animal welfare problems (Osei-Amponsah et al., 2019). Heat stress affects feed intake, growth, and milk production and places a significant financial burden on global animal production (Dunshea et al., 2013). Some candidate genes related to small ruminant adaptation, such as genes encoding growth hormone (GH), growth hormone receptor (GHR), and insulin-like growth factor (IGF-1), have been reported (Sejian et al., 2019). One of the thermotolerant genes, HSP70, is an ideal genetic marker of thermotolerance in small ruminants. Identifying such molecular markers could contribute to efforts to develop climate-resilient breeds that improve animal welfare. Genetic selection of animals adapted to heat stress is expected to increase production and welfare. Therefore, genetically identifying animals that adapt to high temperatures is an important first step. Significant progress has been made in this area (Boettcher et al., 2015). However, there are numerous limitations to the implementation of genomic selection, particularly in developing countries.

The Animal Welfare Council (2004) highlighted the urgent need to develop a farm welfare monitoring system to provide robust and reliable information on the prevalence of a range of health and welfare characteristics for different farm animal species and recommended significant new investments in molecular genetics in cattle and sheep.

4. GENOME EDITING IN ANIMAL WELFARE

Genome editing, a so-called controlled modification of the DNA of a living organism, has opened up the possibility of solving problems in animal production (Proudfoor et al., 2020). Genome editing technologies have the potential to increase the profitability and sustainability of animal production. This can be achieved by eliminating conditions that adversely impact animal welfare. Genome editing allows for the removal of unwanted chromosomal DNA as well as the up- or downregulation of endogenous gene expression patterns via knock-out or knock-in changes (Ricroch, 2019).

Farm animals' inability to resist disease and adaptation problems are important factors affecting animal welfare. In this sense, genome editing will not only improve farm animal resistance or tolerance to infections but also reduce unnecessary animal suffering and enhance animal welfare (Ricroch et al., 2017; Liu et al., 2022). For example, keeping horned cattle poses a risk of injury to oneself and to farmers. Physical dehorning of cattle serves to protect animals and farmers from accidental injury, but results in reduced well-being due to stress and pain (Carlson et al., 2016). Therefore, breeders tend to use naturally polled breeds of cattle that carry specific allelic variants on bovine chromosome 1 to produce polled livestock (Raza et al., 2022). However, this strategy has not been widely used because of the low genetic value of polled dairy sires (Mueller et al., 2019). Genome editing technology offers the opportunity to eliminate horniness, a recessive trait (Long and Gregory, 1978).

Three possible *POLLED* mutations, a complex duplication-insertion of a 202-bp fragment (P_{202ID}), an 80-kb fragment (P_{80kbID}), and a novel duplication-insertion event of a 219 -bp fragment (P_{219ID}), have been identified in the breeds of cattle or dual-purpose, Holstein and Mongolian Turano, respectively (Rothammer et al., 2014; Medugorac et al., 2012; Medugorac et al., 2017). Currently, naturally occurring structural variants that lead to polledness are known in most beef cattle. In one study, the polled Celtic variant of an Angus cow was successfully integrated into dairy cattle using genome editing tools and somatic cell cloning (Carlson et al., 2016). Simulation studies have also shown that gene editing is an effective way to reduce the frequency of recessive alleles (Cole, 2017).

Genome editing, particularly the use of site-specific nucleases such as the CRISPR system, has spread rapidly in the life sciences (Ricroch, 2019). Studies are being conducted on the application of genome editing technology for treating diseases (e.g mastitis and tuberculosis) in livestock (Wall et al., 2005; Maga et al., 2006; Tuggle et al., 2015).

Increasing disease resistance in animals not only improves animal welfare but also brings economic benefits to farmers and consumers. (Proudfoot and Burkard 2017). In this regard, the gene-editing technology shows promise, both in terms of contributing to future human nutritional needs and improving animal welfare. The CRISPR-Cas9 system can be used for editing animal genomes, such as bovine genomes, which could have a major impact on the development of animals resistant to important zoonotic diseases (Ricroch, 2019). There are various opportunities to improve stress and disease tolerance in African cow and chicken breeds. To combat trypanosomiasis in animals, for example, a proof of concept for the introduction of the apolipoprotein L1 (ApoL 1) gene into goats was presented, which has been proven to develop resistance to trypanosomiasis in primates using CRISPR/Cas9 (O'Toole et al., 2017).

In farm animals, genome editing has been used to improve disease resistance, better adapt cattle to agricultural or environmental conditions, increase fertility and growth, and improve animal wellbeing (Ricroch et al., 2017). In this regard, genome editing technologies have the potential to significantly increase animal productivity, profitability, and welfare. The increasing human population is expected to lead to an increase in the production of animals in the future, which will be accompanied by animal welfare problems. Therefore, it can be assumed that gene editing technologies will continue to be refined and widely used.

5. CONCLUSION

Over the last twenty years, the global livestock population, amount of animal products consumed, yield per animal unit have increased significantly. Undoubtedly, many factors influenced this increase. Modernization, traditional and genetic breeding studies are among the most important. In the future, the demand for food derived from animal products will be undoubtedly increased based on inceasing world population and competition for natural resources such as land and water. Therefore, the efficiency to be obtained from animals will be even higher than today. In this sense, the role of genetics is likely to become even more important in the future, both in increasing productivity and in animal welfare studies.

Welfare and genetics are very broad areas and extensive research is needed to fully uncover the relationships between them. What is encouraging today is that the molecular basis of some hereditary diseases that have a negative impact on animal welfare is known. However, important evidence remains on the genetic basis of some diseases affecting animal welfare. Although not currently widely used, technologies that enable gene editing and genotyping of animals will be used more effectively to improve animal welfare in the future

REFERENCES

Akunal, T., & Koknaroglu, H. (2021). Commercial native laying hybrids developed in Turkey are comparable to foreign hybrids in terms of performance and cultural energy use efficiency. Animal Science Papers & Reports, 39(2).

Anonymous. (2001). Scientists' assessment of the impact of housing and management on animal welfare. *Journal of Applied Animal Welfare Science*, *4*(1), 3-52.

Arthur, P. F. (1995). Double muscling in cattle: a review. Australian Journal of Agricultural Research, 46(8), 1493-1515.

Baird, J. D., Sarmiento, U. M., & Basrur, P. K. (1988). Bovine progressive degenerative myeloencephalopathy (weaver syndrome) in brown swiss cattle in Canada: a literature review and case report. The Canadian Veterinary Journal, 29(4), 370.

Bartlett, J. M., & Stirling, D. (2003). A short history of the polymerase chain reaction. PCR protocols, 3-6.

Bennewitz, J., Bögelein, S., Stratz, P., Rodehutscord, M., Piepho, H. P., Kjaer, J. B., & Bessei, W. (2014). Genetic parameters for feather pecking and aggressive behavior in a large F2-cross of laying hens using generalized linear mixed models. Poultry science, 93(4), 810-817.

Berglund, B. (2008). Genetic improvement of dairy cow reproductive performance. Reproduction in domestic animals, 43, 89-95..

Boettcher, P. J., Hoffmann, I., Baumung, R., Drucker, A. G., McManus, C., Berg, P., ... & Thompson, M. C. (2015). Genetic resources and genomics for adaptation of livestock to climate change. Frontiers in genetics, 5, 461.

Bradshaw, R. H., Kirkden, R. D., & Broom, D. M. (2002). A review of the aetiology and pathology of leg weakness in broilers in relation to welfare. Avian and poultry biology reviews, 13(2), 45-104.

Brito, L. F., Bedere, N., Douhard, F., Oliveira, H. R., Arnal, M., Peñagaricano, F., ... & Miglior, F. (2021). Genetic selection of high-yielding dairy cattle toward sustainable farming systems in a rapidly changing world. Animal, 15, 100292.

Carlson, D. F., Lancto, C. A., Zang, B., Kim, E. S., Walton, M., Oldeschulte, D., ... & Fahrenkrug, S. C. (2016). Production of hornless dairy cattle from genome-edited cell lines. Nature biotechnology, 34(5), 479-481.

Ceccobelli, S., Perini, F., Trombetta, M. F., Tavoletti, S., Lasagna, E., & Pasquini, M. (2022). Effect of myostatin gene mutation on slaughtering performance and meat quality in marchigiana bulls. Animals, 12(4), 518.

Cole, J. B. (2017). Management of Mendelian traits in breeding programs by gene editing: a simulation study. BioRxiv, 116459.

Cole, J. B., Null, D. J., & VanRaden, P. M. (2016). Phenotypic and genetic effects of recessive haplotypes on yield, longevity, and fertility. Journal of dairy science, 99(9), 7274-7288.

Curtis, S. E., & W. R. Stricklin. (1991). The importance of animal cognition in agricultural animal production systems—an overview. J. Anim. Sci. 69:5001–5007.

Derks, M. F., Gjuvsland, A. B., Bosse, M., Lopes, M. S., van Son, M., Harlizius, B., ... & Megens, H. J. (2019). Loss of function mutations in essential genes cause embryonic lethality in pigs. PLoS genetics, 15(3), e1008055.

Dunshea, F. R., Leury, B. J., Fahri, F., DiGiacomo, K., Hung, A., Chauhan, S., ... & Gaughan, J. B. (2013). Amelioration of thermal stress impacts in dairy cows. Animal Production Science, 53(9), 965-975.

Dwyer, C. M., Dwyer, C. M., & Lawrence, A. B. (2008). Introduction to animal welfare and the sheep (pp. 1-40). Springer Netherlands.

EFSA Panel on Animal Health and Welfare (AHAW). (2014). Scientific opinion on the welfare risks related to the farming of sheep for wool, meat and milk production. EFSA Journal, 12(12), 3933.

Ellen, E. D., & Bijma, P. (2019). Genetic solutions to reduce injurious pecking in laying hens. In Poultry feathers and skin: the poultry integument in health and welfare (pp. 47-56). Wallingford UK: CABI.

Foxcroft, G. R. (2012). Reproduction in farm animals in an era of rapid genetic change: will genetic change outpace our knowledge of physiology? Reproduction in Domestic Animals, 47, 313-319.

Georges, M. (2010). When less means more: impact of myostatin in animal breeding. Immunology, Endocrine & Metabolic Agents in Medicinal Chemistry (Formerly Current Medicinal Chemistry-Immunology, Endocrine and Metabolic Agents), 10(4), 240-248.

Grandin, T., & Deesing, M. J. (2022). Genetics and animal welfare. In Genetics and the behavior of domestic animals (pp. 507-548). Academic Press.

Greger, M. (2011). Transgenesis in animal agriculture: Addressing animal health and welfare concerns. Journal of agricultural and environmental ethics, 24, 451-472.

Hale, E. B. (1962). Domestication and the evolution of behaviour. In: The Behaviour of Domestic Animals (Hafez, E. S. E., ed.). Bailliére, Tindall & Cox Ltd, London, pp. 22—53.

Havenstein, G. B., Ferket, P. R., Scheideler, S. E., & Larson, B. T. (1994). Growth, livability, and feed conversion of 1957 vs 1991 broilers when fed "typical" 1957 and 1991 broiler diets. Poultry science, 73(12), 1785-1794.

Hocking, P. M. (2014). Unexpected consequences of genetic selection in broilers and turkeys: problems and solutions. British poultry science, 55(1), 1-12.

Hoeschele, I., & Meinert, T. R. (1990). Association of genetic defects with yield and type traits: the weaver locus effect on yield. Journal of dairy science, 73(9), 2503-2515.

Houdebine LM. (2018) Les nouveaux outils des biotechnologies animales. In: Regnault-Roger C, Houdebine LM, Ricroch A (Coordinateurs). Au-delà des OGM. Académie d'Agriculture de France et Presses des mines

Icken, W., Cavero, D., & Schmutz, M. (2017). Selection on beak shape to reduce feather pecking in laying hens. Lohmann Information, 51(1), 22-27.

Jackson, S., & Diamond, J. (1996). Metabolic and digestive responses to artificial selection in chickens. Evolution, 50(4), 1638-1650.

Jones, R. B., Blokhuis, H. J., & Beuving, G. (1995). Open-field and tonic immobility responses in domestic chicks of two genetic lines differing in their propensity to feather peck. British poultry science, 36(4), 525-530.

Julian, R. J. (1998). Rapid growth problems: ascites and skeletal deformities in broilers. Poultry science, 77(12), 1773-1780.

Khan, M. Z., Dari, G., Khan, A., & Yu, Y. (2022). Genetic polymorphisms of TRAPPC9 and CD4 genes and their association with milk production and mastitis resistance phenotypic traits in Chinese Holstein. Frontiers in Veterinary Science, 9, 1008497.

Kjaer, J. B., & Sørensen, P. (1997). Feather pecking behaviour in White Leghorns, a genetic study. British Poultry Science, 38(4), 333-341.

Kjaer, J. B., Sørensen, P., & Su, G. (2001). Divergent selection on feather pecking behaviour in laying hens (Gallus gallus domesticus). Applied Animal Behaviour Science, 71(3), 229-239.

Knowles, T. G., Kestin, S. C., Haslam, S. M., Brown, S. N., Green, L. E., Butterworth, A., ... & Nicol, C. J. (2008). Leg disorders in broiler chickens: prevalence, risk factors and prevention. PloS one, 3(2), e1545.

Kunz, E., Rothammer, S., Pausch, H., Schwarzenbacher, H., Seefried, F. R., Matiasek, K., ... & Medugorac, I. (2016). Confirmation of a non-synonymous SNP in PNPLA8 as a candidate causal mutation for Weaver syndrome in Brown Swiss cattle. Genetics Selection Evolution, 48, 1-14.

Lean, I. J., Westwood, C. T., & Playford, M. C. (2008). Livestock disease threats associated with intensification of pastoral dairy farming. New Zealand Veterinary Journal, 56(6), 261-269.

Liu, Z., Wu, T., Xiang, G., Wang, H., Wang, B., Feng, Z., ... & Li, K. (2022). Enhancing Animal Disease Resistance, Production Efficiency, and Welfare through Precise Genome Editing. International Journal of Molecular Sciences, 23(13), 7331.

Long, C. R., & Gregory K. E. (1978). Inheritance of the horned, scurred, and polled condition in cattle. Journal of Heredity, 69(6), 395-400.

Lush, J. L. (1943). Animal breeding plans. Animal breeding plans., (Edn 2).

Maga, E. A., Cullor, J. S., Smith, W., Anderson, G. B., & Murray, J. D. (2006). Human lysozyme expressed in the mammary gland of transgenic dairy goats can inhibit the growth of bacteria that cause mastitis and the cold-spoilage of milk. Foodbourne Pathogens & Disease, 3(4), 384-392.

Maudlin, J. M. (1995). Behavior and management of broiler breeder chickens. ASAE Pap, (954512).

Medugorac, I., Graf, A., Grohs, C., Rothammer, S., Zagdsuren, Y., Gladyr, E., ... & Capitan, A. (2017). Whole-genome analysis of introgressive hybridization and characterization of the bovine legacy of Mongolian yaks. Nature genetics, 49(3), 470-475.

Medugorac, I., Seichter, D., Graf, A., Russ, I., Blum, H., Göpel, K. H., ... & Krebs, S. (2012). Bovine polledness–an autosomal dominant trait with allelic heterogeneity. PloS one, 7(6), e39477.

Miglior, F., Fleming, A., Malchiodi, F., Brito, L. F., Martin, P., & Baes, C. F. (2017). A 100-Year Review: Identification and genetic selection of economically important traits in dairy cattle. Journal of dairy science, 100(12), 10251-10271.

Morel, P. C. H., Morris, S. T., & Kenyon, P. R. (2008). Effect of birthweight on survival in triplet-born lambs. Australian Journal of Experimental Agriculture, 48(7), 984-987.

Morris, C. A. (2007). A review of genetic resistance to disease in Bos taurus cattle. The Veterinary Journal, 174(3), 481-491.

Moss, R. (1980). The laying hen and its environment: a seminar in the EEC Programme of Coordination of Research on Animal Welfare, held at Luxembourg, March 11–13, 1980. M. Nijhoff for the Commission of the European Comumunities

Mueller, M. L., Cole, J. B., Sonstegard, T. S., & Van Eenennaam, A. L. (2019). Comparison of gene editing versus conventional breeding to introgress the POLLED allele into the US dairy cattle population. Journal of Dairy Science, 102(5), 4215-4226.

Muir, W. M. (1996). Group selection for adaptation to multiple-hen cages: selection program and direct responses. Poultry science, 75(4), 447-458.

Nalon, E., & Stevenson, P. (2019). Addressing lameness in farmed animals: An urgent need to achieve compliance with EU animal welfare law. Animals, 9(8), 576.

National Chicken Council (2022) U.S. https://www.nationalchickencouncil.org/about-the-industry/statistics/u-s-broiler-performance/accessed Agust 14, 2023)

O’Toole, J. F., Bruggeman, L. A., Madhavan, S., & Sedor, J. R. (2017, November). The cell biology of APOL1. In Seminars in nephrology (Vol. 37, No. 6, pp. 538-545). WB Saunders.

Oget, C., Tosser-Klopp, G., & Rupp, R. (2019). Genetic and genomic studies in ovine mastitis. Small Ruminant Research, 176, 55-64.

Oltenacu, P. A., & Algers, B. (2005). Selection for increased production and the welfare of dairy cows: are new breeding goals needed?. AMBIO: A Journal of the Human Environment, 34(4), 311-315.

Osei-Amponsah, R., Chauhan, S. S., Leury, B. J., Cheng, L., Cullen, B., Clarke, I. J., & Dunshea, F. R. (2019). Genetic selection for thermotolerance in ruminants. Animals, 9(11), 948.

Price, E. O. (1998). Behavioral genetics and the process of animal domestication. In: Genetics and the Behavior of Domestic Animals (Grandin, T., ed.). Academic Press, San Diego, pp. 31—65.

Proudfoot, C., & Burkard, C. (2017). Genome editing for disease resistance in livestock. Emerging Topics in Life Sciences, 1(2), 209-219.

Proudfoot, C., McFarlane, G., Whitelaw, B., & Lillico, S. (2020). Livestock breeding for the 21st century: The promise of the editing revolution. Frontiers of Agricultural Science and Engineering, 7(2), 129-135.

Rainard, P., Cunha, P., & Gilbert, F. B. (2016). Innate and adaptive immunity synergize to trigger inflammation in the mammary gland. PLoS One, 11(4), e0154172.

Rauw, W. M., Kanis, E., Noordhuizen-Stassen, E. N., & Grommers, F. J. (1998). Undesirable side effects of selection for high production efficiency in farm animals: a review. Livestock production science, 56(1), 15-33.

Raza, S. H. A., Hassanin, A. A., Pant, S. D., Bing, S., Sitohy, M. Z., Abdelnour, S. A., ... & Zan, L. (2022). Potentials, prospects and applications of genome editing technologies in livestock production. Saudi Journal of Biological Sciences, 29(4), 1928-1935.

Ricroch, A. (2019). Global developments of genome editing in agriculture. In Transgenic research (Vol. 28, pp. 45-52). Springer International Publishing.

Ricroch, A., Clairand, P., & Harwood, W. (2017). Use of CRISPR systems in plant genome editing: toward new opportunities in agriculture. Emerging Topics in Life Sciences, 1(2), 169-182.

Ridler, A. L. (2008). Disease threats to sheep associated with intensification of pastoral farming. New Zealand veterinary journal, 56(6), 270-273.

Ritter, C., Beaver, A., & von Keyserlingk, M. A. (2019). The complex relationship between welfare and reproduction in cattle. Reproduction in Domestic Animals, 54, 29-37.

Rodenburg, T. B., Buitenhuis, A. J., Ask, B., Uitdehaag, K. A., Koene, P., Van Der Poel, J. J., ... & Bovenhuis, H. (2004). Genetic and phenotypic correlations between feather pecking and open-field response in laying hens at two different ages. Behavior Genetics, 34, 407-415.

Rodenburg, T. B., Buitenhuis, A. J., Ask, B., Uitdehaag, K. A., Koene, P., Van Der Poel, J. J., & Bovenhuis, H. (2003). Heritability of feather pecking and open-field response of laying hens at two different ages. Poultry science, 82(6), 861-867.

Rodenburg, T. B., Komen, H., Ellen, E. D., Uitdehaag, K. A., & van Arendonk, J. A. (2008). Selection method and early-life history affect behavioural development, feather pecking and cannibalism in laying hens: A review. Applied Animal Behaviour Science, 110(3-4), 217-228.

Rothammer, S., Capitan, A., Mullaart, E., Seichter, D., Russ, I., & Medugorac, I. (2014). The 80-kb DNA duplication on BTA1 is the only remaining candidate mutation for the polled phenotype of Friesian origin. Genetics Selection Evolution, 46(1), 1-5.

SchuÈtz, K. E., & Jensen, P. (2001). Effects of resource allocation on behavioural strategies: a comparison of red junglefowl (Gallus gallus) and two domesticated breeds of poultry. *Ethology*, *107*(8), 753-765.

Sejian, V., Bagath, M., Krishnan, G., Rashamol, V. P., Pragna, P., Devaraj, C., & Bhatta, R. (2019). Genes for resilience to heat stress in small ruminants: A review. Small Ruminant Research, 173, 42-53.

Shook, G. E., & Schutz, M. M. (1994). Selection on somatic cell score to improve resistance to mastitis in the United States. Journal of Dairy Science, 77(2), 648-658.

Siddiqui, M. F. M. F., Patil, M. S., Khan, K. M., Khan, L. A., & Mafsu, A. M. (2009). Sudden death syndrome–an overview. Veterinary World, 2(11), 444-447.

Simm, G., Conington, J., Bishop, S. C., Dwyer, C. M., & Pattinson, S. (1996). Genetic selection for extensive conditions. Applied Animal Behaviour Science, 49(1), 47-59.

Tuggle, C. K., & Waters, W. R. (2015). Tuberculosis-resistant transgenic cattle. Proceedings of the National Academy of Sciences, 112(13), 3854-3855.

van Hierden, Y. M., Koolhaas, J. M., & Korte, S. M. (2004). Chronic increase of dietary L-tryptophan decreases gentle feather pecking behaviour. Applied Animal Behaviour Science, 89(1-2), 71-84.

van Marle-Köster, E., & Visser, C. (2021). Unintended consequences of selection for increased production on the health and welfare of livestock. Archives Animal Breeding, 64(1), 177-185.

Wall, R. J., Powell, A. M., Paape, M. J., Kerr, D. E., Bannerman, D. D., Pursel, V. G., ... & Hawk, H. W. (2005). Genetically enhanced cows resist intramammary Staphylococcus aureus infection. Nature biotechnology, 23(4), 445-451.

Wehmeier, S. (2005). Oxford advanced learner's dictionary. Oxford University Press.

Weigel, K. A. (2001). Controlling inbreeding in modern breeding programs. Journal of Dairy Science, 84, E177-E184.

Weller, J. I., & Ezra, E. (2016). Genetic analysis of calving traits by the multi-trait individual animal model. Journal of Dairy Science, 99(1), 427-442.

Wysocki, M., Bessei, W., Kjaer, J. B., & Bennewitz, J. (2010). Genetic and physiological factors influencing feather pecking in chickens. World's Poultry Science Journal, 66(4), 659-672.

CHAPTER 5

WELFARE PRACTICES IN ORGANIC ANIMAL HUSBANDRY

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1. INTRODUCTION

Organic agriculture and products derived from organic agriculture have become a trend topic of the last period. Studies to demonstrate the interest of consumers and producers in this system have also started to increase (Manuelian et al., 2020).

The definition of organic agriculture is a production technique in which synthetic and chemical inputs are not used, alternative methods are applied in the fight against diseases and pests, aiming to increase product quality and sustainability, sensitive to human, animal and environmental health and subject to control and certification at every stage (Boz and Yamak, 2018).

In 2016, the United Nations Committee on World Food Security approved "animal welfare as part of sustainable agricultural development, food security and nutrition" (Marchant-Forde, 2015). This has become the issue of greatest interest for consumers. In addition, the World Health Organization has linked animal welfare to human health (Pinillos et al., 2016). Consumers are willing to pay more for products produced under conditions of higher animal welfare (Nurse, 2016; Alonso et al., 2020). People have become more concerned about the inclusion of animal species welfare in national and international legislation (Mellor, 2016; Dwyer, 2020; Papageorgiou et al., 2023).

Animal welfare refers to the physical and psychological condition in which an animal lives and ends its life. This definition was made by the World Organization for Animal Health (OIE). According to this definition, the fact that an animal lives healthy, is well fed, is raised in comfortable and welfare conditions, exhibits its natural behaviors, and is kept away from pain, fear and stress indicates that the animal has welfare living conditions (OIE, 2019).

In animal production, 4 main welfare parameters are applied. These are

- Good Housing
- Good Nutrition
- Good Health
- Appropriate Behavior (Welfare Quality, 2009).

In addition, five freedom clauses were defined by the Farm Animal Welfare Committee in 1979. These articles are given below (Yamak, 2018; Sungur, 2020).

1. Prevention of hunger and thirst (ensuring access to fresh water and feed to maintain the animal's health),
2. Prevention of discomfort (providing the animal with a suitable housing environment with shelter and a comfortable resting area),
3. Prevention of pain, injury and disease (protection of the animal from disease and prompt treatment if the animal is ill)
4. Freedom to exhibit normal behavior (providing the animal with adequate housing and facilities, keeping the animal with its conspecifics),
5. Prevention of fear and stress (providing conditions and care to prevent mental disturbance).

Figure 1. Poultry roaming in the grassland (Anonymous, 2023b)

In this study, organic animal husbandry and its relationship with animal welfare were examined based on the world literature and the "Regulation on the Principles and Implementation of Organic Agriculture" published by the Republic of Turkey.

2. PROSPERITY IN PRODUCTION CONDITIONS

- Animals in organic production conditions must be raised within a certain order and practice. Production takes place within certain rules. These rules are minimum and every practice that increases the welfare level will be an important parameter in the animal breeding-welfare dilemma. Within these rules, the following regulations must be followed with utmost attention (Akerfeldt et al., 2021; Anonymous, 2023a). First, information on breeding material in organic animal production is presented.
- For breeding production in organic animal husbandry, breeds with the highest adaptability to environmental conditions should be selected and bred.
- Likewise, breeding animals should be resistant and resistant to diseases.
- What is important in animal welfare is the selection of breeds adapted to the region where they are raised. For this reason, breeds or hybrids that are adapted to the region as much as possible should be preferred first.
- It is preferable to choose these breeding animals from breeds whose genetic structure has not been altered and which are well adapted to the region.
- Apart from these, for the welfare level of breeding animals to be high,
- Animals need space and flooring for resting and lying down.
- Adequate and necessary equipment must be available in the conditions in which animals are housed,
- Lying down and resting should be possible both indoors and outdoors.
- There should be no cleaning problems in the bodies of animals during lying and resting.
- Animals should be provided with ease of movement both indoors and outdoors.

Figure 2. Cleaning and hygiene in organic livestock shelters (Anonymous, 2023c)

Figure 3. Organic sheep farming and pasture (Anonymous, 2023d)

Figure 4. Organic beekeeping (Anonymous, 2023e)

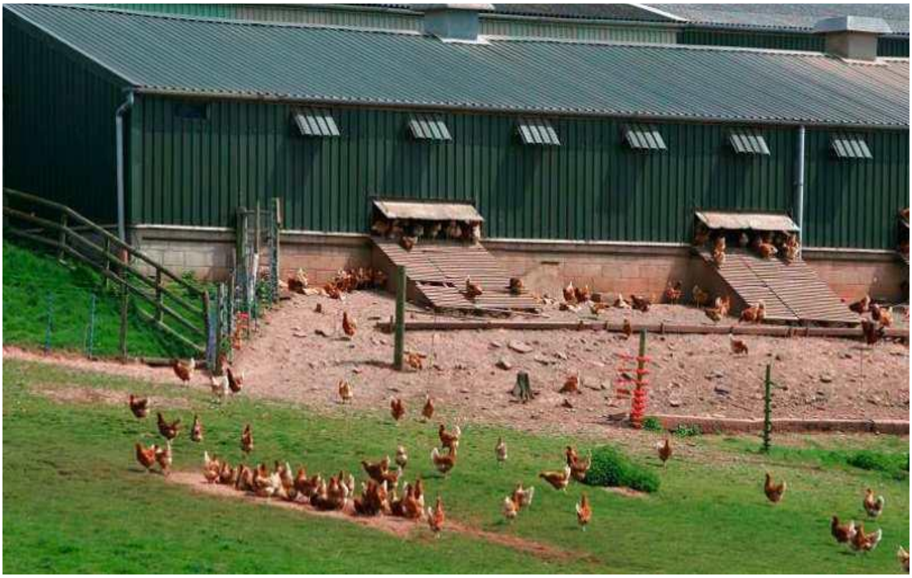

Figure 5. Organic poultry production shelter and promenade (Anonymous, 2023f)

- In organic animal production, the following practices regarding animal health, welfare and freedom of behavior are guaranteed by regulation in all animal groups (bovine, ovine, poultry) and other production groups (fattening, egg production, milk production, etc.) in addition to breeding breeding (Anonymous, 2023a; EFSA, 2023).

- The methods used for tail docking in sheep breeding, such as elastic banding, slaughtering, tooth cutting, dehorning, horn blunting and beak cutting in poultry and live plucking are not practiced (EFSA, 2023).

- If dehorning is compulsory, it can be carried out with the permission and control of authorized institutions for safety, animal health, comfort and hygiene.

- It should be carried out by people of appropriate age and expertise. It should be carried out without causing pain to the animals.

- Especially cattle cannot be kept tied up. In order to realize this situation, it can be applied for a limited period of time and taking into account animal welfare regulations.

- If it is not possible to keep them in a group in accordance with their behavioral needs in cattle breeding with ten heads or less, they can be kept tied in these areas at least twice a week in order to reach grazing areas and open shelter areas or exercise areas. The permission of the authorized body is also required for this to happen.

- If animals are raised in groups, the size of the group is determined depending on the developmental stages and behavioral patterns of the animal species. Animals are not kept in conditions that encourage anemia and are not fed with rations that encourage it.

- Animal shelters are constructed from sanitary building materials. Shelter conditions are designed to meet the biological and breed needs of animals.

- Animals have easy access to feed and water within the shelter.

- Factors such as insulation, heating and ventilation of the buildings to be used in production, air flow, dust level, temperature, relative humidity and gas density are kept within limits that will not harm animals.

- Shelters allow ample natural ventilation and light penetration.

- Adequate protection against rain, wind, sun and extreme heat is provided in free-range areas, open-air roaming areas or open shelter areas, depending on local weather conditions and the species concerned (EFSA, 2023).

- Shelters are large enough for animals to stand comfortably and naturally, lie down easily, turn around, clean themselves, assume all natural positions, and perform all natural movements such as stretching and flapping their wings.

- The minimum areas of closed shelters and open promenade areas are specified in the regulations. Production is carried out in accordance with these rules. These areas are calculated in accordance with animal health and welfare.

- In regions where climatic conditions allow animals to live outdoors, animal shelters are not obligatory. They are allowed to live completely outdoors.

- Shelters, poultry houses, tools and containers are properly cleaned and disinfected to prevent the development or transmission of disease-carrying organisms.

- Products with active ingredients specified in the regulation can be used for cleaning and disinfecting animal buildings and structures.

- Feces, urine and spilled and scattered food are removed from the environment in order to combat insects and rodents and reduce odor in the enterprise.

- In case insects and other rodents cannot be removed from animal shelters and other facilities despite the measures and precautions taken, rodenticides can be used.

- All mammals are provided with access to grazing or outdoor exercise areas and open shelter areas. Animals can use these places as long as the psychological conditions of the animals, weather conditions and the condition of the land permit.

- Herbivores have access to pastures as long as conditions permit. If herbivores have access to pastures during grazing periods and winter shelters allow them freedom of movement, it is not mandatory to provide open promenades and open areas for animals during the winter months. However, bulls older than one year should have access to pastures, open pastures and open areas.

- In animal shelters, the floor is level and made in a slip-resistant manner. At least half of the floor is flat and hard.

- The litter in the shelter consists of stalks, straw or other suitable natural materials. The material used as litter can be improved and strengthened with any mineral substance that is allowed to be used as fertilizer in organic farming.

- In cattle breeding, calves are not kept in individual pens after 1 week of age.

- Poultry are raised in open rearing conditions and are not kept in cages.

- Aquatic poultry have access to rivers, ponds and lakes for animal comfort or hygiene reasons, as long as climatic conditions permit (EFSA, 2023).

- Poultry have access to open-air shelters when climatic conditions permit and this is practiced for at least 1/3 of their lives.

- These open-air shelters are often covered with vegetation and include protective facilities.

- These open-air shelters have sufficient waterers and feeders for animals.

- In order to protect public and animal health, necessary biosecurity measures are taken to prevent animals from going outside.

- For health reasons in poultry farming, poultry houses are left empty between two breeding periods, during which time buildings and installations are cleaned and disinfected (EFSA, 2023).

- In addition, once the rearing of each poultry group is completed, the roaming areas are left empty for health reasons, allowing vegetation to regrow (EFSA, 2023).

As can be seen, organic animal production conditions and practices are completely focused on animal welfare. It is important to raise awareness of consumers on this issue. Because both chemical-free and welfare and animal rights-respecting production is put forward.

3. WELFARE IN ANIMAL NUTRITION

In organic animal husbandry, organically produced roughage and concentrate feeds are used in feeding. In this system, it is forbidden to subject animals to forced feeding. However, milk feeding is compulsory for a certain period of time for animals that need to be fed with milk. They are encouraged to be fed in pastures where they can exhibit their natural behavior (Anonymous, 2023a). Products that they can consume in their natural lives are also provided under organic animal production conditions.

In this system, especially the prevention of forced feeding is an important issue in terms of animal welfare. For example, the production of fatty liver with forced feeding, intensive feeding and short-term fattening do not exist in organic animal production. These are positive developments in terms of welfare (Duval et al., 2020).

Chemical solvents are included in the feed at maximum rates. These can be applied in mandatory situations. Apart from health issues, the use of antibiotics and forcing animals to grow are also prohibited. The use of feeds derived from genetically modified organisms is also prohibited due to possible effects on animal health and welfare. The addition of natural flavors during the production - processing or storage of organic feed is allowed. Apart from these, substances and techniques that can restore lost properties, correct the consequences of negligence during processing or cause misunderstandings about the true nature of these products cannot be used. Genetically modified organisms cannot be used as raw materials or inputs in organic animal production. The use of growth or production enhancing substances and the use of hormones or similar substances to control reproduction or for other purposes are also prohibited (Duval et al., 2020; Anonymous, 2023a).

All these practices allow animals to roam and feed on pastures in conditions suitable for their nature and to exhibit their natural behaviors. Therefore, organic animal production offers suitable conditions for feeding in terms of animal welfare.

4. ANIMAL HEALTH AND WELFARE

The most important title in organic animal production is that the animals used should be highly adaptable to environmental conditions and resistant to diseases (Anonymous, 2023a). In this way, fewer problems related to the health of animals will be encountered. In addition, animals without special health problems and diseases in breeding production can be used in organic animal production.

In organic animal production, preventive measures are more important than disease control. In this regard, preventive medicine practice is at the forefront. In order to increase the natural immunity of the animals, they are provided with access to the promenade areas or pastures for regular exercise and the use of quality feed. Due to the dense settlement density, appropriate settlement density is provided to prevent health problems in animals (Duval et al., 2020; Anonymous, 2023a).

Birkhofer et al. (2016) reported that health problems can occur when non-organic feeds are used in animal feeding. The reason may be the pesticides and pesticides used during the growing period of the raw material. For this reason, it is important to use organic pesticides and additives in the organic production system. The parasite burden and leg health of animals roaming outside can also cause problems in organic production (Akerfeldt et al., 2021). Such problems should never be ignored when increasing welfare (Röös et al., 2018).

Wagner et al. (2021) reported that the organic production system is better than the conventional production system in terms of animal welfare-related health. In his study, he determined that the relationship between welfare and health in animals can change not only with regulations but also with the specific management of the enterprises.

The rules specified in the regulations may be insufficient to solve problems related to animal welfare and health. For this reason, information and training on health and welfare should also be provided at the farm level. The process not only on animals but also in plant production should be well monitored.

5. ANIMAL TRANSPORTATION AND SLAUGHTER WELFARE

In organic animal production, transportation conditions and slaughter conditions are carried out within the framework of the rules determined by regulations. In addition, practices are carried out to increase the level of welfare and to eliminate fear and stress. This subject is among the subjects on which much work has been done.

In our country, the "Regulation on the Principles and Implementation of Organic Agriculture" has set rules on the transportation and slaughter standards of organically produced animals (Duval et al., 2020; Anonymous, 2023a). When we take a look at these, the rules to be followed in the transportation of animals are as follows;

- If organically raised animals are to be transported, the transportation process should be carried out in a stress-free manner and in a short time.

- Great care should be taken in loading and unloading the animals into and out of the vehicles. Electrical stimuli should not be used to force animals to perform these operations.

- Animals should not be given any sedative or medication before or during transportation.

- If animals are to be transported by land transportation, feeding, watering and resting should be done every 8 hours and a break should be taken.

- If feeding is to be done during transportation for transportation, the components of these feeds should be recorded and a list should be kept.

Figure 6. Transportation and unloading of animals (Anonymous, 2023g)

- During the slaughter of animals raised in organic production and separated for slaughter, the stress situation should be carefully monitored and stress factors should be eliminated.

- Animals should be treated in a way that does not cause stress.

As can be seen, the regulation attaches great importance to the welfare of animals in transportation and slaughter conditions. Organic farming is not only a production model but also offers an important welfare standard.

6. CONCLUSION

Duval et al. (2020) reported that in the future, regulations on organic livestock production should focus on welfare standards. This approach is expected to put pressure on farming outside the organic production system and lead to improvements. Increased efforts to improve animal welfare are demanded. Animal welfare is one of the most important issues in organic animal husbandry. Since it is based on animal rights and welfare, it is set out in the regulations in this way. The regulations include maximum welfare practices in organically raised animals and require their implementation.

One of the most important issues in animal production, access to the outdoor environment and the opportunity to exercise is guaranteed in this system. This situation is important in terms of animal welfare health.

It is also important for humanity that living creatures on earth are well in terms of health and quality of life. With this basic perspective, organic production provides important gains in animal welfare. Studies on the applicability of these gains outside of organic animal production should continue.

In the organic system, the feeding, growth, slaughtering and processing of animals into products continue with certain procedures. Animal welfare is better in organic animal husbandry than in other production systems because it is open to continuous inspection and is carried out by authorized companies.

REFERENCES

Akerfeldt, M.P., Gunnarsson, S., Bernes, G., Blanco-Penedo, I. (2021). Health and welfare in organic livestock production systems—a systematic mapping of current knowledge. Organic Agriculture, 11: 105–132.

Alonso, M.E., González-Montaña, J.R., Lomillos, J.M. (2020). Consumers' Concerns and Perceptions of Farm Animal Welfare. Animals, 10: 385.

Anonymous, (2023a). Organik Tarimin Esaslari Ve Uygulanmasina İlişkin Yönetmelik. (Access Date: 10.07.2023). https://www.resmigazete.gov.tr/eskiler/2010/08/20100818-4.htm. (in Turkish).

Anonymous, (2023b). https://apelasyon.com/yazi/92/organik-kanatli-yetistiriciligi), (Access Date: 10.07.2023).

Anonymous, (2023c). https://www.gidahatti.com/makale/11521765/huseyin-sungur/neden-hayvan-refahi, (Access Date: 10.07.2023).

Anonymous, (2023d). https://www.tarimdunyasi.net/2016/06/30/yeni-zelandanin-koyun-varligi-azalirken-et-uretimi-artiyor/, (Access Date: 10.07.2023).

Anonymous, 2023e). https://www.yasamicingida.com/tarim/hayvancilik/organik-aricilara-kovan-destegi/, (Access Date: 10.07.2023).

Anonymous, (2023f). https://organiktavuk.com/index22.html, (Access Date: 10.07.2023).

Anonymous, (2023f). Bayburt İl Tarım ve Orman Müdürlüğü (tarimorman.gov.tr), Access Date: 10.07.2023).

Birkhofer, K., Smith, H.G., Rundlöf, M. (2016). Environmental Impacts of Organic Farming. In: eLS. John Wiley & Sons, Ltd. pp. 1-7. Chichester. doi: 10.1002/9780470015902.a0026341

Boz, M.A., Yamak, U.S. (2018). Organik hayvancılık. Zootekni (Hayvan Yetiştirme ve Besleme. Editor, Yamak, U.S. Pp. 291-303. ISBN: 978-605-245-323-0. Ceylan Ofset, Samsun. (in Turkish)

Duval, E., von Keyserlingk, M.A.G., Lecorps, B. (2020). Organic Dairy Cattle: Do European Union Regulations Promote Animal Welfare? Animals, 10(10):1786.

Dwyer, C.M. (2020). Can improving animal welfare contribute to sustainability and productivity? BSJ Agric., 3: 61–65.

EFSA, (2023). AHAW Panel (EFSA Panel on Animal Health and Animal Welfare), Nielsen, S.S., Alvarez, J., Bicout, D.J., Calistri, P., Canali, E., Drewe, J.A., Garin-Bastuji, B., Gonzales Rojas, J.L., Schmidt, C.G., Herskin, M., Michel, V., Miranda Chueca, M.A., Padalino, B., Roberts, H.C., Spoolder, H., Stahl, K., Viltrop, A., Winckler, C., Berg, C., Edwards, S., Knierim, U., Riber, A., Salamon, A., Tiemann, I., Fabris, C., Manakidou, A., Mosbach-Schulz, O., Van der Stede, Y., Vitali, M., Velarde, A, Scientific Opinion on the welfare of ducks, geese and quail on farm. EFSA Journal 2023;21(5):7992, 157 pp. ISSN: 1831-4732. https://doi.org/10.2903/j. efsa.2023.7992.

Manuelian, C.L., Penasa, M., da Costa, L., Burbi, S., Righi, F., De Marchi, M., (2020). Organic livestock production: a bibliometric Review. Animals, 10 (4): 618.

Marchant-Forde, J.N. (2015). The science of animal behavior and welfare: Challenges, opportunities, and global perspective. Front. Vet. Sci., 2, 16.

Mellor, D.J. (2016). Updating animal welfare thinking: Moving beyond the “Five Freedoms” towards “a LifeWorth Living”. Animals, 6: 21.

Nurse, A. (2016). Beyond the property debate: Animal welfare as a public good. Contemp. Justice Rev., 19: 174–187.

OIE, (2019). World Organization for Animal Health. Introduction to the recommendations for animal welfare (Terrestrial Animal Health Code Article 7.1.1., 235–236). OIE, Paris, France.

Papageorgiou, M., Goliomytis, M., Tzamaloukas, O., Miltiadou, D., Simitzis, P. (2023). Positive Welfare Indicators and Their Association with Sustainable Management Systems in Poultry. Sustainability, 15: 10890.

Pinillos, R.C., Appleby, M.C., Manteca, X., Scott-Park, F., Smith, C., Velarde, A. (2016). One Welfare-A platform for improving human and animal welfare. Vet. Rec., 179: 412-413.

Röös, E., Mie, A., Wivstad, M., Salomon, E., Johansson, B., Gunnarsson, S., Wallenbeck, A., Hoffmann, R., Nilsson, U., Sundberg, C., Christine, A. (2018). Watson Risks and opportunities of increasing yields in organic farming. A review. Agron. Sustain. Dev. 38; 14.

Sungur, H. (2020). Neden hayvan refahı. https://www.gidahatti.com/makale/11521765/huseyin-sungur/neden-hayvan-refahi. (Access Date: 14.08.2023). (in Turkish)

Yamak, U.S. (2018). Hayvan refahı. Zootekni (Hayvan Yetiştirme ve Besleme. Editor, Yamak, U.S. Pp. 281-287. ISBN: 978-605-245-323-0. Ceylan Ofset, Samsun. (in Turkish)

Welfare Quality (WQ), (2009). Welfare Quality Assessment Protocol for Cattle. Welfare Quality Consortium, Lelystad, Netherlands.

CHAPTER 6

WELFARE ORIENTED NUTRITION PRACTICES IN FARM ANIMALS

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1. INTRODUCTION

There are various approaches to the assessment of animal welfare. One of the most common of these different approaches is the "5 freedoms" concept, which was introduced in the UK and is based on assessing whether the following five factors are valid in measuring animal welfare (Farm Animal Welfare Council, 1993).

1. Freedom from thirst, hunger and malnutrition
2. Freedom from discomfort
3. Freedom from pain, injury and disease
4. Freedom to express normal behaviour
5. Freedom from fear and distress

Among the concepts included in the five freedoms, nutrition is an extremely important part of animal welfare and is part of almost every definition of animal welfare. Although adequate nutrition is stated as the first condition to be met in almost all animal welfare statements (Farm Animal Welfare Council, 1993, Kyriazakis and Savory, 1997), the definition of adequate nutrition is left vague, not emphasised and most of the studies in the literature focus on the relationship between welfare and the other four items. However, malnutrition is an important problem that not only causes animals to feel hunger but also damages their biological functions and disrupts all metabolic activities, leading to a decrease in the overall quality of life of animals and a decrease in their productivity. Adequate and balanced nutrition of animals is directly related to their health. This relationship is bidirectional, and nutritional disorders in animals can affect health, and deterioration of health triggers nutritional disorders in general. Proper nutrition is an indispensable condition for the prevention of diseases caused by improper, inadequate or unbalanced feeding of animals, as well as for the fight against new diseases after the treatment of microbial diseases and for the reorganisation of animal productivity. Farm animals are raised for economic efficiency. The higher the yield, the more intense the metabolism of the animal. Feeding should be adjusted in a correct and balanced way in order to maintain the healthy lives of especially high-yielding animals. Mistakes in feeding can be caused by many factors such as feed quality, feed quantity, feed form, suitability of the ration, and all of them ultimately cause a nutritional disorder. These nutritional disorders may cause diseases in organs and tissues, metabolic disorders, poisoning and behavioural disorders (Figure 1). Inadequate feed, energy and nutrient intake, insufficient quality feed, failure to meet nutrient requirements and misuse of requirement norms lead to inadequate supply of energy and essential metabolites in animals. This situation is expressed as malnutrition. The quality of feed raw materials that make up a ration is closely related to feed disorders. Health disorders caused by improper feeding are expressed as feeding errors. Inadequate feeding, feed disorders and feeding errors are related to each other and are defined as "malnutrition".

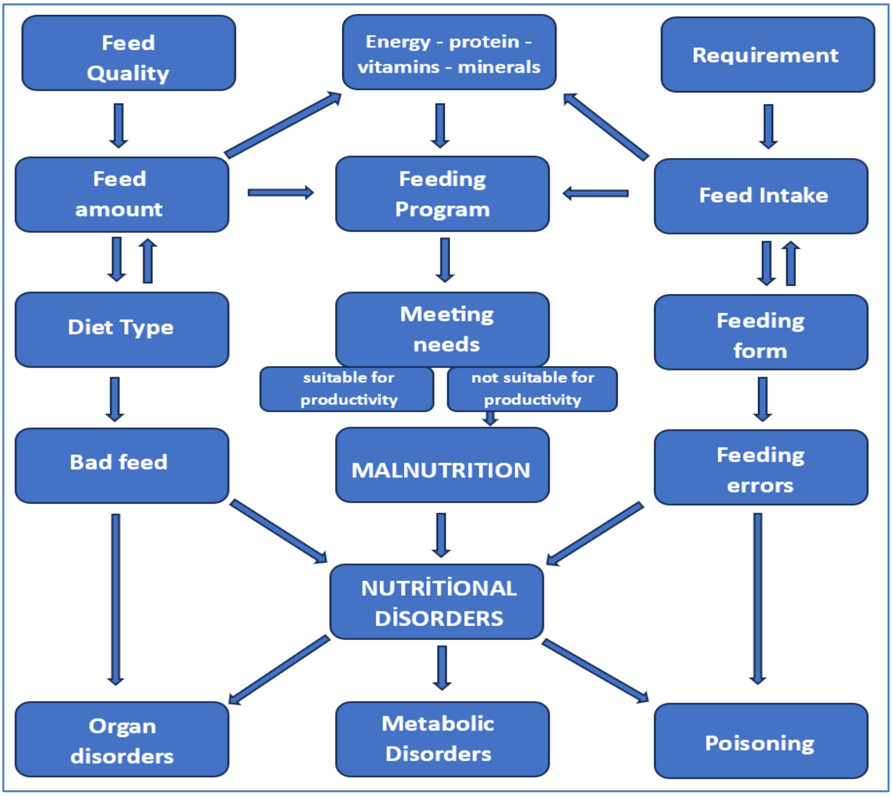

Figure 1. Relationships between feeding programme and health disorders (Ergün et al. 2008).

Inadequate or unbalanced nutrition is also known to cause behavioural problems beyond the health of the animals. Behavioural problems are considered to be an indicator of poor welfare (Cronin et al. 1986) and this is already the most important reason for examining animal behaviour in welfare assessment. For example, low energy intake increases tail biting behaviour in pregnant pigs (Robert et al., 2002), salt or essential amino acid deficiencies increase tail biting behaviour in fattening pigs (Fraser, 1987), and can cause feather pulling and cannibalism in poultry (Bearse et al. 1940, Scott et al., 1954, Cain et al., 1984, Blokhuis 1989, Ambrosen and Petersen, 1997). In many animal species, it can be seen that various nutrient imbalances due to improper feeding may cause undesirable behaviours in animals.

Both these undesirable behaviours and metabolic diseases based on improper, inadequate or unbalanced feeding are considered as poor welfare indicators that may adversely affect animals. In this context, when we consider feeding practices in farm animals on the basis of welfare, applying the correct feeding practices for the correct and balanced nutrition of animals is the main way, while an additional research area may be studies on feed selection.

2. CORRECT AND BALANCED NUTRITION OF FARM ANIMALS ON THE BASIS OF WELFARE

2. 1. Nutrition and Welfare of Poultry

The overall objective of poultry nutrition is to maximise the economic production performance of poultry. The ration is formulated by least-cost linear programming to provide specific levels of nutrients required for optimum performance. The main production criteria are body weight, egg production, feed conversion, health and body composition.

The amount of protein required to provide adequate amino acid balance depends on the amino acid content of feed raw materials and the use of synthetic amino acids. The most costly input of rations is protein and it is seen that the first limiting amino acid requirement increases in direct proportion to the crude protein (CP) content of the ration (Whitehead, 2002). Therefore, in terms of cost, it is desirable to formulate rations on the basis of the lowest economic CP that can meet amino acid needs. Failure to meet any amino acid requirement may result in growth suppression in broiler chickens. In laying hens, protein or amino acid deficiency may reduce egg weight, while a more severe deficiency may affect egg production. Poultry regulate their feed intake to meet their metabolisable energy (ME) requirements (Leeson and Summers, 2005). Therefore, a good energy-protein balance is essential for rations. An animal that will consume less of a high-energy ration will consequently not be able to obtain the protein and amino acid levels it requires. Manipulation of the ME/CP ratio in the diet has been used as a tool to control body fatness of market broilers, especially in finisher diets. In broilers, growth and body composition can be altered by varying the protein (and amino acids) and energy contents of the ration at different periods. This practice is not thought to have any detrimental welfare effects, even if a broiler does not reach its maximum weight for a given age (Whitehead, 2002). When the correlations between rapid growth potential and a range of metabolic disorders in poultry are considered together, it may even be beneficial for a broiler not to reach its maximum growth potential. There are more welfare issues in laying hens, where heavy feed intake leading to excessive energy supplementation can lead to excessive body fat accumulation and death from fatty liver syndrome.

Changes in diet composition can be made to help birds cope with stress. For poultry exposed to heat stress, the following can be applied:

- Reducing the crude protein content of the ration,
- Using synthetic amino acids to acquire optimum amino acid intake,
- Balancing the proportion of ME supplied by usage of fat will help to reduce feed heat gain and metabolic heat production by the birds.

If some of the sodium addition to the ration is provided in the form of bicarbonate, the electrolyte balance can be maintained at desired levels. Some metabolic problems caused by heat stress can be alleviated by adding vitamin C, which is not necessary for poultry under normal conditions, to drinking water or ration (Leeson and Summers, 2005). It has been reported that the addition of vitamin E at the level of 250 mg/kg to laying hen diets exposed to heat stress helps to eliminate the decline in egg production (Whitehead, 2002). In other stress situations such as disease, the addition of various vitamins to the ration, especially vitamins A and E, may help to strengthen the immunological system (Whitehead, 2002). It has been reported that the addition of selenium (Se), vitamin E and zinc (Zn) to the rations of breeding male geese, which have decreased sperm quantity and quality in the summer months outside the cool breeding period, has been reported to improve both testicular histological parameters and sperm quality factors (Baş et al. 2023, Taşkesen et al. 2023). In some broiler breeding practices, vitamin supplements are removed from the ration before release to the market in order to save costs. This practice is unfavourable in terms of welfare as it changes the balance in a critical period.

The addition of vitamins E and C, in particular, can help overcome transport-related stress and improve the welfare and meat quality of animals brought to the slaughterhouse (Whitehead 2002).

Nutrition can also influence the occurrence or severity of various metabolic disorders. Some metabolic disorders, even if they are not actually related to nutrition, can be counteracted through ration composition or manipulation of the ration. This is especially valid for conditions such as leg problems, which are associated with rapid growth. The frequency of mentioned problems can be reduced by slowing down growth using various ration manipulations. The use of crumble or powdered feeds instead of pellet feeds or feed restriction has been reported to reduce the incidence of ascites and sudden death syndrome (SDS) in poultry (Whitehead 2002). Furthermore, the use of ration calcium or calcium/phosphorus ratios which are above NRC (1994) recommendations has been reported to increase mortality from SDS (Whitehead 2002).

Fatty liver and kidney problems, which caused serious broiler losses 50 years ago, can now be prevented by the addition of biotin to the diet (Whitehead et al., 1976). The most common metabolic disorder directly related to nutrition is tibial dyschondroplasia (TD). Various nutritional factors have been associated with this condition. Decrease in Ca/P ratio in the ration increases the occurrence of TD. Electrolyte balance between different anions and cations, especially Na^+, K and $C1^-$, may also be a factor in the development of TD; metabolic acidosis caused by high C1- content is associated with an increase in incidence, while alkalosis is associated with a decrease. Among the factors affecting the formation of Tibial Dyschondroplasia, the most important one related to feeding is the level of anions and cations in the ration. Studies have been conducted on the effects of anions such as chlorine (Cl^-), sulphate (SO_4^-2), phosphate (PO_4^{-3}) and cations such as calcium (Ca), sodium (Na), magnesium (Mg) and potassium (K). It has been reported by different researchers that increasing the amount of Cl in the ration increases TD formation and increasing the Ca ratio decreases it (Bond et al., 1991; Murakami et al., 1999; Rondon et al., 1999). However, it has not been conclusively shown that improving electrolyte balance is an effective strategy to prevent TD (Whitehead 2002). Vitamin D supplementation to the diet is the most effective way to prevent TD in broilers. Supplementation with 25-dihydroxyvitamin D has been shown to completely prevent TD in broiler chickens (Edwards, 1990).

One of the most common nutritional problems in laying hens is osteoporosis, which causes cage fatigue (Whitehead and Fleming, 2000). Although feeding has no direct effect on this process, the problem can be alleviated by the following feeding measures:

- Adequate supply of calcium, phosphorus and vitamin D,
- the use of calcium source in particulate form,
- the use of a ration with increased calcium content at the beginning of the ovulation period,
- no feed withdrawal before moult (Whitehead 2002).

Nutrition can also indirectly affect bird welfare by influencing the environment. The use of high levels of sodium salt in the ration can increase the water content of faeces, resulting in wet litter. Furthermore, high levels of raw materials which are rich in non-starch polysaccharides (NSPs), which birds cannot digest, can increase the water content of litter, while excessive crude protein concentrations can increase the nitrogen content of litter and cause foot lesions (Meluzzi and Sirri, 2009).

2. 2. Nutrition and Welfare of Ruminants

Nutritional systems of ruminant animals is different from non-ruminants. The nutrients taken by monogastric animals can be estimated from the raw materials of the ration they consume. If a nutrient in the ration is considered to be deficient, this deficiency can be corrected by additions to the ration. However, in ruminants, where grazing is a major part of the diet, we cant precisely know the the quantity or quality of feed intake. Even when the composition of the ration is known, such as in cattle kept in feedlots and fed under control, feed analysis does not directly indicate nutrient supply due to microbial fermentation in the rumen. Therefore, ruminant nutrition systems are more difficult to manage than monogastric animal systems, hence malnutrition is a bigger risk (Hogan and Phillips, 2008). While the digestive enzymes of monogastric animals can break down the alpha-bonds in starch in cereals, breaking of beta-bonded cellulose consumed by ruminants depends on the rumen microorganisms. In addition, the fact that most of the ration protein is catabolised in the rumen forces ruminants to digest microbial proteins synthesised in the rumen in the small intestine in order to obtain essential amino acids (Hogan and Phillips, 2008).

The difficulties experienced by breeders in determining the nutrient requirements of ruminant animals and the important effect of nutrition on the welfare of ruminant animals have led researchers to determine nutrient intake and animal performance by two methods. The first one considers the evaluation of the energy balance, which is the difference between the gross energy intake from feed and the losses due to energy expended for survival and yield share. In order to do this, digestible energy, metabolisable energy and net energy intake are calculated, and these energies spent in faeces, urine, fermentation gases and heat production are subtracted from the gross energy intake from feed. The energy spent for heat varies depending on whether the net energy is used for weight maintenance or production. The magnitude of energy losses experienced can be high enough to be associated with animal welfare (Hogan and Phillips, 2008). The digestibility of grasses grown in cooler climates is almost 15 per cent less digestible than those grown in warmer regions (Minson, 1990). Faecal energy expenditure can reach up to 60 per cent of gross energy intake (Hogan and Phillips, 2008). Reduced digestibility correspondingly reduces the intake of metabolisable energy, since in a varied feeding pattern, metabolisable energy accounts for approximately 81% of digestible energy for ruminants (Hogan and Phillips, 2008). The amount of energy utilised, released as heat energy, varies depending on whether the animal is fed at or above the survival level. For example, Armstrong (1964) reported that when a feed with 64% digestibility was used, heat energy accounted for 14% of gross energy in animals fed below the survival margin and 31% of gross energy in animals fed at the efficiency margin. Based on this, it can be said that animals fed at the efficiency margin are more resistant to cold stress than animals fed at the survival margin (Hogan and Phillips, 2008).

Another method is to try to understand the differences between the nutritional values of feeds and their causes by conducting digestibility studies in different parts of the digestive system. These studies (AFRC 1993; Freer et al., 2007) are based on determining the proportion of compounds that are and are not converted into compounds favourable for the animal as a result of the degradation of organic substances taken in feeds by rumen microorganisms and intestinal digestion.

Animal welfare can also be compromised by inadequate feed intake as a factor other than feed composition. Feed intake in ruminants can vary depending on many vegetation, the environment or the animal itself (Hogan and Phillips, 2008). In terms of vegetation, the composition of the available pasture, its easy access, the level of vegetation growth and the chemicals it contains, including various toxic substances, will have a direct impact on the animal's feed intake. Grasses that are too short or low in density can reduce feed intake (Weston, 2002). While there is limited information in the literature on the effects of plant taste on feed intake (Weston, 2002), one of the important factors affecting feed intake under intensive grazing conditions is plant maturity. Immature plants have relatively low levels of cellulose and are therefore rapidly fermented in the rumen. Grazing ruminants prefer a leaf-dominated diet. This selective grazing depends on the species of ruminant, with wide-mouthed cattle being less selective than narrow-mouthed sheep and goats. As vegetation maturity increases, grasses become more fibrous and highly lignified and therefore less fermentable, protein and mineral levels decrease and nutritional value decreases. In the late stages, the vegetation consists almost entirely of highly lignified stems that are devoid of protein and minerals and can only be slowly fermented. With this type of diet, feed intake of ruminants can be reduced to the point where welfare is threatened (Hogan and Phillips, 2008).

Environmental conditions affecting feed intake include temperature, frost, rainfall, presence of parasites, distances to be traveled to obtain feed and water, and the availability and accessibility of drinking water. This quality of drinking water is considered particularly important when salt-based mineral blocks used to compensate for mineral deficiencies in animal diets are placed away from drinking water. In such cases, supplements provided to improve animal welfare can actually act in the opposite way, causing excessive increases in plasma osmolarity (Hogan and Phillips, 2008). Another of the factors influencing feed intake are those related to the animals themselves. These can be summarised as genotype and environment interactions, the ability to move, graze and/or roam, their physiological state and the interaction of the digestive system with various feeds. The capacity of animals to consume and utilize feed is related to their ability to walk smoothly and without problems and to have sound teeth and mouth structure. The development of robust limbs and efficient locomotion, especially in young developing animals, can be impaired by inadequate or unbalanced calcium and phosphorus sources that cause lameness. Problems with dietary calcium and phosphorus can also be observed during the development of permanent teeth. The "milk teeth" with which the young animal is born are gradually replaced by permanent teeth. This is an important period in sheep, occurring between 3 and 6 months of age, and requires a properly adjusted, optimized supply of calcium and phosphorus (Hogan and Phillips, 2008). Lambs weaned on a wheat grain diet, in which Ca ratios remained low relative to phosphorus, were reported to fail to develop a full set of intact teeth, either incisors or molars, and showed low productivity for the rest of their lives (Franklin, 1950).

All these processes need to be carried out properly for the welfare of the animal. Also inability to remove gas causes bloat development, which is a condition observed in some feed mills (Cheng et al., 1998) and in some fast fermenting pastures (Phillips et al., 1996) where gas pressure leads to animal death. If necessary, regulating the mineral balance of grasses by fertilising the vegetation eliminates the risk of bloat. The arrest of rumen movements due to the effect of some plant toxins, while blocking the flow of the digestive system, facilitates toxin absorption by delaying excretion from the system, thus endangering the animal's life (Hogan and Phillips, 2008).

3. ANTIOXIDANTS AND FARM ANİMAL WELFARE or “-OMICS” BASED APPROACHES

The term "-omics" refers to several biological fields in biology that have names ending with the -omics prefix, such as genomics, proteomics, metabolomics, transcriptomics, etc. Omics is intended to enable the collective identification and quantification of collections of biomolecules which determines the form, function and dynamics of organisms. (Subedi et al, 2022).

Numerous studies have reported that many of the most common and severe infectious diseases in farm animals are fundamentally associated with oxidative stress (Skaperda et al., 2019). In particular, the development of common diseases such as pneumonia, enteritis and sepsis is associated with disturbances in animal redox status and underlying oxidative changes that cause damage to biomolecules (proteins, lipids and DNA) (Skaperda et al., 2019). Oxidation of macromolecules produces a variety of end products that can be measured and characterized as redox markers to assess oxidative stress in vivo (Veskoukis et al., 2019). Based on this, various biomarkers are used in biological fluids and tissues to determine the impact of oxidative stress on livestock welfare. Protein oxidation has been reported to be an indicator of parasitic, bacterial and viral infections and to cause various pathological conditions (Celi and Gabai, 2015). Reducing protein oxidation seems to be a good method to improve livestock welfare, protect them from diseases (Skaperda et al., 2019), improve meat quality (Velasko and Williams, 2011) and even improve sperm quality (Taşkesen et al., 2022) by improving testicular histology (Baş et al., 2023). One of the ways to reduce oxidation is to use natural antioxidants found in feeds. As reported by Skaperda et al. (2019), increases in meat or milk quality have been reported in studies in sheep (Lobón et al., 2017) and cattle (Castillo et al., 2013), in addition to large clinical trials conducted to investigate the putative benefit of antioxidant supplements in disease prevention. Gene Skaperda et al. (2019) reported that feeding diets containing bioactive compounds derived from winery by-products improved the redox profile of livestock. It was reported that diets supplemented with grape pomace reduced the effects of oxidative stress and improved redox status and hence health in chickens, protecting them from protein oxidation and lipid peroxidation and increasing reduced glutathione (GSH) in blood and various tissues (Makri et al., 2017). When the same feed was tested in lambs, the growth of probiotic bacteria improved, while the growth of pathogen populations such as Enterobacteriacae and E. Coli was reported (Kafantaris et al., 2017). It has been reported that similar treatments can be used to reduce oxidative stress to proteins and lipids in broiler chickens, and piglets have lower omega 6 / omega 3 and PUFA/MUFA ratio compared to the control group, which may also improve health by reducing oxidative stress in dairy cows (Skaperda et al., 2019). All these observations indicate the importance of administering natural antioxidants with beneficial properties in terms of improving the redox status of farm animals and promote animal welfare. The determination of oxidative damage in livestock is important for understanding the basic procedures related to diseases and metabolic disorders. Therefore, in order to avoid high mortality rates of farm animals from the aforementioned diseases and to protect their tissues from the harmful oxidation process, it may be useful to analyse and study their redox molecular background by measuring specific redox markers (Figure 2) (Skaperda et al., 2019).

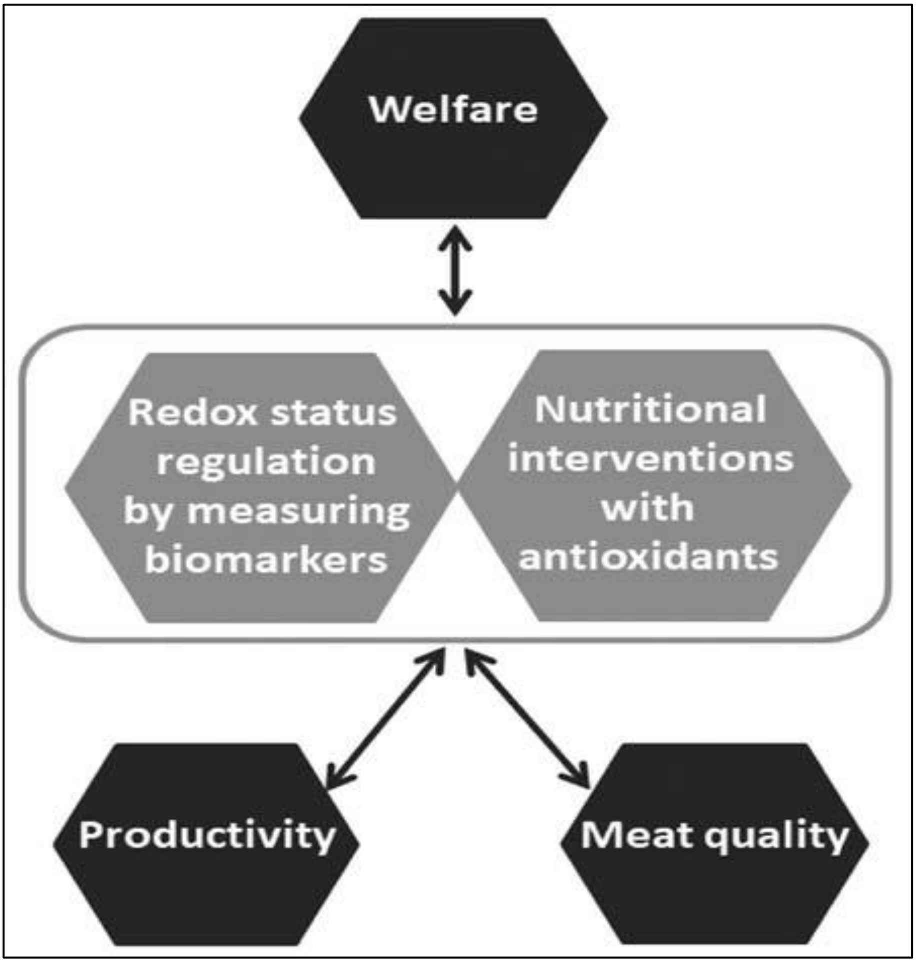

Figure 2. Interactions between welfare of livestock and antioxidant supplementation to diets (Skaperda et al. 2019).

4. FEED CHOICE AS A WELFARE PRACTICE

4. 1. Feed Choice

Although feed selection of animals is a promising research area, research on the relationship between diet selection and animal welfare is limited (Manteca et al., 2008). Since livestock farming is based on an economic basis, researchers are intensively engaged in studies linked to increasing the yield of animals or the quality of products, and producers implement practices accordingly. This usually leads to intensive feeding of animals in terms of macronutrients (energy and protein). It is clear that nutrient deficiency is stressful for every organism, but nutrient excesses or nutrient imbalances are also known to be harmful to animals (Okuyan and Filya, 2003; Provenza et al., 2003; Leeson and Summers, 2005).

Researchers who suggest that there may be a relationship between feed diversity and animal welfare approach the issue mainly through the importance of choice (Manteca et al., 2008; Villalba et al., 2010, Nielsen et al., 2016). Providing animals with the opportunity to choose among various feed alternatives may be important for animal welfare for three reasons:

- Individual needs and preferences: even the circumstances of individuals for whom a particular ration is appropriate may vary within a meal, from meal to meal and between days. These preferences cannot be expressed without dietary diversity;

- Even if a foodstuff contains an excess or deficiency of nutrients for a particular animal, this may not be the case for a different animal due to physiological differences, even between individuals from the same herd or family; and

- The availability of alternatives may allow animals to better cope with toxins and parasite burdens, reducing the incidence of disease (Manteca et al., 2008).

According to these researchers, allowing animals to choose their own rations can improve their productivity and welfare, as monotonous rations may not fully meet the daily needs of individuals in the herd and may even provide excess nutrients. Thus, the availability of alternatives can improve the ability of animals individually and collectively to increase their intrinsic and environmentally specific nutrient efficiency as well as reduce stress levels (Figure 3).

This proposition that animal welfare and ration choice are closely linked is based on the assertion that not only do all animals differ from each other in terms of their individual needs, but that the needs of each individual vary considerably over time depending on many factors such as individuality, temporal satiation, biochemical complementarity and environmental context (Manteca et al, 2008). Thus, mandatory uniform feeding favours the welfare of some individuals less than others, with no ration being able to fully meet the specific needs of a given individual. Therefore, uniform feeding systems, by their very nature, are detrimental to animal welfare and violate freedom (Manteca et al, 2008; Villalba and Provenza, 2009; Villalba et al, 2010).
Studies in this area emphasise "individuality", suggesting that the productivity of a herd can be negatively affected if animals that differ from the average are fed a uniform ration formulated to meet the needs of the "average" individual (Manteca et al., 2008). An example of such a study was conducted by Atwood et al. (2001), in which fattening calves had ad libitum access to a chopped, mixed ration consisting of barley (31.3%), maize (31.3%), maize silage (15.5%) and alfalfa hay (18.9%), or could choose from these individually offered raw materials. It was reported that animals fed the total mixed ration (TMR) or free choice of the constituents of the TMR did not differ in their average protein/energy ratio over the 63-day trial (43 vs. 43 g CP/Mcal ME; $P = 0.50$). However, the $P = 0.50$ value here is suggestive. The related study also has economic implications. Animals given a mixed ration tended to eat more (109 vs 102 g/kg MBW/day; $P = 0.10$), but did not gain weight faster (0.89 vs 0.92 kg/day; $P = 0.65$) than animals offered a choice. While feed evaluation was reported to be similar for both groups (0.09 vs 0.10 kg/kg; $P = 0.38$), daily feed cost was reported to be higher for animals fed a mixed ration compared to those offered an option ($1.58 vs $1.36; $P = 0.03$). Consequently, cost/kg gain was reported to be higher in the mixed ration group than in the option group ($1.84 vs. $1.49/kg; $P = 0.045$) (Atwood et al., 2001).

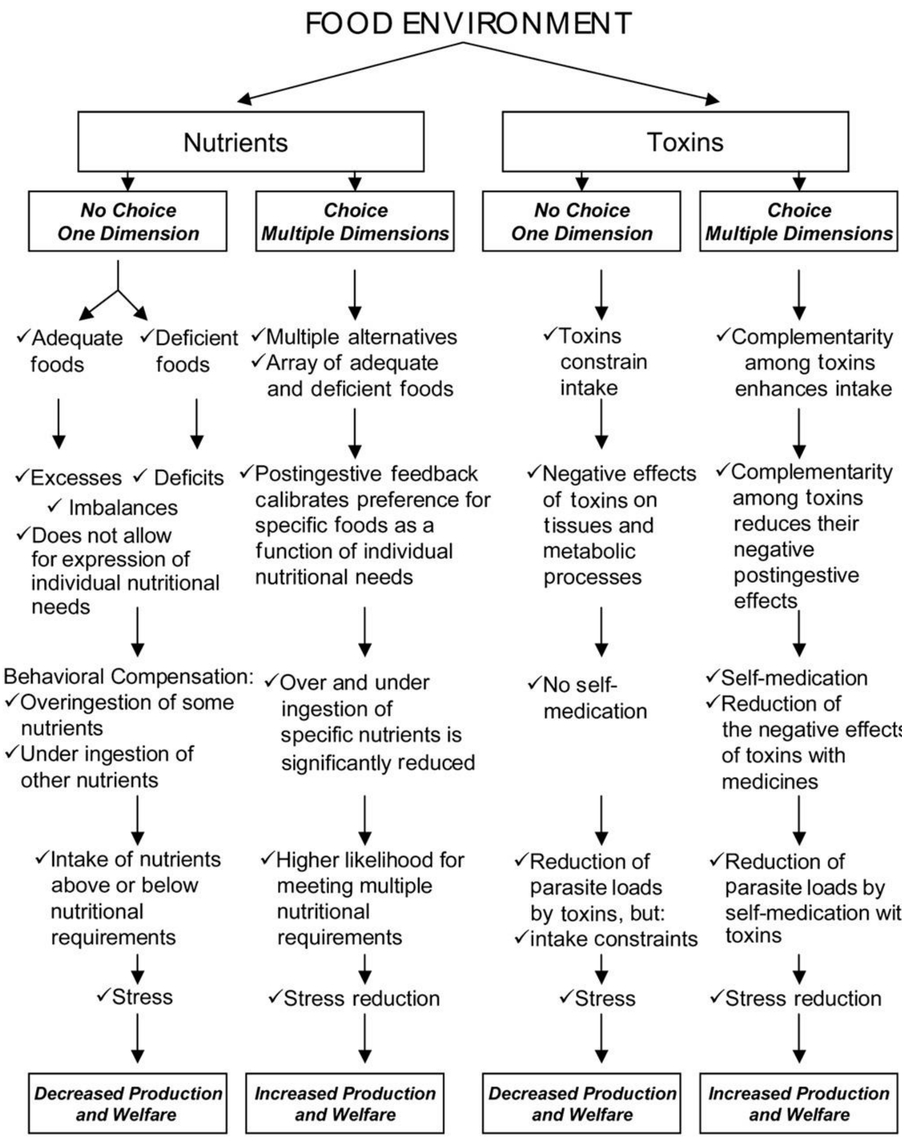

Figure 3. Free feed choice and animal welfare interactions (Manteca et al., 2008).

Based on these findings, the researchers conclude that;

- Animals are able to fulfil their individual needs for macronutrients more efficiently when given a choice between ration ingredients;

- Temporary anorexia increases the inefficiency of a single mixed diet by suppressing consumption, even among animals with the corresponding nutritional profile;
- Alternative feeding practices can reduce disease and improve performance through better nutrition of animals.

4. 2. Biochemical Complementarity

Although there is a large number and variety of chemicals ingested by livestock in feed, many research focus on the effects of these chemicals individually. Studies examining multiple interactions between different compounds show that feed selection is important for animal welfare (Provenza et al., 2003).

4. 2. 1. Nutrient-nutrient interactions

When different nutrients interact, behavioural responses depend on the characteristics of the interaction. Animals show a greater preference for diets with favourable energy and protein ratios, whereas in the opposite case preference is reduced (Kyriazakis and Oldham, 1997; Villalba and Provenza, 1997). The release of by-products of energy and nitrogen metabolism at different times causes accumulation of organic acids and ammonia, which reduces preference (Cooper et al., 1995; Francis, 2003). These relationships, which increase or decrease preference by affecting feed intake, affect animal welfare. Fermentable carbohydrate and nitrogen intake optimises microbial protein synthesis and increases the amount of degradable nitrogen in the rumen (Sinclair et al., 1995). However, when ammonia formation exceeds the rate of carbohydrate fermentation, microorganisms cannot utilise nitrogen efficiently and too much nitrogen is lost in the urine (Russell et al., 1992). High nitrogen/energy levels cause ammonia toxicity (Lobley and Milano, 1997), while excessive energy increase triggers acidosis (Francis, 2003).

4. 2. 2. Toxin-toxin interactions

It has been suggested that livestock are generally not harmed by poisonous plants when given a choice during grazing, that a plant community with a variety of toxins will allow animals to take in more nutrients while toxin intake will remain at levels that do not affect welfare. According to some researchers, since each toxin affects different organs and different detoxification processes related to these organs, consuming a dilute mixture of related toxins may be less toxic than consuming a larger dose of each toxin (Manteca et al. 2008). In studies conducted in this field, it has been reported that the coexistence of feeds containing toxins may lead to beneficial results depending on their interactions with each other, and that the consumption of feeds together may give more favorable results than the consumption of any feed alone (Manteca et al., 2008). For example, it has been observed that feed intake increased when rats consumed tannins and saponins together because tannins and saponins chelate in the intestinal tract, reducing the negative effects of both components (Freeland et al., 1985), but no such complementary relationship has been reported in sheep. (Burritt and Provenza, 2000). It has been reported that when ewes were offered free-choice diets containing either amygdalin or lithium chloride, they ate more feed than lambs given a diet containing only one of these toxins; similar patterns were observed for nitrate and oxalate selection (Burritt and Provenza, 2000). When 3 different feeds containing terpenes, tannins and oxalates were presented on a choice basis, sheep were reported to eat more of the feeds containing only 1 or 2 of these toxins (Villalba et al., 2004). They were also reported to eat more of the feed containing terpenes when they first ate the feed containing tannins (Mote et al., 2008). It was reported that ewes given the opportunity to choose feeds containing spartein or saponin ate less of both feeds than lambs given feeds containing only one of these compounds, and it was stated that this was due to the fact that these toxins were not complementary to each other (Manteca et al., 2008).

4. 2. 3. Nutrient-toxin interactions

Since the detoxification and elimination processes of plant toxins require nutrients such as nitrogen and glucose (Illius and Jessop, 1995), animals can tolerate more toxin-containing foods when they receive sufficient energy and protein. Lambs may consume more LiCl as ration energy content increases (Wang and Provenza, 1996). Similarly, it has been reported that sheep fed diets with high energy or protein contents and containing terpenes can tolerate more terpenes, as there is a positive relationship between available energy or protein and terpene intake (Villalba and Provenza, 2005). Balancing energy and protein levels increases the ability of sheep and goats to consume feeds containing various toxins such as terpenes (Banner et al., 2000), tannins (Villalba et al., 2002) and saponins (Williams et al., 1992; Martinez et al., 1993). However, livestock limit toxin intake when nutrients such as sodium are in short supply (Freeland et al., 1985; Freeland and Choquenot, 1990). Furthermore, some researchers, who consider the beneficial antiparasitic effects of tannins (Athanasiadou et al., 2000), based on the "dose kills, not poison" argument, suggest that livestock can reduce their parasite burden by consuming foods high in tannins (Hutchings et al., 2003).

5. CONCLUSION

Animal production is a commercial sector and generally aims to maximise profit in a sustainable manner. In any given region, environmental and nutritional constraints, together with the consideration of animal welfare, may initially force decisions about the nature of the enterprise. Conversely, welfare regulations are important in enabling livestock enterprises to be structurally improved by ensuring that animals, the main input of livestock production practices, are healthy, free from poor care and feeding conditions and raised under more optimised conditions. Although feeding practices tend to be summarised as "good feeding" when discussing animal welfare practices, as mentioned above, there are research and applications to improve the welfare of animals with many different feeding approaches. Regardless of which system is used, it is likely that animals will encounter one or more of the health or welfare problems mentioned. As there will often be more than one cause for the poor performance of animals in a given area, techniques are available to diagnose these causes and suggest the correct method of addressing the problem. For example, supplementary feeding can be used to improve or prevent mineral deficiencies. If animals are suffering from energy deficiency, the breeder must decide how much weight loss can be tolerated and develop feeding strategies to keep animals at the desired weight using the cheapest available energy sources. To address protein deficiency and related problems, it is generally recommended to use sulfur-amended urea and an energy source for rumen micro-organisms in ruminants, while digestible synthetic amino acids can be added to rations in animals with simple stomachs. In extreme cases, it may be necessary to remove animals from affected areas in conjunction with efforts to eradicate harmful plants. In non-severe cases, restricting grazing in areas where noxious plants are present can be effective. In the case of plant toxins, the selection method proposed in the referenced studies could be considered. A similar situation may apply to mineral toxicities. Such toxicities are imposed on the animal receiving mineral supplements, for example if phosphate supplements are contaminated with cadmium, other sources of phosphorus may be considered. Whatever the nutritional issue, the owner and manager are responsible for the welfare of the animals in their care. It is therefore a moral obligation to take into account recommendations regarding animal nutrition.

REFERENCES

AFRC (1993). Energy and protein requirements of ruminant, an advisory manual prepared by the AFRC (Agricultural and Food Research Council) Technical Committee on responses to nutrients. Wallingford: CAB International.

Ambrosen, T., and Petersen, V.E. (1997). The influence of protein level in the diet on cannibalism and quality of plumage of layers. Poultry Science 76: 559-563.

Armstrong, D.G. (1964). Evaluation of artificially dried grass as a source of energy for sheep II. The energy value of cocksfoot, timothy and two strains of ryegrass at varying stages of maturity. J Agric Sci. 62:399-416.

Athanasiadou, S., Kyriazakis, I., Jackson, F., Coop, R.L. (2000). Effects of short-term exposure to condensed tannins on adult Trichostrongylus colubriformis. Vet. Rec. 146, 728-732.

Atwood, S.B., Provenza, F.D., Wiedmeier, R.D., Banner, R.E. (2001). Influence of free-choice vs. mixed-ration diets on food intake and performance of fattening calves. J. Anim. Sci. 79, 3034-3040.

Banner, R.E., Rogosic, J., Burritt, E.A., Provenza, F.D. (2000). Supplemental barley and charcoal increase intake of sagebrush by lambs. J. Range Manag. 53, 415-420.

Baş, H., Taşkesen, H.O., Boz, M.A., Sarıca, M., Erensoy, K., Dotas, V., Symeon, G. (2023) The Effects of Varying Combinations of Dietary Selenium, Vitamin E, and Zinc Supplements on Antioxidant Enzyme Activity, and Developmental and Histological Traits in Testicular Tissues of 1-Year-Old Native Turkish Ganders. Sustainability. 15(16):12245. https://doi.org/10.3390/su151612245

Bearse, G, E., Miller, M.I., McClary, G.F. (1940). The cannibalism preventing properties of fiber fraction of oat hulls. Poultry Science 18; 210-214.

Blokhuis, H.J. (1989). The effect of a sudden change in floor type on pecking behaviour in chicks. Appl. Anim. Behav. Sci. 22, 65-73.

Bond, P.L., Sullvan. T.W., Douglas, J.D., Robenson, L.G. (1991). Influence of age, sex and method of rearing on tibia lenght and minereal deposition in broilers, Poultry Science, 70: 1936- 1942.

Burritt, E.A., Provenza, F.D. (2000). Role of toxins in intake of varied diets by sheep. J. Chem. Ecol. 26, 1991-2005.

Castillo, C., Pereira, V., Abuelo, Á., Hernández, J. (2013). Effect of supplementation with antioxidants on the quality of bovine milk and meat production. Scientific World Journal, 616068

Celi, P., and Gabai, G. (2015). Oxidant/antioxidant balance in animal nutrition and health: The role of protein oxidation. Front Vet Sci 2: 48.

Cain, J.R., Weber, J.M., Lockamy, T.A., and Creger, C.R. (1984). Grower diets and bird density effects ongrowth and canibalism in ring-necked pheasants. Poultry Science 63: 450-457.

Cheng, K.J., McAllister, T.A., Popp, J.D., Hristov, A.N., Mir, Z., Shin, H.T. (1998). A review of bloat in feedlot cattle. J. Anim. Sci. 76, 299-308.

Cooper, S.D.B., Kyriazakis, I., Nolan, J.V., Anderson, D.H. (1995). Diet selection in sheep: the role of the rumen environment in the selection of a diet from two feeds that differ in their energy density. Br. J. Nut. 74, 39-54.

Cronin, G.M., van Tartwijk, J.M.F.M., van der Hel, W., Verstegen, M.W.A. (1986). The influence of degree of adaptation to tether-housing by sows in relation to behaviour and energy metabolism. Anim. Prod. 42, 257-268.

Edwards, J.R., Hardy, M. (1990). Efficacy of several vitamin D compounds in the prevention of tihial dyschondroplasia in broiler chickens. J. Nutr: 120: 1054-1061.

Ergün, A., Çolpan, İ., Yıldız, G., Küçükersan, S., Tuncer, Ş.D., Yalçın S., Küçükersan, M.K., Şehu, A. (2008). Hayvan Besleme ve Beslenme Hastalıkları. 4. Baskı. Ankara Üniversitesi Veteriner Fakültesi. Pozitif Yayıncılık. ISBN: 975-97808-2-8.

Farm Animal Welfare Council, (1993). Second report on priorities for research and development in farm animal welfare. MAFF, Tolworth.

Francis, S.A. (2003). Investigating the role of carbohydrates in the dietary choices of ruminants with an emphasis on dairy cows (PhD thesis). University of Melbourne, Australia.

Franklin, M.C. (1950). The influence of diet on dental development in the sheep. Melbourne: CSIRO, Bull,252.

Freeland, W.J., Calcott, P.H., Anderson, L.R. (1985). Tannins and saponin: interaction in herbivore diets. Biochem. System. Ecol. 13, 189-193.

Freeland, W.J., Choquenot, D. (1990). Determinants of herbivore carrying capacity: Plants, nutrients, and Equus asinus in northern Australia. Ecology. 71, 589-597.

Freer, M., Dove, H., Nolan, J.V. (2007). Nutrient Requirements of Domesticated Ruminants. Melbourne, Victoria, Australia: CSIRO Publications.

Hogan, J.P., and Phillips, C.J.C. (2008). Nutrition and the Welfare of Ruminants. ARBS Annu Rev Biomed Sci;10:T33-T50. doi: http://dx.doi.org/10.5016/1806-8774.2008.v10pT33.

Hutchings, M.R., Athanasiadou, S., Kyriazakis, I., Gordon, I.J. (2003). Can animals use foraging behaviour to combat parasites? Proc. Nutr. Soc. 62, 361-370.

Illius, A.W., Jessop, N.S. (1995). Modeling metabolic costs of allelochemical ingestion by foraging herbivores. J. Chem. Ecol. 21, 693-719.

Kafantaris, I., Kotsampasi, B., Christodoulou, V., Kokka, E., Kouka, P., Terzopoulou, Z., Gerasopoulos, K., Stagos, D., Mitsagga, C., Giavasis, I., et al. (2017). Grape pomace improves antioxidant capacity and faecal microflora of lambs. J Anim Physiol Anim Nutr (Berl) 101: e108-e121.

Kyriazakis, I., Oldham, J.D. (1997). Food intake and diet selection in sheep: the effect of manipulating the rates of digestion of carbohydrates and protein of the foods offered as a choice. Br. J. Nutr. 77, 243-254.

Kyriazakis, I., Savory, C.J. (1997). Hunger and thirst. In: Appleby, M.C., Hughes, B.O. (Eds.). Animal Welfare. CAB International: Wallingford, UK, pp. 49-62.

Leeson, S., Summers, J.D. (2005). Commercial Poultry Nutrition. 3rd Edition. Nottingham University Press. ISBN: 978-1-904761-78-5.

Lobley, G.E., Milano, G.D. (1997). Regulation of nitrogen metabolism in ruminants. Proc. Nutr. Soc. 56, 547-563.

Lobón, S., Sanz, A., Blanco, M., Ripoll, G. and Joy, M. (2017). The type of forage and condensed tannins in dams' diet: Influence on meat shelf life of their suckling lambs. Small Rumin Res 154: 115-122.

Makri, S., Kafantaris, I., Stagos, D., Chamokeridou, T., Petrotos, K., Gerasopoulos, K., Mpesios, A., Goutzourelas, N., Kokkas, S., Goulas, P., et al. (2017). Novel feed including bioactive compounds from winery wastes improved broilers' redox status in blood and tissues of vital organs. Food Chem Toxicol 102: 24-31.

Manteca, X., Villalba, J.J., Atwood, S.B., Dziba, L., Provenza, F.D. (2008). Is dietary choice important to animal welfare? Journal of Veterinary Behavior, 3:229-239. doi:10.1016/j.jveb.2008.05.005.

Martinez, J.H., Ross, T.T., Becker, K.A., Smith, G.S. (1993). Ingested dry snakeweed foliage did not impair reproduction in ewes and heifers during late gestation. Proc. West. Sec. Am. Soc. Anim. Sci. 44, 32-35

Meluzzi, A., and Sirri, F. (2009). Welfare of broiler chickens, Italian Journal of Animal Science, 8:sup1, 161-173, doi: 10.4081/ijas.2009.s1.161.

Minson, D.J. (1990). Forage in Ruminant Nutrition. New York: Academic Press.

Mote, T.E., Villalba, J.J., Provenza, F.D. (2008). Sequence of food presentation influences intake of foods containing tannins and terpenes. Appl. Anim. Behav. Sci. 113, 57-68.

Murakami, A.E., Rondon, E.O.O., Furlan, A.C., Moreıra, I., Vasconcelos, F. (1999). Sodium and chloride nutritional requirements for growing broiler chickens (21 to 42 days of age), Poultry Abst., 88th Annual Meeting, 78:1, 63.

Nielsen, B.L., de Jong, I.C., DeVries, T.J. (2016). The Use of Feeding Behaviour in the Assessment of Animal Welfare. Nutrition and the Welfare of Farm Animals, Animal Welfare, 16. doi: 10.1007/978-3-319-27356-3_4.

NRC (1994). Nutrient Requirements of Poultry, ninth revised edition. National Academy of Sciences, Washington, DC.

Okuyan, R., Filya, İ. (2003). Hayvan Besleme Biyokimyası. Uludağ Üniversitesi Ziraat Fakültesi, Yayın no.: 94, 2. Baskı, Bursa.

Phillips, C.J.C., James, N., Murray-Evans, J.P. (1996). Effect of forage supplements on the incidence of bloat in dairy cows grazing a high clover pasture. Vet Rec.139:162-5.

Provenza, F.D., Villalba, J.J., Dziba, L.E., Atwood, S.B., Banner, R.E. (2003). Linking herbivore experience, varied diets, and plant biochemical diversity. Small Ruminant Res. 49, 257-274.

Rondon, E.O.O., Murakami, A.E., Martıns, E.N., Pereıra, M.S., Scapınello, C. (1999). Sodium and chloride nutritional requirements for young broiler chickens (1 to 21 days of age), Poultry Abst., 88th Annual Meeting, 78:1, 63.

Russell, J.B., O’Connor, J.D., Fox, G.G., Van Soest, P.J., Sniffen, C.J. (1992). A net carbohydrate and protein system for evaluating cattle diets: I. Ruminal fermentation. J. Anim. Sci. 70, 3551-3561.

Villalba, J.J., and Provenza, F.D. (2009). Learning and dietary choice in herbivores. Rangeland Ecology & Management In Press.

Scott, M.L., Holm, E.R., Reynolds, R.E. (1954). Studies on pheasant nutrition 2. Protein and fiber levels in diets for young phesants. Poultry Science 33: 1237-1244.

Sinclair, L.A., Garnsworthy, P.C., Newbold, J.R., Buttery, P.J. (1995). Effects of synchronizing the rate of dietary energy and nitrogen release in diets with a similar carbohydrate composition on rumen fermentation and microbial protein synthesis in sheep. J. Agric. Sci. 124, 463-472.

Skaperda, Z., Aristidis, S.V., Demetrios, K. (2019). Farm animal welfare, productivity and meat quality: Interrelation with redox status regulation and antioxidant supplementation as a nutritional intervention (Review). World Academy Of Scıences Journal. 1: 177-183.

Subedi, P., Moertl, S., Azimzadeh, O. (2022). Omics in Radiation Biology: Surprised but Not Disappointed. Radiation. 2:124-129. doi:10.3390/radiation2010009.

Taşkesen, H.O., Cilavdaroğlu, E. (2022). Rasyona Selenyum, E vitamini ve Çinko İlavesinin Yerli Damızlık Erkek Kazlarda Semen Miktar ve Kalitesi Üzerine Etkileri. Yozgat Bozok Üniversitesi, yayınlanmamış proje sonuç raporu. 6602b-ZF/20-416.

Veskoukis, A., Kerasioti, E., Priftis, A., Kouka, P., Spanidis, Y., Makri, S., and Kouretas, D. (2019). A battery of translational biomarkers for the assessment of the in vitro and in vivo antioxidant action of plant polyphenolic compounds: The biomarker issue. Curr Opin Toxicol 13: 99-109.

Villalba, J.J., Provenza, F.D. (1997). Preference for flavored wheat straw by lambs conditioned with intraruminal infusions of acetate and propionate. J. Anim. Sci. 75, 2905-2914.

Villalba, J.J., Provenza, F.D., Banner, R.E. (2002). Influence of macronutrients and polyethylene glycol on intake of a quebracho tannin diet by sheep and goats. J. Anim. Sci. 80, 3154-3164.

Villalba, J.J., Provenza, F.D., Han, G.D. (2004). Experience influences diet mixing by herbivores: implications for plant biochemical diversity. Oikos. 107, 100-109.

Villalba, J.J., Provenza, F.D. (2005). Foraging in chemically diverse environments: Energy, protein and alternative foods influence ingestion of plant secondary metabolites by lambs. J. Chem. Ecol. 31, 123-138.

Villalba, J.J., Provenza, F.D., Manteca, X. (2010). Links between ruminants' food preference and their welfare. Animal, 4:7, pp 1240-1247. doi:10.1017/S1751731110000467.

Wang, J., Provenza, F.D. (1996). Food preference and acceptance of novel foods by lambs depend on the composition of the basal diet. J. Anim. Sci. 74, 2349-2354.

Weston, R.H. (2002). Constraints on feed intake by grazing sheep. In: Freer M, Dove H (editors). Sheep Nutrition. Wallingford: CAB International.

Whitehead, C.C., Blair, R., Bannister, D.W., Evans, A.J. and Jones, R.M. (1976). The involvement of biotin in preventing the Fatty Liver and Kidney Syndrome in chicks. Res. Vet. Sci. 20 180-184.

Whitehead, C.C. (2002). Nutrition and poultry welfare. Nutrition and poultry welfare, World's Poultry Science Journal, 58:3, 349-356, doi: 10.1079/WPS20020027.

Williams, J.L., Campos, D., Ross, T.T., Becker, K.A., Martinez, J.M., Oetting, B.C., Smith, G.S. (1992). Snakeweed (Gutierrezia app.) Toxicosis in beef heifers. Proc. West. Sec. Am. Soc. Anim. Sci. 43, 67-69.

CHAPTER 7

CURRENT APPROACHES TO ASSESS THE CALF WELFARE IN CATTLE FARMS

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1. INTRODUCTION

The wellbeing of animals is a significant new concern that has emerged in recent years. The term ‘’animal welfare’’ refers to the condition of an individual and how they interact with their surroundings; it includes both the physical and mental well-being of sentient animals (Calderón-Amor and Gallo, 2020). According to Svensson et al. (2003), farm animal welfare is also a topic of great public concern. Nowadays, animal welfare is a significant global issue in the animal industry due to ethical, legal, and business considerations. Concern over how animals are handled is influenced by a variety of factors, such as socioeconomic status, societal culture, religion, and traditions (Kumar et al., 2011).

For a high future milk and meat output, the welfare of the calves is crucial. However, there are significant issues with dairy calf welfare. These issues are primarily the result of insufficient colostrum intake, poor ventilation, unsanitary floor conditions, insufficient health monitoring, and exposure to infections that cause gastrointestinal and respiratory illnesses. In addition, ongoing restocking and mixing of calves from various sources, inadequately balanced solid food, inadequate access to water, and generally subpar responses of farmers to health problems, particularly necessary dietary changes, are all contributing factors to welfare issues in calves (Hristov et al., 2012).

Unfavorable conditions can interfere with a calf ’s regular breathing, feeding, drinking, digestion growth, rest and sleep, behavior, social interactions, thermoregulation, and self-grooming. Negative circumstances can also alter how fear, pain, injuries, and diseases manifest in the calf (Hristov et al., 2011). Effective management techniques are crucial for the welfare and health of calves. Health and welfare of calves vary among herds (Vasseur et al., 2010a). Calves must meet the following requirements to develop normally: they must be able to breathe clean air; they must feed and drink, including suckling, handling food, and ruminating; they must be able to explore and interact with people; they must have few diseases; they must be able to groom themselves; and they must have no fear.

Calves need quality care during the first month of life because they are at danger from several threats that affect their welfare, growth, body mass gain, and condition. Because all of these factors affect production effectiveness and consumer attitudes, research in this area has become increasingly fascinating recently. It is well known that factors affecting calf welfare during rearing include microclimate, hygiene practices, diet, and farm management. Welfare issues such as unpleasant emotions, behavioral disorders, skin, digestive, respiratory, and locomotor system diseases, accidents, and mortality may occur if the raising conditions are poor (Samolovac et al., 2019).

While calf welfare is currently a topic of concern for many farmers and researchers worldwide, the issue has historically been approached from a different angle. The welfare of dairy calves can be increased by implementing management techniques that increase resistance to stress and illness. What is the dairy calf 's performance and are there direct links between it and its short- and long-term welfare? (James, 2008). All of the calf 's needs should be met for its proper welfare and for good future stock. According to the European Welfare Quality® protocol, four general criteria must be evaluated on-farm to define the level of welfare in dairy calves: good nutrition, good housing, appropriate behavior, and good health (Calderón-Amo and Gallo, 2020). In this study, these issues were evaluated in detail.

2. GOOD NUTRITION

2. 1. Colostrum Management

For the welfare of animals, few management techniques require special consideration. Colostrum feeding is one such method. The single most crucial management technique for enhancing dairy calf health is colostrum management (Godden et al., 2019). To establish a healthy immune system, calves should be given sufficient colostrum as soon as possible after birth. Immunoglobulins (Ig, primarily IgG), which provide protection from infectious illnesses, are abundant in colostrum (Gorden and Plummer, 2010).

The two biggest health risks for young calves are respiratory disease (Gorden and Plummer, 2010) and diarrhea (Svensson et al., 2006), both of which are frequently caused by viruses. When calves are young, their ability to survive heavily depends on the proper administration of high-quality colostrum. One of the most important risks to the wellbeing of calves is improper colostrum management (Godden, 2008).

In contrast to dogs, cats, and humans, pregnant cows do not pass on their passive immunity to their calf. Thus, calves lack sufficient immunoglobulins at birth and must depend on colostrum to receive maternal antibodies (Quigley et al., 2002). If the calf survives after calving, obtaining enough colostrum will be its next obstacle. Calves must consume colostrum to obtain sufficient immunoglobulins (IgG, IgM, and IgA) at birth. Quantity, quality, timing of feeding, and cleanliness are all thought to be essential factors of colostrum management (Alley et al., 2020; Renaud et al., 2020). To survive, the calf needs a sufficient amount of high-quality colostrum, the first milk produced after calving and rich in immunoglobulins (IgG, IgM, and IgA). Colostrum must be administered to the calf as soon as possible after birth, ideally within 2 h because in the first few hours after birth, the gut ’s capacity to absorb the colostrum ’s antibodies start to rapidly decline, and after around 24 h, it almost completely disappears. Producers should therefore attempt to feed all calves within 1–2 h of delivery and by 6 h (Godden, 2008).

Colostrum quantity and quality are crucial for preventing passive transfer failure. High-quality colostrum is frequently saved for heifer calves that will remain with the herd, whereas calves are given inferior or inferior colostrum. Male and female calves had different colostrum delivery methods, sources, removal times from the dam, volumes, and storage types, which may have contributed to lower serum total protein levels and a subsequent partial or complete failure of passive transfer (Alley et al., 2020). During the first feeding, it is typically advised to give the calf 10-12% of its live weight in colostrum (Godden et al., 2019).

The measurement of serum total protein from calves using a refractometer or Brix refractometer is a useful method to assess the transfer of passive immunity in farms (Lombard et al., 2020). Most farmers who undertake control do so visually, based on how the colostrum appears, rather than using a colostrometer or refractometer. Cattle and calf separation and painful procedures to lower the risk of infections, ensure successful colostrum delivery, prevent potential cow-calf bonding and behavioral discomfort upon later separation, and limit infection risk, it is advised that the calf be immediately separated from the cow after calving and housed separately in a clean pen. (Pempek et al., 2017).

Colostrum is generated by the mammary gland in the three weeks before calving and contains IgG, which is necessary for the transmission of passive immunity, as well as carbs, fats, and proteins that are used as the metabolic fuel for the newborn's first few hours of life. Failure to transmit passive immunity is described as the insufficient intake of colostrum and the transfer of immunoglobulins into the calf 's blood, which is then linked to a higher risk of calf death (Urie et al., 2018; Lombard et al., 2020). Blood total protein concentrations below 5.2 g/dL or IgG concentrations below 10 g/L are the conventional cutoffs used to define failure transmission of passive immunity (Lombard et al., 2020). Accordingly, rather than relying on conventional dichotomous values to determine failed transfer of passive immunity, a vision of achieving greater concentrations of IgG in serum should be stressed to reduce calf mortality (Lombard et al., 2020). A high-quality colostrum is traditionally defined as having 50 g/L of IgG, although this is disputed because there isno conclusive proof that this concentration categorizes colostrum quality (Buczinski and Vandeweerd, 2016). A verified cut -off point of 22% Brix is used on farms to signify excellent quality colostrum (Quigley et al., 2002; Lopez et al., 2020). Failed passive transfer is classified differently depending on the situation, but in general, it is defined as supplying calf serum IgG concentrations of 50 mg/mL within 6 h but no later than 12 h postpartum at roughly 10% of birth weight (Godden, 2008; Roche et al., 2015).

After every usage, rinse the colostrum harvesting tools, nipples, bottles, and tube feeders with warm water to prevent milk solids from drying on the surfaces, disinfect, and let dry to reduce bacterial contamination. For buckets used for starter feed, milk, or water, as well as automatic milkers and waterers, it is advised to continue these activities following colostrum feeding (Relić et al., 2014). Storage of colostrum is a crucial component of management. It is advised to keep colostrum chilled at 4°C if it is not used immediately (Stewart et al., 2005). According to research, contamination is more likely to occur during the harvesting procedure and bacterial counts are lower when taken straight from the udder (Hyde et al., 2020). For instance, heat-treated fresh colostrum increased the serum concentration of IgG while reducing the number of coliform bacteria. Additionally, heat-treated colostrum lowers the levels of microorganisms such as Mycoplasma bovis, Escherichia coli, Salmonella enteritidis, and Listeria monocytogenes that cause acute or chronic sickness (Godden et al., 2012).

2. 2. Milk Feeding And Weaning

Calf welfare in feeding management may be impacted by milk type, pasteurization, utilization of waste milk, amount of milk, number of meals, and milk distribution technique (Vasseur et al., 2010b). The availability of drinking water soon after birth could enhance the growth and development of calves before and after weaning, possibly by stimulating rumen development and thereby increasing nutrient availability (Wickramasinghe et al., 2019). Water access is a crucial issue because on many farms, calves do not have ad libium access to water for a long time after birth.

Common methods of milk feeding calves include individual feeding from a bucket, teat, and automatic calf feeder (Abuelo et al., 2019). A teat permits calves to consume milk in a more natural way than a bucket does (Bøe and Havrevoll, 1993). The main effect of this is to prolong the duration of feeding, particularly when a teat with a small opening is employed (Haley et al., 1998). Individually feeding calves from a bucket minimizes competition for drinking space but stifles the calf 's strong need to suck, which may affect digestion and satiety levels (De Passille, 2001). Cross-sucking may increase the risk of disease transmission and cause injury (Rushen and de Passille, 2010). The maximum amount of control over calf intake is available with automated calf feeders because they provide milk via a teat at customized amounts (Barkema et al., 2015).

Normally, calves are fed 10% milk twice daily, but when given the chance (Palczynski et al., 2020), they drink multiple times daily and ingest more than twice as much milk. Increased milk consumption results in greater weight growth, improved feed conversion, and a reduction in the age of first breeding, according to recent research conducted under commercial conditions. Almost immediately after the calves are taken away from the cow, hunger appears. By giving calves extra milk (or colostrum) in the hours after separation, vocalizations by recently separated calves can be almost reduced (Weary, 2008).

Calves are biologically prepared for rapid growth in the first few weeks of life (Roche et al., 2015); hence, feeding large volumes for the first 5–6 weeks of life, followed by more restrained volumes until weaning, is one way to lessen the economic effects of higher milk volumes. Calves' ad libitum milk consumption increases from birth until it hits a plateau at around 5 weeks of age. In contrast, very little solid feed is consumed before this time (De Passillé et al., 2011). Although calves receiving greater milk quantities consume less solid feed overall, their daily calorie intake is still higher than that of calves receiving restricted feeding, and as a result, they put on more weight while receiving milk (Jongman et al., 2020). Diarrheic calves lose a lot of fluid and electrolytes, which causes acidosis and dehydration. Therefore, ad libitum access to water should be made available to calves experiencing diarrhea (USDA, 2016).

In dairy calves fed a biologically normal diet, fewer cases of diarrhea and fewer days with diarrhea were observed (Ollivett et al., 2012). Traditional thought was that restricting milk or milk substitute intake was the best feeding approach because it encouraged the consumption of the starting concentrate, which was linked to effective ruminal growth (Khan et al., 2011). When it comes to limit the spread of disease from calf to calf, milk feeding equipment hygiene is crucial. Between each calf, the equipment should be cleaned and sanitized (USDA, 2016).

The performance and behavior of calves are similar when they are gradually weaned off high milk volumes through incremental daily reductions of milk or through stepwise reductions every few days (Parsons et al., 2020). Weaning off milk requires careful management, especially if calves are being weaned off high milk volumes, to maintain calorie intake and avoid a growth check. To maintain average daily growth and support ruminant development while reducing milk intake, calves should consume >0.8 kg/day of starter concentrate (Klopp et al., 2019). While diluting milk with warm water increases the amount of solid food calves ingest during weaning without changing their behavioral response to complete weaning, substituting milk with warm water for the first two days of weaning diminishes the behavioral response to weaning (Jasper et al., 2008).

3. GOOD HOUSING

The main threats to calf welfare are inadequate ventilation, air temperature, air inflow speed, and exposure to microorganisms that cause respiratory and gastrointestinal diseases (Relić and Bojkovski, 2010). For calves, +25°C is the upper critical temperature, and the most challenging circumstance generally occurs in hot weather (Pálka et al., 2013). If the calves thrive in their surroundings, they can use the nutrients in their feed dose to fuel their growth rather than to combat environmental stressors. In contrast, calves raised in improper conditions use a significant portion of the nutrients to compensate for numerous additional stresses. A regulatory system with receptors in the skin, veins, internal organs, hypothalamus, and other regions of the brain controls thermoregulatory systems that are engaged when maintained in a high-temperature environment (Pálka et al., 2013).

Every dairy heifer rearing program starts with the primary objective of raising healthy calves with a maximum growth rate. The growth and health of dairy calves can be optimized by good nutrition and a comfortable environment. Young calves' bedding appears to be a significant environmental factor in their welfare. Because bedding materials come into close contact with calves, the quality, amount, and type of bedding can have a significant impact on the calves’ health and growth. When a disease outbreak and cold weather threaten dairy calves, bedding management is especially essential. Calves can stay healthy by adjusting the type, amount, and quality of bedding under any circumstance. The most common bedding materials used worldwide include rubber or plastic mats, sand, shavings, straw, and wheat sawdust (Nikkhah and Alimirzaei, 2022).

The housing and management techniques used frequently diverge from those used in more naturalistic settings. Pair-housing, or group-housing are viable housing options. Calves engage in social interactions with conspecifics in natural settings as early as infancy. Calves kept in pairs, for instance, perform better on a reversal learning exercise than calves housed alone, indicating higher learning flexibility (Vasseur et al., 2010a). Individual housing may be detrimental to calf social, cognitive, and developmental maturation (Costa et al., 2016). Calves housed in pairs, for instance, perform better on a reversal learning challenge than calves housed alone, indicating more learning flexibility (Gaillard et al., 2014). Compared with calves raised in individually housed systems, those raised in groups performed better socially when they entered a mixed pen after weaning and withdrew less frequently during agonistic encounters (Alley et al., 2020). Compared with calves separated alone or with an unfamiliar calf, groupreared calves with a familiar calf had less vocalization and more exploratory behavior (Faerevik et al., 2006). In comparison to calves separated alone or with an unfamiliar calf, groupreared calves with a familiar calf displayed less vocalization and greater exploratory activity (Faerevik et al., 2006).

Compared with individually reared calves, group-reared calves spend more time engaging in play behavior (Jensen et al., 1998). Reduced reactions to stressful stimuli, greater play behavior, calves' high drive to engage in full social contact, and increased cognitive performance are all beneficial for the animal's affective state (Alley et al., 2020). However, many of these worries are related to management issues that can frequently be resolved, such as administering the right amounts of milk from a nipple rather than a bucket (Jensen, 2003), implementing good hygiene management, and implementing early disease detection. As automatic feeding systems become more prevalent, group rearing becomes more feasible, labor costs are reduced, and early illness diagnosis is made possible (Medrano-Galarza et al., 2017).

Because individual or movable outdoor individual pens may be relocated once a week, breaking the life cycle of some viruses, they help to maintain young calves largely free from clinical illnesses (Jensen and Larsen, 2014). The use of a concrete block placed beneath a plastic hutch can promote ventilation, which reduces carbon dioxide levels inside the hutch and the calves' respiration rates (Moore et al., 2012). Dry bedding must be added to housing and management systems during the winter months so that the calf can insulate itself. Additionally, calves often exhibit more nutritive and nonnutritive oral habits in colder regions. Therefore, dietary changes must be coordinated with adjustments to housing plans. Because they can rest next to one another and thus enhance thermoregulation, calves may benefit from paired or group housing throughout the winter (Hepola et al., 2006). Long wheat straw had the warmest surface temperature, whereas sand was the least sanitary substance. However, straw bedding had the highest coliform count after one week of use. In addition, when housed in bedding made of granite fine sand as opposed to bedding consisting of rice hulls, long wheat, and wood shavings, calves were treated for scours more frequently (Panivivat et al., 2004). The walls of a single calf pen must be designed such that the calves may see and touch each other while standing to support their wellness. Dairy calves that are kept in pairs and given more milk also tend to gain more body weight and exhibit more play behavior, which is a sign of good animal wellbeing (Jensen et al., 2015).

Poor ventilation, overcrowding, and a lack of routine cleaning and disinfection in calf houses expose calves to different infections, particularly respiratory tract disorders, which increase calf mortality. Neonatal mortality is caused by infections such as *E. coli*, Salmonella, Pasteurella, and parasites, which can spread to young calves in unsanitary environments (Radostits et al., 1994). Because of the limited amount of nose-to-nose contact, individual housing lowers the danger of disease transmission among hand-fed calves (Norton et al., 2010). Individual housing makes it easier to provide specialized care and nutrition and lowers the risk of illness transmission. Although human labor is labor intensive, the principal advantage of raising animals in sheds is that the likelihood of disease transmission is minimized. These stables are comparable, and the following requirements must be fulfilled: shelter from intense sunlight, rain, snow, and wind; use of dry bedding; adequate and high-quality hay; adequate ventilation in the area where the calves are housed; and water of the proper temperature, quantity, and quality for the calves (Pálka et al., 2013).

4. APPROPRIATE BEHAVIOUR

4. 1. Cow-Calf Separation

Calves are typically taken away from their mothers within 24 h of birth on dairy farms, where they are then given milk by bucket or bottle until they are 4 to 10 weeks old. Early separation of the cow and calf is expected to allow for better monitoring of colostrum, milk, and solid food intake and aid in disease prevention. Early separation is also believed to be less stressful for both parties, given that the cow and calf will eventually be separated (Phillips, 1993).

Cow and calf form deep relationships in their natural environment and stay together until the calf is progressively weaned at around 6 to 8 months (Phillips, 1993). As cows and calfs are typically separated immediately after birth in conventional dairy production, the animals are typically not permitted to form bonds. There are no requirements for nursing or being with the mother. If permitted, the cow will typically separate herself from the herd just before giving birth (Jensen, 2002).

When a cow and calf are together, they vocalize to strengthen their maternal attachment (Marchant-Forde et al., 2002). However, many have characterized the high-pitched vocalization made with an open mouth as a reaction to separation, either by extremely hungry animals or by cows that have lost their calf (Weary and Chua, 2000). Therefore, it is likely that this vocalization represents displeasure. The cow's vocalization at separation has also been shown to affect the calf 's cardiac response (Marchant-Forde et al., 2002), demonstrating that the dam 's behavior might have an impact on the calf 's wellbeing. In addition, it has been demonstrated that calves who were only given auditory contact with their dams after being separated exhibited greater alert behavior, such as looking and angling their ears, heads, and necks toward the cow (Enríquez et al., 2010).

Early calf removal is thought to reduce the possibility of disease spreading from the cow to the calf, increase control over the quality and quantity of colostrum fed, allow for close monitoring of calf health, and prevent the formation of a strong maternal bond (Godden, 2008; Meagher et al., 2019). When given permission, cows and their calves display reinstatement behavior after a brief separation and continue to stay close to one another even when there is no nursing contact (Wenker et al., 2020). According to behavioral and physiological research, the acute discomfort that results from the breakup of the cow-calf bond can continue for up to 3 days (Meagher et al., 2019).

4. 2. Disbudding, Dehorning, Castration and Tail Docking

Dehorning and debugging are frequent practices that are known to be painful but are necessary to ensure both human and animal safety. Because horns, facilities, and handling can cause carcass injury, dehorning is especially crucial for dairy bulls bred for beef (Alley et al., 2020). To limit the potential of harm to other animals and stockmen as well as carcasses and hide damage, disbudding and dehorning are performed (Stull and Reynolds, 2008). Dehorning cattle may be an industry effort to adjust to their behavioral responses when they are placed in unsuitable surroundings (Alley et al., 2020). Although required, this treatment is uncomfortable to perform and painful for the calf. Surgery is typically used to remove the horns of calves older than three months, and physiological reactions suggest that this process is painful (Sylvester et al., 1998).

One of the most contentious animal welfare issues is inflicting unneeded pain and suffering on animals; however, dairy producers still brand and dehorn their animals without using any type of anesthetic (Weary, 2008). Therefore, better dehorning procedures for dairy calves present a chance to enhance calf welfare (Alley et al., 2020). To minimize pain during dehorning and in the hours that follow, sedatives, local anesthetics, and non-steroidal anti-inflammatory drugs are often used . Although using local anesthetics alone does not completely reduce pain, local blocks do help manage it. In the hours following dehorning, plasma cortisol and behavioral reactions can be maintained close to baseline levels using nonsteroidal anti-inflammatory medicines in addition to a local anesthetic (Weary, 2008). After dehorning, elevated levels of stress hormones such as corticosteroids are frequently found in the blood (McMeekan et al., 1998). Farmers prefer using hot iron cauterization to dehorn animals because it causes less immediate pain than dehorning with caustic chemicals (Stafford and Mellor, 2011) and has a lower cortisol response than dehorning with amputation (Stafford and Mellor, 2005). If the calf is very young (less than seven days), caustic chemicals can be used to remove the horn bud, but this is a less common method of disbudding than using a hot iron to destroy the bud and surrounding tissue (Verdon, 2022).

Disbudding and dehorning primarily harm animal welfare because of the pain (Lecorps et al., 2019). Inflammation and psychological stress brought on by the operation can impair the immunological response and have a secondary negative effect on well-being, especially in young calves whose immune systems are still maturing (Verdon, 2022). After surgery, cortisol levels start to rise immediately, peaking 30 min later. They then gradually start to fall until they approach normal levels 6–8 h later (McMeekan et al., 1998). They frequently make motions that show extreme stress and agony in their calves, including head shaking and jerking, ear flicking, leg stamping, and kicking. Frequent walking, restlessness, shorter periods of relaxation, and less ruminating were further behavioral patterns. Analgesics and anesthetics can be used to reduce pain during dehorning (Alley et al., 2020). In the hours and days after disbudding, local anesthesia combined with a non-steroidal anti-inflammatory medicine is more successful at lowering pain and tension than local anesthesia alone (Ede et al., 2019).

Bull calves that are not intended for reproduction are frequently castrated before slaughter. Physical, pharmacological, and hormonal castration techniques fall into three broad groups (Alley et al., 2020). The most popular technique of castration is surgical castration, which is also the method most frequently used by dairy-beef calf raisers (Coetzee et al., 2010). Castrating calves for meat consumption is mostly done to prevent conception, even though it may also lessen aggressive behavior and change carcass quality (Price et al., 2003).

Castration is a painful procedure regardless of the technique utilized, as shown by changes in the calf 's physiological and behavioral response after treatment. According to Stafford and Mellor (2005), castration causes acute discomfort during the initial tissue injury as well as an inflammatory reaction that may continue for days to weeks. The highest level of acute pain is likewise experienced following surgical castration (Alley et al., 2020). All castration methods can cause adverse side effects, including illness, physiological stress, immunosuppression, acute and chronic pain, bleeding, and disease (Stafford and Mellor, 2005). It is strongly advised to use a nonsteroidal anti-inflammatory medicine after surgery (Huber et al., 2013).

When performed either with elastic rings that restrict blood flow and kill the distal portion of the tail or with a docking iron that simultaneously cuts the tail and cauterizes the stump, tail docking offers an interesting contrast to dehorning. Young calves and adult cattle that have had their tail nerves cut develop neuromas and experience persistent agony, similar to the phantom pain experienced after amputation. In addition, docked animals exhibit higher fly avoidance responses and have more flies on them. However, numerous large-scale controlled tests have demonstrated that docking tails does not consistently improve cow hygiene or udder health (Weary, 2008).

4. 3. Transportation

Transport of young calves is a welfare concern. When compared with adult cattle, young calves under 3 months of age are more susceptible to welfare violations and are at a comparatively high risk of morbidity and mortality (Roadknight et al., 2021). Cattle of any age are known to experience stress before and after transportation, with young calves being more prone to welfare compromise. This vulnerability is caused by several factors, including the fasting required for transportation, which puts young calves at risk for hypoglycemia, energy depletion, and hunger, especially given that calves have lower body fat reserves than adult cattle (Fisher et al., 2014).

The wellbeing of calves may be threatened both during and after transportation by several factors, including lack of food and water, illness, injury, social interaction, stress from handling, and unfamiliar locations (Roadknight et al., 2021). Young calves' defense against infectious illness depends on their colostral immunity. There is a substantial risk of morbidity and mortality if passive transfer fails (Tyler et al., 1999).

Long transit and fasting periods, young age at transfer, insufficient colostral immunity, a lack of bedding in trucks, high stocking densities, and timing during the calving season are the key risk factors for poor calf welfare associated with transport. Thus, maximizing calf welfare necessitates a multifaceted strategy that includes cutting down on fasting and transport times, moving calves at the right stocking density with comfortable bedding, moving only fit and healthy calves, and maximizing pre-transport calf management (Roadknight et al., 2021).

To lessen the strain of transportation, changes can be made to the environment, including the temperature, stocking density, distance, and type of road used (Hulbert and Moisá, 2016). Because they maintain heat more effectively when they are resting than when they are standing, calves will probably also benefit from resting while being transported (Schrama et al., 1993). Older cattle may benefit from these stress-relieving elements; however, transportation stress-reduction techniques may be essential for 1-day-old calves that are not yet fully immunocompetent and do not regulate their body temperature like a calf that is over a week old (Hulbert and Moisá, 2016).

Because calves under 14 days old are deemed inappropriate to travel, the Federation of Veterinarians of Europe uses navel healing as a measure of transport readiness. Unweaned calves are only allowed to travel for a maximum of 19 h per the European Union guidelines for cattle movement. The EU allows an additional 2-hour grace period for unforeseeable events. Cattle must be given a 24-hour rest break and the proper amount of milk or milk substitute before continuing their journey if they have not reached their destination by that time (Alley et al., 2020). According to recent research, calf welfare during and after transport can be maximized by reducing travel distance and duration, reducing fasting time (to 24 h), providing enough room for lying on trucks (0.3-0.5 m^2 per 40-kg calf), and providing enough bedding such as straw on trucks to allow for rest and comfort during transport (Roadknight et al., 2021).

5. GOOD HEALTH

5. 1. Mortality and Morbidity

Welfare is a broad notion that may include aspects of science, ethics, and economics (Lawrence et al., 2005), but excellent health is a prerequisite for good welfare. Calf mortality is calculated as the ratio of the number of deceased calves to the total number of individuals at risk within a certain group or community. Morbidity and mortality rates are useful for assessing poor welfare (Ortiz-Pelaez et al., 2008).

One of the main barriers to dairy farms' economic goals and the welfare of the animals themselves is calf mortality (Kansal et al., 2022). The industry target for mortality is <10% of calves dying at birth (Ortiz-Pelaez et al., 2008). According to the accepted definition of perinatal mortality, it refers to a perinate's passing before, during, or within 48 h of calving after at least 260 days of gestation (Mee et al., 2019). The most dangerous time in an animal's existence is during the perinatal stage. From 24 h to 60 days of life, an industry target is to have <3% of calves die (DCHA, 2016).

Because calf mortality delays genetic development, limits the number of replacements available for voluntary herd culling, and increases replacement costs, the dairy industry suffers financial losses (Mee et al., 2019). Increasing the calf 's degree of immunity against sickness and reducing its exposure to infectious agents are essential components of raising healthy dairy calves. Calves are highly susceptible to viruses during the initial few days of life, and any management errors consequently affect their survival and future development (Svensson et al., 2006). To reduce perinatal mortality, a focus should be placed on identifying and managing key mortality risk factors that are considered likely to occur in dairy farms and practical to solve (Schuenemann et al., 2011). To improve welfare, productivity, and moral standards for dairy calves, these issues must be addressed. To employ management techniques that are ultimately effective, permit healthy growth, and minimize discomfort and disease, a greater understanding of wellbeing indicators in dairy calves is necessary (Alley et al., 2020).

Calf mortality in dairy farms can result from a variety of variables, including management, environmental factors, and the genetic makeup of the animals (Kansal et al., 2022). Combined respiratory and metabolic acidosis, parturient trauma, hypoglobulinemia, congenital infections and deficiencies, and omphalophlebitis are the leading causes of perinatal morbidity (Mee et al., 2019). Pneumonia and diarrhea are contagious illnesses caused by bacteria, viruses, and protozoa (Mandal et al., 2019).

The most typical non-infectious causes are dystocia, poor colostrum feeding, low birth weight, and subpar care practices. More than half of all calf deaths are caused by dystocia, which is the most common cause of calf death (Mandal et al., 2019). Dystocia, hunger caused by improper colostrum management, hypothermia, metabolic problems, infectious infections, and trauma are the main causes of early calf death or illness (Relić, et al., 2014). Parity is the best predictor of perinatal mortality, followed by difficult calving in heifers and difficult calving and gestation length in older cows (Meyer et al., 2000).

Herd, year, season of calving, larger herd size, and calving management are significant herd-level risk factors for perinatal mortality (Mee et al., 2019). Excessive body condition before calving, especially in heifers, has been linked to decreased hunger as calving approaches and the mobilization of fat reserves as a result (Chassagne et al., 1999). Due to their threefold increased risk of dying during pregnancy, twins are frequently cited as a cause of perinatal death in Holstein cows (Lombard et al., 2007). The increased prevalence of dystocia linked to longer gestation and heavier birth weight in male calves compared with female calves may be one explanation for the higher perinatal mortality in these calves (Dhakal et al., 2013).

The rates of calf illness and mortality are decreased when pregnant cows are vaccinated (Razzaque et al., 2009). It is possible to protect newborn calves against etiologic agents such as enterotoxigenic *E. coli* by immunizing pregnant cows even in the early stages of pregnancy (6 months before calving) (Jayappa et al., 2008). The morbidity and mortality of calves from severe infectious illnesses can be decreased by a sequential course of vaccinations administered after birth (Wildman et al., 2008). The key to preventing neonatal calf diarrhea is to improve the standard of calf rearing (Phillips, 2002).

5. 2. Calf Health Score

The calves' well-being is essential for a high level of future milk and meat production. The public is particularly concerned about the welfare of farm animals. Good management practices are essential for the health and well-being of calves. The welfare level of an individual can be assessed using behavioral and physiological measures (Ortiz-Pelaez et al., 2008). Calves are highly vulnerable and require high-quality care because of the numerous risks that affect their wellness during the first month after birth (Samolovac et al., 2019). The most common cause of calf death is infectious diseases, such as neonatal diarrhea and pnomoni (Uetake, 2013). Therefore, it is essential to monitor calves at regular intervals. Although there are different practices in many countries, the calf health scoring system given in Table 1 can be applied for this purpose (Calderón-Amo and Gallo, 2020).

Table 1. Calf health scoring system

	0	**1**	**2**	**3**
Body condition[1]	Normal: the calf is of the same weight and condition as the average of the batch	Lower condition: the calf is between 15 % and 30% below the average of the batch	Severe lower condition: the calf is 30% below the average weight or condition of the batch	
Calf cleanliness score[1]	Clean: no manure	Moderately dirty: 25% of the surface is covered by manure	Dirty: More than 25% of the surface is covered by manure	
Fecal score[2]	Normal	Semi-formed, pasty	Loose, but stays on top of the bedding	Watery, shifts through bedding
Eye score[2]	Normal	A small ocular discharge	A moderate amount of bilateral discharge	Heavy ocular discharge
Cough[2]	None	Induce single cough	Induced repeated coughs or occasional spontaneous cough	Repeated spontaneous coughs
Skin lesion[1]	No evidence of spots of skin lesions	The evidence of spots on skin lesions.		
Lameness[1]	No evidence of lameness	The evidence of lameness		

[1] European Welfare Quality® protocol. [2] Protocol of the University of Wisconsin-Madison.

6. RESULTS

All the needs of the calf must be met for the welfare of the calf and the well-being of future generations. For this purpose, to provide sufficient passive immunity and to protect calves from diseases, calves should be given colostrum in sufficient quantity and quality as soon as possible after birth. In addition, keeping the front of the calves constantly watered, ensuring milk consumption during weaning, and weaning when the concentrated feed consumption exceeds approximately 800 g are among the important good feeding practices. Calf pens should be designed considering thermal, physical, psychological, and behavioral comfort for animals, they should be protected from intense sunlight, rain, snow, and wind, the litter used should be dry, clean, hygienic, and of high quality, and the pens should be adequately stocked with animals. Calves should be separated from their calves as soon as possible after birth. Painkillers, tranquilizers, local anesthetics, and non-steroidal anti-inflammatory drugs should be used to prevent calves from suffering and stress during disbudding, dehorning, castration, and tail docking, which have negative consequences for animal welfare. In addition, the distance and time taken to transport calves should be shortened, the duration of hunger should be reduced, sufficient space and bedding should be provided in trucks, and calf welfare should be maximized during and after transportation. To prevent calf mortality, which is an important criterion for calf health and welfare in the perinatal and pre-weaning period, all herd management practices should be fully implemented. Therefore, good nutrition, good housing, appropriate behavior, and good health practices should always be given importance for calf welfare.

REFERENCES

Abuelo, A., Havrlant, P., Wood, N., Hernandez-Jover, M. (2019). An investigation of dairy calf management practices, colostrum quality, failure of transfer of passive immunity, and occurrence of enteropathogens among Australian dairy farms. Journal of Dairy Science, 102(9), 8352-8366.

Alley, M. L., Smith, G. W., Pairis-Garcia, M. D., Wagner, B., Cramer, M. C. (2020). Welfare implications for dairy bull calves. CABI Reviews, 15, 058.

Barkema, H. W., von Keyserlingk, M. A., Kastelic, J. P., Lam, T. J., Luby, C., Roy, J. P., ... Kelton, D. F. (2015). Invited review: Changes in the dairy industry affecting dairy cattle health and welfare. Journal of Dairy Science, 98(11), 7426-7445.

Bøe, K., O. Havrevoll (1993) Cold housing and computer-controlled milkfeeding for dairy calves: behaviour and performance. Anim. Prod. 57, 183-191.

Buczinski, S., Vandeweerd, J. M. (2016). Diagnostic accuracy of refractometry for assessing bovine colostrum quality: A systematic review and meta-analysis. Journal of Dairy Science, 99(9), 7381-7394.

Calderón-Amor, J., Gallo, C. (2020). Dairy calf welfare and factors associated with diarrhea and respiratory disease among Chilean dairy farms. Animals, 10(7), 1115.

Chassagne, M., Barnouin, J., Chacornac, J. P. (1999). Risk factors for stillbirth in Holstein heifers under field conditions in France: a prospective survey. Theriogenology, 51(8), 1477-1488.

Coetzee, J. F., Nutsch, A. L., Barbur, L. A., Bradburn, R. M. (2010). A survey of castration methods and associated livestock management practices performed by bovine veterinarians in the United States. BMC Vet. Res., 6, 12.

Costa, J. H. C., Von Keyserlingk, M. A. G., Weary, D. M. (2016). Invited review: Effects of group housing of dairy calves on behavior, cognition, performance, and health. Journal of Dairy Science, 99(4), 2453-2467.

DCHA, (2016). Dairy Calf and Heifer Association. Gold standards.

De Passille, A.M. (2001). Sucking motivation and related problems in calves. Applied Animal Behaviour Science, 72, 175-187.

De Passillé, A. M., Borderas, T. F., Rushen, J. (2011). Weaning age of calves fed a high milk allowance by automated feeders: Effects on feed, water, and energy intake, behavioral signs of hunger, and weight gains. Journal of Dairy Science, 94(3), 1401-1408.

Dhakal, K., Maltecca, C., Cassady, J. P., Baloche, G., Williams, C. M., Washburn, S. P. (2013). Calf birth weight, gestation length, calving ease, and neonatal calf mortality in Holstein, Jersey, and crossbred cows in a pasture system. Journal of Dairy Science, 96(1), 690-698.

Ede, T., Lecorps, B., von Keyserlingk, M. A., Weary, D. M. (2019). Symposium review: Scientific assessment of affective states in dairy cattle. Journal of Dairy Science, 102(11), 10677-10694.

Enríquez, D. H., Ungerfeld, R., Quintans, G., Guidoni, A. L., Hötzel, M. J. (2010). The effects of alternative weaning methods on behaviour in beef calves. Livestock Science, 128(1-3), 20-27.

Færevik, G., Jensen, M. B., Bøe, K. E. (2006). Dairy calves social preferences and the significance of a companion animal during separation from the group. Applied Animal Behaviour Science, 99(3-4), 205-221.

Fisher, A.D., Stevens, B.H., Conley, M.J., Jongman, E.C., Lauber, M.C. Hides, S.J. (2014). The effects of direct and indirect road transport consignment in combination with feed withdrawal in young dairy calves. Journal of Dairy Research, 81, 297-303.

Gaillard, C., Meagher, R.K., von Keyserlingk, M.A.G., Weary, D.M. (2014). Social housing improves dairy calves performance in two cognitive tests. PLOS One 9, e90205.

Godden, S. (2008). Colostrum management for dairy calves. Vet. Clin. North Am. Food Anim. Pract. 24, 19–39.

Godden, S. M., Lombard, J. E., Woolums, A. R. (2019). Colostrum management for dairy calves. Veterinary Clinics: Food Animal Practice, 35(3), 535-556.

Godden, S. M., Smolenski, D. J., Donahue, M., Oakes, J. M., Bey, R., Wells, S., ... Fetrow, J. (2012). Heat-treated colostrum and reduced morbidity in preweaned dairy calves: Results of a randomized trial and examination of mechanisms of effectiveness. Journal of Dairy Science, 95(7), 4029-4040.

Gorden, P. J., Plummer, P. (2010). Control, management, and prevention of bovine respiratory disease in dairy calves and cows. Veterinary Clinics: Food Animal Practice, 26(2), 243-259.

Haley, D. B., Rushen, J., Duncan, I. J. H., Widowski, T. M., De Passillé, A. M. (1998). Effects of resistance to milk flow and the provision of hay on nonnutritive sucking by dairy calves. Journal of Dairy Science, 81(8), 2165-2172.

Hepola, H., Hänninen, L., Pursiainen, P., Tuure, V. M., Syrjälä-Qvist, L., Pyykkönen, M., Saloniemi, H. (2006). Feed intake and oral behaviour of dairy calves housed individually or in groups in warm or cold buildings. Livestock Science, 105(1-3), 94-104.

Hristov, S., Stanković, B., Maksimović, N. (2012). Welfare of dairy cattle-today and tomorrow. In 3rd International Scientific Symposium, Agrosym Jahorina, 55-62.

Hristov, S., Stanković, B., Todorović-Joksimović, M., Mekić, C., Zlatanović, Z., Ostojić-Andrić, D., Maksimović, N. (2011). Welfare problems ın daıry calves. Biotechnology in Animal Husbandry, 27 (4), 1417-1424.

Huber, J., Arnholdt, T., Möstl, E., Gelfert, C. C., Drillich, M. (2013). Pain management with flunixin meglumine at dehorning of calves. Journal of Dairy Science, 96(1), 132-140.

Hulbert, L.E., Moisá, S.J. (2016). Stress, immunity, and the management of calves[1]. J. Dairy Sci., 99, 3199–3216.

Hyde, R. M., Green, M. J., Hudson, C., Down, P. M. (2020). Quantitative analysis of colostrum bacteriology on British dairy farms. Frontiers in Veterinary Science, 7, 1033.

James, R. E. (2008). Managing the pre-weaned calf. Department of Dairy Science, Virginia Tech, Blacksburg.

Jasper, J., Budzynska, M., Weary, D. M. (2008). Weaning distress in dairy calves: Acute behavioural responses by limit-fed calves. Applied Animal Behaviour Science, 110(1-2), 136-143.

Jayappa, H., Davis, R., Dierks, L., Sweeney, D., Wasmoen, T. (2008). Demonstration of passive protection in neonatal calves against colibacillosis following immunization of pregnant heifers at 3 months of gestation. Veterinary Therapeutics 9, 283-289.

Jensen, M.B., Duve, L.R., Weary, D.M. (2015). Pair housing and enhanced milk allowance increase play behavior and improve performance in dairy calves. J. Dairy Sci. 98, 2568-2575.

Jensen, M.B., Larsen, L.E. (2014) Effects of level of social contact on dairy calf behavior and health. Journal of Dairy Science 97(8), 5035–5044.

Jensen, P. (2002). The ethology of domestic animals: an introductory text. CABI Pub., Wallingford.

Jensen, M. B. (2003). The effects of feeding method, milk allowance and social factors on milk feeding behaviour and cross-sucking in group housed dairy calves. Appl. Anim. Behav. Sci. 80, 191–206.

Jensen, M. B., Vestergaard, K. S., Krohn, C. C. (1998). Play behaviour in dairy calves kept in pens: the effect of social contact and space allowance. Applied Animal Behaviour Science, 56(2-4), 97-108.

Jongman, E.C., Conley, M.J., Borg, S., Butler, K.L., Fisher, A.D. (2020). The effect of milk quantity and feeding frequency on calf growth and behaviour. Anim. Prod. Sci. 60, 944–952.

Kansal, G., Hitesh, A.K., Yadav, V. (2022). Factors affecting neonatal calf mortality, controlling measures and welfare practices: A review. The Pharma Innovation Journal, 11(7), 3220-3224.

Khan, M. A., Weary, D. M., Von Keyserlingk, M. A. G. (2011). Invited review: Effects of milk ration on solid feed intake, weaning, and performance in dairy heifers. Journal of Dairy Science, 94(3), 1071-1081.

Klopp, R. N., Suarez-Mena, F. X., Dennis, T. S., Hill, T. M., Schlotterbeck, R. L., Lascano, G. J. (2019). Effects of feeding different amounts of milk replacer on growth performance and nutrient digestibility in Holstein calves to 2 months of age using different weaning strategies. Journal of Dairy Science, 102(12), 11040-11050.

Kumar, V., Singh, B. P., Kumar, R. (2011). Welfare practices in calf rearing: a comparative study in Madhubani district of Bihar. Indian Journal of Veterinary Sciences Biotechnology, 7(2), 29-31.

Lawrence, A.B., Dwyer, C.M., Jarvis, S., Roberts, D. (2005). Welfare implications of dairy calf and heifer rearing. In: Garnsworthy, P.C. (Ed.), Calf and Heifer Rearing. Nottingham University Press, Thrumpton, Nottingham NG11 0AX, UK, pp. 197–213.

Lecorps, B., Kappel, S., Weary, D.M., von Keyserlingk, M.A. (2019) Social proximity in dairy calves is affected by differences in pessimism. PLoS ONE 14(10), e0223746.

Lombard, J.E., Garry, F.B., Tomlinson, S.M., Garber, L.P. (2007). Impacts of dystocia on health and survival of dairy calves. Journal of Dairy Science 90, 1751–1760.

Lombard, J., Urie, N., Garry, F., Godden, S., Quigley, J., Earleywine, T., McGuirk, S., Moore, D., Branan, M., Chamorro, M., Smith, G., Shivley, S., Catherman, D., Haines, D., Heinrichs, A.J., James, R., Maas, J., Sterner, K. (2020). Consensus recommendations on calf- and herd-level passive immunity in dairy calves in the United States. Journal of Dairy Science, 103, 7611–7624.

Lopez, A. J., Jones, C. M., Geiger, A. J., Heinrichs, A. J. (2020). Comparison of immunoglobulin G absorption in calves fed maternal colostrum, a commercial whey-based colostrum replacer, or supplemented maternal colostrum. Journal of Dairy Science, 103(5), 4838-4845.

Mandal, A., Pathak, K., Karunakaran, M., Ghosh, M. K. (2019). Postnatal calf mortality—a review. Indian J. Anim. Health, 58(2), 147-156.

McMeekan, C. M., Stafford, K. J., Mellor, D. J., Bruce, R. A., Ward, R. N., Gregory, N. G. (1998). Effects of regional analgesia and/or a non-steroidal anti-inflammatory analgesic on the acute cortisol response to dehorning in calves. Research in Veterinary Science, 64(2), 147-150.

Meagher, R. K., Beaver, A., Weary, D. M., von Keyserlingk, M. A. (2019). Invited review: A systematic review of the effects of prolonged cow–calf contact on behavior, welfare, and productivity. Journal of Dairy Science, 102(7), 5765-5783.

Mee, J., Sen, I., Kizi, A. A., Uulu, N. A., Tas, A. (2019). Risk factors for, and causes of, perinatal calf mortality and implications for calf welfare. Manas Journal of Agriculture Veterinary and Life Sciences, 9(1), 35–41.

Medrano-Galarza, C., Leblanc, S.J., Jones-Bitton, A., DeVries, T.J., Rushen, J., de Passillé, A.M., Haley, D.B. (2017). Producer perceptions of manual and automated milk feeding systems for dairy calves in Canada. Can. J. Anim. Sci. 98, 250–259.

Marchant-Forde, J.N., Marchant-Forde, R.M., Weary, D.M. (2002). Responses of dairy cows and calves to each other's vocalisations after early separation. Appl. Anim. Behav. Sci. 78, 19-28.

Meyer, C. L., Berger, P. J., Koehler, K. J. (2000). Interactions among factors affecting stillbirths in Holstein cattle in the United States. Journal of Dairy Science, 83(11), 2657-2663.

Moore, D. A., Duprau, J. L., Wenz, J. R. (2012). Effects of dairy calf hutch elevation on heat reduction, carbon dioxide concentration, air circulation, and respiratory rates. Journal of Dairy Science, 95(7), 4050-4054.

Nikkhah, A., Alimirzaei, M. (2022). Bedding management for young calves: health, welfare and growth perspectives. Welfare and Growth Perspectives, 4(1), 1561-1562.

Norton, T., Grant, J., Fallon, R., Sun, D. W. (2010). Assessing the ventilation performance of a naturally ventilated livestock building with different eave opening conditions. Computers and Electronics in Agriculture, 71(1), 7-21.

Ollivett, T. L., Nydam, D. V., Linden, T. C., Bowman, D. D., Van Amburgh, M. E. (2012). Effect of nutritional plane on health and performance in dairy calves after experimental infection with Cryptosporidium parvum. Journal of the American Veterinary Medical Association, 241(11), 1514-1520.

Ortiz-Pelaez, A., Pritchard, D. G., Pfeiffer, D. U., Jones, E., Honeyman, P., Mawdsley, J. J. (2008). Calf mortality as a welfare indicator on British cattle farms. The Veterinary Journal, 176(2), 177-181.

Quigley, J., Hammer, C. J., Russel, L. E., Polo, J. (2002). Passive immunity in newborn calves. Advances in Dairy Technology, 14, 273-292.

Palczynski, L. J., Bleach, E. C., Brennan, M. L., Robinson, P. A. (2020). Appropriate dairy calf feeding from birth to weaning:“it’s an investment for the future”. Animals, 10(1), 116.

Pálka, V., Šoch, M., Zábranský, L., Švejdová, K., Šimková, A., Peksa, Z., Dušová, H. (2013). Influence of dıfferent housıng systems on the welfare of calves. Acta Universitatis Cibiniensis. Series E: Food Technology, 17(2), 89-98.

Panivivat, R., Kegley, E.B., Pennington, J.A., Kellogg, D.W. Krumpelman, S.L. (2004). Growth performance and health of dairy calves bedded with different types of materials. Journal of Dairy Science 87, 3736-3745.

Parsons, S. D., Steele, M. A., Leslie, K. E., Radostis, D. L., DeVries, T. J. (2020). Investigation of weaning strategy and solid feed location for dairy calves individually fed with an automated milk feeding system. Journal of Dairy Science, 103(7), 6533-6556.

Pempek, J. A., Schuenemann, G. M., Holder, E., Habing, G. G. (2017). Dairy calf management-A comparison of practices and producer attitudes among conventional and organic herds. Journal of Dairy Science, 100(10), 8310-8321.

Phillips, C.J.C. (1993). Cattle behaviour. Farming Press, Ipswich.

Phillips, C (2002). Cattle behaviour and welfare. Blackwell Science Ltd., Oxford, UK.

Price, E. O., Adams, T. E., Huxsoll, C. C., Borgwardt, R. E. (2003). Aggressive behavior is reduced in bulls actively immunized against gonadotropin-releasing hormone. Journal of Animal Science, 81(2), 411-415.

Razzaque, M. A., Al-Mutawa, T., Abbas, S., Bedair, M. (2009). Performance of pre-weaned dairy calves under hot arid environment: effects of immunoglobulins and age on diseases and mortality. American Journal of Applied Sciences, 6(11), 1885-1891.

Relić, R., Bojkovski, J. (2010). Housing conditions in calves welfare risk assessment. Journal of Agricultural Sciences (Belgrade), 55(3), 283-292.

Relić, R., Hristov, S., Samolovac, L., Bojkovski, J., Rogožarski, D. (2014). Colostrum management in calves' welfare risk assessment. Bulletin UASVM Veterinary Medicine, 71(1), 187-192.

Renaud, D. L., Steele, M. A., Genore, R., Roche, S. M., Winder, C. B. (2020). Passive immunity and colostrum management practices on Ontario dairy farms and auction facilities: A cross-sectional study. Journal of dairy science, 103(9), 8369-8377.

Roadknight, N., Mansell, P., Jongman, E., Courtman, N. (2021). Invited review: The welfare of young calves transported by road. Journal of Dairy Science, 104, 6343–6357.

Roche, J. R., Dennis, N. A., Macdonald, K. A., Phyn, C. V. C., Amer, P. R., White, R. R., Drackley, J. K. (2015). Growth targets and rearing strategies for replacement heifers in pasture-based systems: a review. Animal Production Science, 55(7), 902-915.

Radostits, O. M., Blood, D. C., Gay, C. C. (1994). Veterinary medicine. A textbook of the diseases of cattle, sheep, pigs, goats and horses (No. Ed. 8). Bailliere Tindall Ltd.

Rushen, J., de Passille, A.M. (2010) Cross-Sucking. In 'The encyclopedia of applied animal behaviour and welfare'. (Eds DS Mills, JN MarchantForde, PD McGreevy, DB Morton, CJ Nicol, CJC Phillips, PS Andoe, RR Swaisgood). pp. 152–154.

Samolovac, L., Hristov, S., Stankovic, B., Maletic, R., Relic, R., Zlatanovic, Z. (2019). Influence of rearing conditions and birth season on calf welfare in the first month of life. Turkish Journal of Veterinary Animal Sciences, 43(1), 102-109.

Schrama, J. W., Arieli, A., Van der Hel, W., Verstegen, M. W. A. (1993). Evidence of increasing thermal requirement in young, unadapted calves during 6 to 11 days of age. Journal of Animal Science, 71(7), 1761-1766.

Schuenemann, G. M., Nieto, I., Bas, S., Galvão, K. N., Workman, J. (2011). Assessment of calving progress and reference times for obstetric intervention during dystocia in Holstein dairy cows. Journal of Dairy Science, 94(11), 5494-5501.

Stafford, K. J., Mellor, D. J. (2011). Addressing the pain associated with disbudding and dehorning in cattle. Applied Animal Behaviour Science, 135(3), 226-231.

Stafford, K., Mellor, D. (2005). Dehorning and disbudding distress and its alleviation in calves. The Veterinary Journal, 169(3), 337–349.

Stewart, S., Godden, S., Bey, R., Rapnicki, P., Fetrow, J., Farnsworth, R., Ferrouillet, C. (2005). Preventing bacterial contamination and proliferation during the harvest, storage, and feeding of fresh bovine colostrum. Journal of Dairy Science, 88(7), 2571-2578.

Stull, C., Reynolds, J. (2008). Calf welfare. Veterinary Clinics of North America: Food Animal Practice, 24(1), 191–203.

Svensson, C., Lundborg, K., Emanuelson, U., Olsson, S. O. (2003). Morbidity in Swedish dairy calves from birth to 90 days of age and individual calf-level risk factors for infectious diseases. Preventive Veterinary Medicine, 58(3-4), 179-197.

Svensson, C., Linder, A., Olsson, S. O. (2006). Mortality in Swedish dairy calves and replacement heifers. Journal of Dairy Science, 89(12), 4769-4777.

Sylvester, S. P., Mellor, D. J., Stafford, K. J., Bruce, R. A., Ward, R. N. (1998). Acute cortisol responses of calves to scoop dehorning using local anaesthesia and/or cautery of the wound. Australian Veterinary Journal, 76(2), 118-122.

Tyler, J. W., Hancock, D. D., Thorne, J. G., Gay, C. C., Gay, J. M. (1999). Partitioning the mortality risk associated with inadequate passive transfer of colostral immunoglobulins in dairy calves. Journal of Veterinary Internal Medicine, 13(4), 335-337.

Uetake, K. (2013). Newborn calf welfare: A review focusing on mortality rates. Animal Science Journal, 84, 101-105.

Urie, N. J., Lombard, J. E., Shivley, C. B., Kopral, C. A., Adams, A. E., Earleywine, T. J., ... Garry, F. B. (2018). Preweaned heifer management on US dairy operations: Part V. Factors associated with morbidity and mortality in preweaned dairy heifer calves. Journal of Dairy Science, 101(10), 9229-9244.

USDA, (2016). Dairy 2014: Health and Management Practices on U.S. Dairy Operations, 2014. USDA–APHIS–VS–CEAH–NAHMS, Fort Collins, CO.

Vasseur, E., Borderas, F., Cue, R. I., Lefebvre, D., Pellerin, D., Rushen, J., ... de Passillé, A. M. (2010a). A survey of dairy calf management practices in Canada that affect animal welfare. Journal of Dairy Science, 93(3), 1307-1316.

Vasseur, E., Rushen, J., De Passillé, A. M., Lefebvre, D., Pellerin, D. (2010b). An advisory tool to improve management practices affecting calf and heifer welfare on dairy farms. Journal of Dairy Science, 93(9), 4414-4426.

Verdon, M. (2022). A review of factors affecting the welfare of dairy calves in pasture-based production systems. Animal Production Science, 62(1), 1–20.

Weary, D.M., Chua, B. (2000). Effects of early separation on the dairy cow and calf. 1. Separation at 6 h, 1 day and 4 days after birth. Appl. Anim. Behav. Sci. 69, 177–188.

Weary, D. M., Jasper, J., Hötzel, M. J. (2008). Understanding weaning distress. Applied Animal Behaviour Science, 110(1-2), 24-41.

Wenker, M. L., Bokkers, E. A., Lecorps, B., von Keyserlingk, M. A., van Reenen, C. G., Verwer, C. M., Weary, D. M. (2020). Effect of cow-calf contact on cow motivation to reunite with their calf. Scientific Reports, 10(1), 14233.

Wildman, B. K., Perrett, T., Abutarbush, S. M., Guichon, P. T., Pittman, T. J., Booker, C. W., ... Jim, G. K. (2008). A comparison of 2 vaccination programs in feedlot calves at ultra-high risk of developing undifferentiated fever/bovine respiratory disease. The Canadian Veterinary Journal, 49(5), 463-472.

Wickramasinghe, H. K. J. P., Kramer, A. J., Appuhamy, J. A. D. R. N. (2019). Drinking water intake of newborn dairy calves and its effects on feed intake, growth performance, health status, and nutrient digestibili

CHAPTER 8

CURRENT APPROACHES ON SHEEP HUSBANDRY AND WELFARE

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1. INTRODUCTION

Animal welfare affects the life, health, and productivity of small ruminants. While evaluating welfare practices in sheep breeding, ventilation of sheep shelters, floor structure, area per animal, access to water and feeders, walking area, health protection systems, transportation systems, climate parameters, altitude, and breeding practices should be considered. Living beings are physically and sensoryly affected by their environment. Environmental impacts affect animal welfare, and the quality of animal products is also affected. Animal welfare and animal product quality have been on the agenda in recent years. In sheep breeding, early detection methods are important in ensuring animal welfare as well as monitoring and protecting health. Animal health and welfare affect food safety and public health. In this respect, the standards to be applied for animal welfare have become mandatory (M’Hamdi et al., 2021; Van der Heijden, 2022).

Sheep are affected by nutrient deficiencies, disease, and flock management. These are the most basic animal welfare factors. Feeding and husbandry practices should be emphasized for sheep to be healthy. Early detection of problems related to sheep welfare can prevent disease and losses. Therefore, management tools can be used by breeders (M'Hamdi et al., 2021). Individual tracking systems for determining animal welfare and monitoring pen conditions have become important in improving animal welfare and health in sheep breeding. By tracking animal behavior, early detection of diseases, prevention of losses, and sustainability of animal production can be ensured (Silva et al., 2022). One of the applications that has become widespread in sheep breeding in recent years is the use of drones. With this technology, problems in pasture areas can be detected in a short time and solutions can be offered. Providing training and support to sheep breeders on the use of this technology can improve sheep welfare. The use of drones in pasture areas is a technology that facilitates animal tracking and behavior monitoring. Animal welfare indicators for sheep are given in Table 1.

In recent years, farm management strategies have been emphasized in animal welfare assessments. There are technological problems in implementing animal tracking and monitoring systems in closed systems and pasture areas. However, the implementation of these systems will be beneficial in improving animal welfare (Silva et al., 2022). By improving welfare, it is aimed at minimizing the effects of adverse effects such as stress, pain, suffering, and disease in sheep (Van der Heijden, 2022).

Table 1. Animal welfare indicators for sheep (AWIN, 2015)

Welfare Principles	**Welfare Criteria**	**Welfare Indicators**
Good feeding	Proper nutrition	Body condition score Score lamb mortality
	Thirst	Water availability
Good housing	Comfort resting	Fleece cleanliness
	Thermal comfort	Panting Access to shade/shelter
	Ease of movement	Stocking density Hoof overgrowth
Good health	Absence of injuries	Body and head lesions Leg injuries
	Absence of diseases	Lameness Faecal soiling Mucosa colour Ocular discharge Mastitis Udder lesions (lactating ewes only) Respiratory quality Fleece quality
	Absence of pain	Tail length
Appropriate behavior	Social behavior	Social withdrawal
	Other behaviours	Stereotypy Excessive itching
	Human- animal relationship	Human approach
	Positive emotional state	Qualitative Behaviour Assessment

2. EFFECT OF HUSBANDRY PRACTICES ON ANIMAL WELFARE IN SHEEP BREEDING

Sheep welfare can be affected by nutritional stress, water scarcity, climate change, parasitic diseases, lameness, and shank problems. Natural pastures are grazing areas where internal and external parasites are dense. Sheep grazing in these areas can be exposed to a wide range of parasites. AWIN protocol is used to assess the welfare of sheep (Nenadović et al., 2022). Animal welfare is affected by inadequate feeding, temperature stress, neonatal survival, metabolic diseases, and parasitic diseases. Such factors negatively affect breeders and the labor force working in the enterprise (Silva et al., 2022).

A study evaluating the welfare of Tunisian sheep addressed the presence of clinical diseases, lameness, and cough in the flock. In this study, respiratory rate 8.1±0.21, lesions 9.7±0.33, dirtiness 57.3±5.17, lameness 10.48±1.12 were determined (M'Hamdi et al., 2021).

Trainings to be given to breeders in order to adopt animal welfare practices will have important contributions in terms of raising awareness (Canan et al., 2022).

The main welfare problems identified in the study conducted by Nenadović et al. (2022) were wool cleanliness (84.14%), nasal discharge (45.12%), eye discharge (19.51%), respiratory problems (18.29%, 15/82), body condition score (15.85%), fleece quality (20.73%), and anemia (9.76%). In addition, leg lesions and mild lameness were observed in 4.88% of the sheep. In addition, coccidiosis was the most common infection in the study. The indicators for evaluating welfare practices in sheep farms include underweight, fleece condition, fleece cleanliness, skin lesions, tail docking, lameness, excessive hoof growth, and mastitis. In one study, mastitis ranked first among welfare indicators, underweight second, and lameness third (Marcone et al., 2022).

Animal health monitoring methods have been used since 2006. Supporting these methods with new monitoring technologies is thought to have a positive effect on determining and improving animal welfare (Van der Heijden, 2022). Cost-effective real-time temperature monitors can be used in limited space to monitor temperature stress in sheep. Temperature stress can be reliably measured by infrared thermography measurements in sheep (Joy et al., 2022). The parameters monitored in determining animal welfare are given in Table 2.

Table 2. Parameters monitored in determining animal welfare (M'Hamdi et al., 2021; Silva et al., 2022; Van der Heijden, 2022).

Parameters Monitored
Population structure
Death
Animal movements
Body temperature
Respiratory rate
Heartbeat
Decrease in yield
Body condition score
Lameness
Clinical diseases
Maintenance and feeding practices
Seasonal weight loss
Blood parameter measurements in the diagnosis of pregnancy toxemia

New technologies (such as drones, in-rumen sensors, or ear tags with accelerometers) are being used to assess animal welfare in small ruminants. However, there are challenges to using these technologies in terms of cost, accuracy, and real-time data collection (Silva et al., 2022).

3. THE EFFECT OF FEEDING PRACTICES ON ANIMAL WELFARE IN SHEEP

It has been reported that the most reliable indicators to be included in welfare protocols in sheep farming are animal-based indicators (M'Hamdi et al., 2021).

One of the indicators of welfare is the animal's adequate intake of food and water. Parameters that can be measured from blood are taken into consideration in determining nutritional adequacy. In this study, blood biochemical parameters (urea, total cholesterol, triglycerides, L-aspartate:2-oxoglutarate aminotransferase (AST), gamma-glutamyl transferase (GGT), and alkaline phosphatase) may be useful in animal welfare and physiological evaluation in dairy sheep (Nedeva et al., 2022).

The weaning of lambs in sheep farming is a practice that affects animal welfare. Weaning is the separation of ewe and lamb and the termination of lactation. The application of this process varies according to the purpose and facilities of sheep farms. The lamb's age, body weight, purpose of rearing, and nutritional resources affect the weaning age. Weaning is stressful for lambs and ewes. Gradual mixed practices and flock management rather than abrupt weaning practices can improve animal welfare by reducing weaning stress (Freitas-de-Melo et al., 2022). Common weaning practices are given in Table 3.

Table 3. Weaning practices (Freitas-de-Melo et al., 2022).

Type of weaning	Weaning age	Sheep production system
Precocious	From 24 h until 29 days	Dairy sheep reared intensively or semi-extensively
Early	From 30 until 60 days	Meat and wool sheep reared intensively or semi-intensively
Traditional	From 61 until 90 days	Meat and wool sheep reared intensively, semi-intensively or extensively
Late	After 90 days	Meat and wool sheep reared extensively

The other parameter taken into account for adequate feeding control is the body condition score. The average body condition score (BCS) in a Tunisian sheep flock was 2.4, and 47% of the ewes had a BCS of 2.0. In the same study, the body condition scores of lambs were also evaluated as an indicator of a welfare problem. It was found that 7% of the lambs had low BCS. Body condition scores may be associated with increased nutritional stress, disease, and low fertility (M'Hamdi et al., 2021).

Changes in precipitation patterns can be seen due to climate change under the influence of global warming. Especially the amount of salt in water affects the quality of the water. As the amount of precipitation decreases, the amount of salt in the water increases. Sheep and goats are more resistant to water deficiency than other species. It is reported that especially local breeds have good tolerance to salty water (Tulu et al., 2023a). A study was conducted in Kubada to measure the effects of water stress on sheep. In this study, there were 3 groups: free water, watered every 3 days, and watered every 6 days. As a result of the study, sheep weight and rectal temperature did not change with water stress. However, respiratory rates decreased from 23.3 to 13.3. The number of lymphocytes decreased (from ±63 to 43%), and the number of neutrophils (from about 38% to 54%) and leukocytes (from 3133 to 4933 per mm3) increased with water stress (Serrano et al., 2022). The quality of water, as well as its quantity, has an impact on animal nutrition and welfare. The use of pesticides and herbicides in areas where intensive agricultural practices are practiced causes pollution of groundwater resources. Salt, acidity, toxic elements and their contents, as well as algae growth, have an impact on water quality. Water use is related to air temperature and food quality. At the same time, breed differences, age of the animal, physiological periods (such as pregnancy and lactation), and flock condition affect water consumption (Markwick, 2007). Periodic water consumption averages for sheep are given in Table 4.

Table 4. Average water consumption in sheep (Markwick, 2007).

Stock type	Consumption per head per day (L)
Sheep weaners	2-4
Adult dry sheep (grassland)	2-6
Adult dry sheep (saltbush)	4-12
Ewes with lambs	4-10

There is a decrease in the amount of water and an increase in salt content due to climate change. It poses a threat to livestock livelihoods, especially in arid regions. A study was conducted to determine the effects of lake water salinity on the growth performance, behavior, physiology, and blood constituents of indigenous sheep in Eastern Ethiopia. A total of 28 lambs were divided into four groups based on their initial body weights, and water was assigned to salinity levels (510mg/l TDS (Total Dissolved Solids), 2600mg/l

TDS, 5200mg/l TDS, and 7900mg/l TDS). As a result of the study, it was determined that increasing TDS levels in Lake Basaka water changed water intake, watering frequency, time spent drinking water, sedentary behavior, rectal temperature, and respiratory rate. As a result of the same study, the concentrations of hemoglobin, glucose, albumin, urea, triglyceride, sodium, triiodothyronine, alanine, aspartate aminotransferase enzymes, and thyroxine hormone slightly decreased. Increased salinity may affect animal welfare and productivity (Tulu et al., 2023b).

To improve the welfare of sheep and ensure sustainability, it is important to preserve indigenous breeds. Improving care and feeding conditions under the impact of global warming is important for sustaining sheep breeding.

4. THE IMPACT OF HUMAN BEHAVIOR ON SHEEP WELFARE

In the evaluation of sheep welfare, the human-animal relationship is also used as a welfare indicator. One of the factors affecting the welfare of sheep is human influence. The reactions of the sheep to the people taking care of them and to the new people they see should be used in the assessment of animal welfare. In the evaluation of sheep welfare in Tunisian sheep, the reaction of the sheep to the breeder and the new person was evaluated. As a result of the study, the mean distance for avoiding the new person and the breeder was determined as 10.47 ± 1.23 and 8.12 ± 0.97 m, respectively. The average heart rate in sheep was 128.4 ± 1.42 and 97.8 ± 6.45 in the new person and breeder, respectively (M'Hamdi et al., 2021).

Improving animal welfare aims to minimize adverse effects such as stress, pain, suffering, and disease (Muhammad et al., 2022).

5. THE EFFECT OF HOUSING CONDITIONS ON ANIMAL WELFARE IN SHEEP

The housing of sheep in closed and semi-open systems varies considerably due to the duration of housing and the diversity of climatic conditions in different geographical regions (Stubsjøen et al., 2022). The m^2 area per animal in sheep housing is used in the assessment of animal welfare.

Animal welfare indicators according to the area per adult ewe without lambs and the area required for ewes with lambs are given in Table 5.

In sheep breeding, pens with insulated and slatted floors are used in the latest pens. In these pens, an area of 0.7-0.9 m2 per animal is kept in the pens. The use of deep litter floors in sheared sheep requires attention during periods of low temperatures. Traditional housing systems with slatted flooring may be suitable in terms of hygiene. In this respect, the use of little or no litter material can reduce the cost (Færevik et al., 2005).

Table 5. Assessment of animal welfare in shelters (AWIN, 2015)

Good	Adult ewes (without lambs): least 1.5 m^2 each; ewes with lambs at foot: least 2 m^2.
Adequate	Adult ewes (without lambs): less than 1.5 m^2; Ewes with lambs at foot: least 1.5 m^2.
Poor	Adult ewes (without lambs): 1 m^2 or less. Ewes with lambs at foot: less than 1.5 m^2.

Outdoor management conditions, ectoparasite infections, and mineral imbalances have led to the deterioration of fleece (Marcone et al., 2022). In Norway, sheep are usually housed in insulated enclosures with metal floors during the cold season. In the study on the effect of shelters on sheep welfare, welfare assessments were carried out on 64 farms (35 insulated and 29 non-insulated/open shelter designs). As a result of the study, the most common physical conditions identified in sheep were callus (hard and thickened skin area) on the carpal joints (27.5%), dirt on the abdomen (18.8%), overgrown claws (18.1%), and wool loss (16.0%). Calluses were more common in sheep pens with metal floors compared to pens with deep litter and plastic floors. In sheep, dirt on the abdomen was positively correlated with dirt in the lying area, while dirt was less when there was more space per ewe. The risk rate for severe skin lesions was also found to be significantly lower in sheep that had not been recently sheared (Stubsjøen et al., 2022). In old pens, poor hygiene conditions, litter, and flooring can lead to weakened immunity and an increased incidence of pathogen-borne diseases. Since claw growth, knee calluses, soiling, and skin lesions are associated with flooring type, hygiene of sleeping areas, space allowance, and shearing, these are areas that need more attention in the design of new sheep housing in Norway. Walking sheep in the open has been reported to have a positive effect on their sensory status and cause fewer skin lesions. In the planning of pens, more freedom of behavior, exercise, and usable space for sheep should be considered (Stubsjøen et al., 2022; El Sabry et al., 2023).

It can be said that as the size of sheep farms increases, animal welfare, housing conditions, transportation, and physical health and well-being conditions increase. Providing training to breeders on animal welfare will increase awareness (Canan et al., 2022).

6. THE EFFECT OF TRANSPORTATION PRACTICES ON ANIMAL WELFARE IN SHEEP

Animal losses can be prevented by evaluating the effects of transportation on sheep welfare. Considering the conditions and duration of transportation will reduce the level of physiological and psychological negative effects on sheep. During the transportation of animals, behavioral and physiological mechanisms and reactions occur due to factors affecting animal welfare. The effects of temperature and humidity are important factors to be considered in transportation processes. Temperature stress causes behavioral, physiological, and biochemical changes in sheep. At the same time, heat stress negatively affects animal welfare and productivity (Joy et al., 2022). Exposure to high temperatures causes stress in sheep. Continuous heat stress causes death in sheep. Mortality rates for sheep were increased on board ship compared to mortality on land (mean equivalent daily mortalities for sheep were 0.10% on board ship and 0.007% on land, i.e., 14 × higher for ship). It has been observed that the mortality rate increases in ship transportation compared to land transportation (Phillips, 2016). The effects of transportation stress on sheep during cold months have been studied. In the study, the effects of open and closed vehicles, short- and long-term transportation, and pre-transport feeding on transportation stress were determined. As a result, it was determined that the temperature increase in the legs of sheep increased during long-term transportation. More stress was detected in long-term open vehicles and in groups that were not fed before transportation (Carnovale et al., 2021). The effects of transportation and altitude on hormones and blood parameters were evaluated in Karayaka sheep. Transportation time was 5 hours. Sheep were transported 1500 meters above sea level. As a result of the study, Triiodothyronine (T3) (P<0.039) and Tyrosine (T4) (P<0.000) hormones were affected by transportation and altitude in Karayaka sheep. In the same study, Malondialchehyche (MDA) (P<0.039), one of the oxidative stress parameters, was affected (Tozlu Çelik et al., 2021).

One study investigated the effects of transporting sheep from Australia to the Middle East during the summer season from 2005 to 2014. It addressed the welfare issues faced by sheep due to heat stress on long-distance voyages. Sheep use behavioral and physiological mechanisms to reduce heat stress. In study, it was reported that the mortality rate doubled in sheep moved from Australia to the Middle East in the summer compared to the winter. This was increased by salmonellosis-induced diseases and heat stress. Therefore, improving temperature monitoring on ships and in transportation systems and creating a model for determining the impact of rising temperatures on sheep morbidity and mortality and a scale of heat stress for sheep will help to identify and understand welfare problems (Phillips, 2016). In the long-term transportation of sheep in high temperatures, care should be taken to ensure that the transportation vehicles have conditions that will not negatively affect the welfare of the sheep. Consideration of seasonal conditions in long-term transportation is thought to prevent animal losses.

7. EFFECT OF GRAZING AREAS ON SHEEP WELFARE

Among the factors affecting the welfare of sheep and lambs, stress factors caused by grazing conditions include high and low temperatures, excessive solar radiation, poisonous plants, various endo and ectoparasites, snake and insect bites, and pasture-borne infections (Bozakova and Ivanov, 2022). The addition of antioxidant substances to feed as a supplement to reduce stress in sheep is one of the applications that has attracted more attention in recent years. In a study conducted in mice, it was concluded that silymarin (Silybum marianum) prevented the development of acute lung damage in the treated group.

Encouraging quality grass production in pasture areas, giving probiotic-supplemented feeds to sheep, and using agricultural wastes as feed by improving their digestibility can be solutions to global warming-induced feeding problems (Durmuş and Koluman, 2019). It was reported that this result may be due to the anti-inflammatory and antioxidant effects of silymarin

(Canikli Adıgüzel et al., 2016). Silymarin applications as a feed supplement in grazing conditions are emphasized, especially because of its antioxidant effect associated with decreasing reactive oxygen species content, malondialdehyde (a marker of lipid peroxidation), and cortisol levels in the blood and stimulating the activity of antioxidant enzymes glutathione peroxidase, superoxide, and heat shock protein 70 (HSP70). It is also reported to positively affect animal welfare, growth, and milk yield (Bozakova and Ivanov, 2022).

8. CONCLUSION

The realization of animal welfare is associated with the improvement of the living conditions of sheep and the applicability of monitoring systems. Increasing temperatures cause heat stress in sheep. There is a need for a feasible air conditioning system to reduce the effects of heat stress. Arranging the pens according to the climatic conditions in the regions where sheep farms are located will provide positive results from sheep breeding. It should be ensured that the cistern system is implemented in the enterprises to combat the water shortage that may be experienced on sheep farms as a result of global warming. With this system, meeting the water needs of the sheep and the water needed in the pen with the collected rainwater will provide two-way benefits. Firstly, it will improve animal welfare, and any water stress that may be experienced due to water scarcity will be reduced. The second benefit will facilitate water supply in sheep farming enterprises and provide an economic contribution (both visual and written information should be provided with the cistern system). Problems that may be experienced with feed supply directly affect animal welfare. Evaluation of alternative sources for feed supply as feed raw materials can prevent nutrient deficiencies. Feed crops may be affected by global warming. Alternative feed resources should be evaluated on the basis of provinces in feed supplies. In this way, the increase in the cost of transportation will be prevented. In the diagnosis and diagnosis of diseases, early warning systems should be monitored by cameras in sheep farms; monthly blood tests, fever measurements, and live weight follow-up should be done. Scientific-based methods should be used and evaluations should be made in determining welfare in sheep breeding. In this respect, the use of technological applications of welfare assessment methods in regions where sheep breeding is intensive can reduce mortality rates in sheep, increase productivity, and prevent negative effects on product quality. In addition, providing transportation conditions in which temperature and humidity are controlled according to seasonal conditions and ventilation is good will positively affect sheep welfare. By introducing legal obligations for animal welfare, animal losses and national income losses can be prevented. More studies are needed in this respect.

REFERENCES

AWIN, (2015). AWIN welfare assessment protocol for sheep. https://doi.org/10.13130/AWIN_SHEEP_2015.

Bozakova, N., Ivanov, V. (2022). Opportunities for sheep welfare improvement by silymarin additive – a review article. Bulg. J. Agric. Sci., 28(3), 502-509.

Canan, S., Ocak Yetişgin, S., Yüksel, H.M. (2022). Animal welfare perception of sheep farmers and consumers: The case of Samsun. Journal of Agriculture, Food, Environment and Animal Sciences, 3(1), 27-47.

Canikli Adıgüzel, Ş., Pirat, A., Türkoğlu, S., Bayraktar, N., Özen, Ö., Kaya, M. (2016). Bir sıçan akut respiratuvar distres modeli'nde silimarin'in antiinflamatuvar ve antioksidan etkisi. J Turk Soc Intens Care, 14, 18-27 https://doi.org/10.4274/tybdd.71501

Carnovale, F., Xiao, J., Shi, B., Kaart, T., Arney, D., Phillips, C.J.C. (2021). The Effects of Vehicle Type, Transport Duration and Pre-Transport Feeding on the Welfare of Sheep Transported in Low Temperatures. Animals, 11, 1659. https://doi.org/10.3390/ ani11061659

Durmuş, M., Koluman, N. (2019). Impacts of stockbreeding on global warming. Journal of Environmental Science and Engineering B 8, 223-229. https://doi.org/10.17265/2162-5263/2019.06.003

El Sabry, M.I., Motsei, L.E., Abdel-Mageed, I.I., Almasri, O. (2023). Space allowance impacts behavior, productivity, reproductivity and immunity of sheep-a review. Tropical Animal Health and Production, 55, 207. https://doi.org/10.1007/s11250-023-03615-2

Færevik, G., Andersen, I.L., Bøe, K.E. (2005). Preferences of sheep for different types of pen flooring. Applied Animal Behaviour Science, 90, 265-276. https://doi.org/10.1016/j.applanim.2004.08.010

Freitas-de-Melo, A., Orihuela, A., Hötzel, M.J., Ungerfeld, R. (2022). What do we know and need to know about weaning in sheep? An overview of weaning practises, stress and welfare. Front. Anim. Sci. 3, 823188. https://doi.org/10.3389/fanim.2022.823188

Joy, A., Taheri, S., Dunshea, F.R., Leury, B.J., DiGiacomo, K., Osei-Amponsah, R., Brodie, G., Chauhan, S.S. (2022). Non-invasive measure ofheat stress in sheep using machine learning techniques and infrared thermography. Small Ruminant Research, 207, 106592. https://doi.org/10.1016/j.smallrumres.2021.106592

M'Hamdi, N., Darej, C., Attia, K., Guesmi, H., Znaïdi, I.E.A., Bouraoui, R., M'Hamdi, H., Marzouki, L., Ayadi, M. (2021). Assessment of meat-type sheep welfare using animal-Based Measures. Animals, 11, 2120. https://doi.org/10.3390/ani11072120

Marcone, G., Carnovale, F., Arney, D., De Rosa, G., Napolitano, F. (2022). A Simple Method For on-Farm Evaluation of Sheep Welfare Using Animal-Based Indicators. Small Ruminant Research, 208, 106636. https://doi.org/10.1016/j.smallrumres.2022.106636.

Markwick, G. (2007). Water Requirements for Sheep and Cattle. Primafact, 326,1-4.

Muhammad, M., Stokes, J.E., Manning, L. (2022). Positive Aspects of Welfare in Sheep: Current Debates and Future Opportunities. Animals, 12, 3265. https://doi.org/10.3390/ani12233265.

Nedeva, I., Slavov. T., Radev, V., Panayotov, D., Varlyakov, I. (2022). Blood biochemical profile as an objective measure of welfare in Lacaune sheep. Bulgarian Journal of Agricultural Science, 28 (2), 324–330.

Nenadović, K., Vučinić, M., Jovanović, N., Bugarski, D., Ilić, T. (2022). Welfare and parasitology condition of extensively reared sheep during winter. ISAE August 2022, Proceedings of the55th Congress of the ISAE, Animal Behaviour and Beyond. Session 09: Behaviour and welfare of indigenous breeds and in extensive production systems. P:55.

Phillips, C. (2016). The welfare risks and impacts of heat stress on sheep shipped from Australia to the Middle East. The Veterinary Journal, 218, 78–85. http://dx.doi.org/10.1016/j.tvjl.2016.09.011

Serrano, J.O., Villares-Garachana, A., Correa-Herrera, N., González-Morales, A., Lisbet Pérez-Bonachea, L., Hernández, L., Lorente, G., Hajari, E., Fonseca-Fuentes, N., Martínez-Melo, J., Lorenzo, J.C. (2022). Impacts of short-term water restriction on Pelibuey sheep: physiological and blood parameters. Tropical Animal Health and Production, 54, 39. https://doi.org/10.1007/s11250-022-03050-9.

Silva, S.R., SacarrãoBirrento, L., Almeida, M., Ribeiro, D.M., Guedes, C., González Montaña, J.R., Pereira, A.F., Zaralis, K., Geraldo, A., Tzamaloukas, O., González Cabrera, M., Castro, N., Argüello, A., Hernández-Castellano, L.A., Alonso-Diez, A.J., Martín, M.J., Cal-Pereyra, L.G., Stilwell, G., de Almeida, A.M. (2022). Extensive Sheep and Goat Production: The Role of Novel Technologies towards Sustainability and Animal Welfare. Animals, 12, 885. https://doi.org/10.3390/ani12070885

Stubsjøen, S.M., Moe, R.O., Mejdell, C.M., Tømmerberg, V., Knappe-Poindecker, M., Kampen, A.H., Granquist E.G., Muri, K. (2022). Sheep welfare in different housing systems in South Norway. Small Ruminant Research, 214, 106740. https://doi.org/10.1016/j.smallrumres.2022.106740

Tozlu Çelik H., Aslan, F.A., Us Altay, D., Kahveci, M.E., Konanç, K., Noyan, T., Ayhan, S. (2021). Effects of transport and altitude on hormones and oxidative stress parameters in sheep. PLoS ONE, 16(2), e0244911. https://doi.org/10.1371/journal.pone.0244911

Tulu, D., Gadissa, S. Hundessa, F. (2023a). Impact of water stress on adaptation and performance of sheep and goat in dryland regions under climate change scenarios: a systematic review. Journal of Animal Behaviour and Biometeorology, 11(2), e2023012. https://doi.org/10.31893/Jabb.23012.

Tulu, D., Urge, M., Yusuf, Y. (2023b). Adaptation Capacity of Indigenous Sheep to Saline Lake Drinking Water in Dry Area of Ethiopia Under Climate Change. FARA Research Report, 7(28), 358-368. https://doi.org/10.59101/frr072328

Van der Heijden, M., Dijkstra, E., Holstege, M., van den Brom, R., Vellema, P. (2022). Data analysis supports monitoring and surveillance of sheep health and welfare in the Netherlands. Small Ruminant Research, 216, 106831. https://doi.org/10.1016/j.smallrumres.2022.106831

CHAPTER 9

GOAT BREEDING AND WELFARE

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1. INTRODUCTION

Transitioning to a more sustainable livestock sector is one of today's biggest challenges. At the same time, animal welfare is an important component of livestock production. To make an overall on-farm sustainability assessment, it is necessary to consider both environmental impact and animal welfare (Lanzoni et al., 2023). Animal welfare is difficult to monitor. Keeping farm animals clinically healthy and free from disease or distress is essential for the production of safe and quality food. This issue is extremely important for both governments and food industries worldwide. Furthermore, consumers are increasingly paying attention to how animals are raised and, consequently, how food products of animal origin are obtained. The concept of animal welfare includes a wide range of aspects (Miretti, 2020). According to the existing literature, livestock welfare indicators fall into three main categories: physiological measurements, behavioral observations and product quality (Sánchez-Hidalgo et al., 2020; Munoz et al., 2019; Vasdal et al., 2019; Chulayo et al., 2017).

The concept of animal welfare protection has historically been defined as derived from the concept of the 'five freedoms' developed in 1979, with five domains later developed in 1994. Today, these five domains are defined as health, physical environment, nutrition, behavioral interactions and mental state. In earlier models, the five domains mainly focused on identifying and correcting negative welfare states, whereas the current model emphasizes the presence of positive welfare states (Card et al., 2018; Mellor and Beausoleil, 2015; Mellor et al., 2020). While the five domains model remains an important part of animal welfare assessment, it does not focus on factors related to animal guardians that can lead to negative animal welfare (McDowall et al., 2023). Over the years, European Union Regulations, national and international initiatives, provisions and guidelines have been developed to ensure that animal welfare requirements are set out and to provide tools based on scoring systems for an appropriate animal welfare assessment. However, comprehensive and objective assessment of animal welfare remains challenging (Fabrile et al., 2023).

In monitoring welfare, animals can be observed for their level of mobility, posture, vocalizations, aggression, movement patterns, feed and water intake, and sleeping patterns. When the animal encounters a situation that negatively affects its welfare, the amount of effort it makes to avoid this situation can be used as a measure of the degree of avoidance of the stimulus. In this way, the suitability of housing systems, feed and other environmental factors can be tested. In other words, animal preference tests can be conducted to assess whether the animal is negatively affected by a particular situation to which it is exposed (Squires, 2003).

Animal welfare is an important component of sustainable livestock production (Broom, 2021). Among livestock, the goat is recognized as a multifunctional animal and a resource with ideal qualities, especially for sustainable red meat production. Goats are also highly adaptable to harsh environments considering production, reproduction and disease resistance (Alexandre and Mandonnet, 2005; Laczo et al., 2007; Mene´ndez Buxadera and Mandonnet, 2006). Goats are considered to be a good animal model for coping with multiple environmental stressors and have the potential to qualify as an animal of the future, especially in arid and semi-arid regions (Aleena et al., 2018; Ramachandran et al., 2019; Ramachandran and Sejian, 2022).

Goat production forms an important part of the economic activities of most rural dwellers and pastoral systems. It ensures the economic security of the people. It is a good source of milk, meat, skin and fiber for human use (Abioja et al., 2023; Mioˇc et al., 2008; Mazhangara et al., 2019; Salehi et al., 2013). Goat breeding has advantages such as the capital needed for the establishment of the enterprise and the provision of the necessary animal material is less than that calculated for other animal species, maintenance costs are low, goats have a high utilization rate of cellulose-rich feeds and short gestation period (Tüfekci, 2023). It is seen that there have been significant developments in goat breeding in recent periods due to the successes achieved in low-income countries as well as middle and high-income countries (Baş et al., 2023). The number of goats in the world is 1,128,106,236 heads and the countries with the highest number of goats are India (13.3%), China (11.8%), Nigeria (7.4%), Pakistan (6.9%) and Bangladesh (5.3%) (FAO, 2022).

The assessment of animal welfare in ovine production systems is discussed and there are several monitoring programs and welfare assessment protocols used to assess ovine welfare at farm level (Caroprese et al., 2016). These are derived from the results of the Animal Welfare Indicators (AWIN) project funded under the European Commission's 7th Framework Program.

Table 1 shows the animal welfare indicators of the AWIN welfare assessment protocol for goats.

Table 1. Animal welfare indicators of the AWIN welfare assessment protocol for goats, divided according to principles and criteria (AWIN, 2015)

Welfare principles	Welfare criteria	Welfare indicators	
		First level	Second level
Good feeding	Appropriate nutrition Absence of prolonged thirst	Hair coat condition, queuing at feeding Queuing at drinking	Body condition score, hair coat condition, queuing at feeding Queuing at drinking
Good housing	Comfort around resting Thermal comfort Ease of movement	Bedding Thermal stress Kneeling at the feeding rack	Bedding Thermal stress Kneeling at the feeding rack
Good health	Absence of injuries Absence of disease	Severe lameness Abscesses, hair coat condition, oblivion, overgrown claws, udder asymmetry	Severe lameness Abscesses, body condition score, faecal soiling, hair coat condition, nasal discharge, oblivion, ocular discharge, overgrown claws, udder asymmetry
Appropriate behaviour	Absence of pain and pain induced by management procedures Expression of social behaviour Expression of other behaviour Good human–animal relationship Positive emotional stat	Improper disbudding, severe lameness Queuing at drinking, queuing at feeding Oblivion Latency to the first contact test Qualitative behaviour assessment	Improper disbudding, severe lameness Queuing at drinking, queuing at feeding Oblivion Latency to the first contact test Qualitative behaviour assessment

2. NUTRITION AND WELFARE IN GOAT BREEDING

Under natural conditions, goats show great adaptability and flexibility in their feeding behavior (Cellier et al., 2022; Ngwa et al., 2000; Dziba et al., 2003). Some studies have reported that feeding time in wild goats is affected by both time of year and time of day (Shi et al., 2003). Goats are classified as both browsers and grazers and actively forage at different elevations. Goats have also been reported to forage by perched in trees (Goetsch et al., 2010; El Aich A et al., 2007). In another study, it was reported that goats can graze up to a height of 2.1 m (Sanon et al., 2007). Their flexible lip and tongue structures allow goats to be selective for buds, leaves, fruits and flowers, which contain more protein and are more digestible than stems (Ngwa et al., 2000; Ouédraogo-Koné et al., 2006). Goats also have the ability to "probe" and "shake" the branches of plants, which can help them avoid pests on leaves (Berman et al., 2017). In addition, the ability to discriminate and tolerate bitter tastes (Bell, 1959) probably contributes to feeding flexibility (Zobel et al., 2019).

Nutrition plays an important and specific role in goat farming systems. Feed quantity, feed composition and nutrition have a significant impact on the cost of production and the quality of the product obtained. Nutrition also directly affects other components of goat production systems, such as animal health and reproductive performance. In addition, a feeding program for goats should always be established taking into account the genetic characteristics of the goat breed or genotype, age, physiological stage, etc. (Morand-Fehr, 2005).

The time spent for feed consumption in goats varies greatly according to the quality, type and feeding method of the feed. The daily feed intake capacity depends on the time spent grazing and the rate of feed intake during this time. Therefore, daily feed intake is a function of the number of bites per unit time (bite rate) and the amount of feed taken per bite (bite mass) (Hodgson, 1990) (Figure 1). In addition, seasonal changes such as precipitation, temperature, relative humidity, vegetative stages, as well as different periods such as animal production and reproduction are factors that affect daily feed intake (Newman et al., 1994). Consequently, daily feed intake is the result of the time the animal spends grazing and the rate of feed intake during this time. Several factors, such as herd management, regional climatic conditions, animal activity in the group, nutritive value and availability of feed, affect the duration and intensity of activities that goats perform during the day (such as grazing, resting and rumination) (Dias-Silva and Filho, 2020).

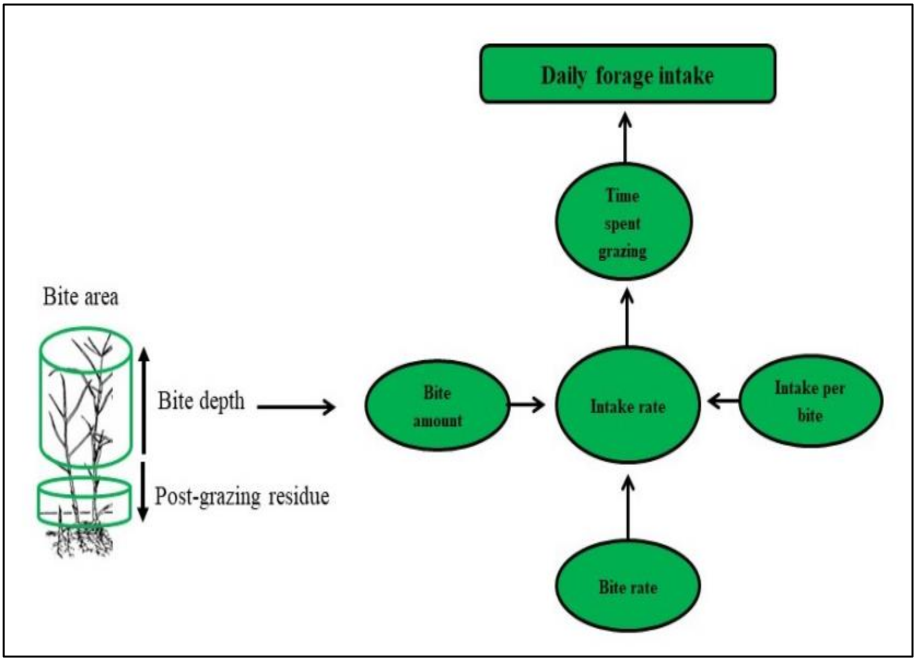

Figure 1. Components of ingestive behavior (Hodgson, 1990; Dias-Silva, 2020).

Stress factors such as nutritional deficiencies, changes in temperatures, cold, crowding, noise and transportation in livestock reduce the body's immunity and predispose it to diseases. Animals fed unbalanced rations produce lower yields at higher costs and cause more methane production. In addition, unbalanced nutrition negatively affects animal health, products obtained, fertility, environment and therefore animal welfare (Garg and Sherasia, 2015).

Singh (2018) reported that goats respond readily to good herd management and appropriate nutrition and that these practices should be paid attention to as with other livestock to achieve the best results. He also stated that success in feeding can be achieved by formulating a nutritious and inexpensive ration and the preparation of a balanced ration requires consideration of factors such as nutritional value, volume, palatability, digestibility, local availability and cost. In addition, fresh, clean water should always be available for the animals. In their study, the nutrient requirements of goat and the acceptable amounts of macro and micro minerals in goat diets are given in Table 2 and Table 3.

Table 2. Nutritional requirement of goat (Singh, 2018)

Nutrient	Requirement
Dry matter	For dairy goats
	In temperate region 5-6% of live weight
	In tropical region 4-5% of live weight
	For meat type goats – 2.5-3% of live weight
Concentrate	
For maintenance ration	250g for every 50 kg body weight
For production ration	450g for every 2.5 lt. milk/ doe
For pregnancy ration	During last 2 month of gestation 220g daily/ doe
Stud buck	400g daily
Water	450- 680 g/ day for a goat weighting 18-20 kg
Dry matter: total water intake ratio	1:4

Table 3. Acceptable quantity of macro and micro minerals in a goat's diet (Singh, 2018)

Macro minerals (%)		Micro minerals (ppm)	
Calcium	0.3-0.8	Iron	50-1000
Phosphorus	0.25-0.4	Copper	10-80
Sodium	0.2	Cobalt	0.1-10
Potassium	0.8-2.0	Zinc	40-500
Chloride	0.2	Selenium	0.1-3
Sulfur	0.2-0.32	Molybdenum	0.1-3
Magnesium	0.18-0.4	Iodine	0.5-50

Opportunities and challenges to improve animal welfare through animal nutrition approaches in ruminantsa re expressed as;

- Assessing welfare
- Nutrient balance
- Undesirable behavior
- Infectious afflictions
- Toxicity issues
- Facilities
- Parasite control
- Salinity
- Morbidity and mortality in young stock (FAO, 2011).

The key challenge is to reach consensus on relevant welfare indicators that may be affected by feeding. The measurements needed to assess animal welfare due to feeding may differ from those needed to measure animal welfare during transportation or housing, and the required measurements can be made on a case-by-case basis. The number of visits to the feeding area, walking and ruminant activity, behavioral measurements (chewing, etc.) may be important variables to investigate to assess appropriate feeding and welfare. Animal selection and preferences may be variables that require further attention (FAO, 2011).

3. HOUSING AND WELFARE IN GOAT FARMING

Different management and housing-related factors can promote stress in livestock and significantly affect physiological and productive parameters (Miretti, 2020). In order to raise animals efficiently and healthily and to ensure comfort, housing should be planned in accordance with the biology of the animal to be raised (Öztürk and Tölü, 2016). Sheep and goat shelters should meet the needs of the breeder at the lowest possible cost as well as meeting animal requirements. In goat breeding, housing systems should be designed to improve animal welfare and encourage the natural behavior of animals. These practices can improve the quality of life as well as production efficiency (Zobel et al., 2019). In animal husbandry, providing shelter under cold conditions can increase survival and improve growth and reproduction. Similarly, providing shelter under warm conditions can increase growth, production and reproduction and minimize disease. Such measures have significant impacts on animal welfare (Figure 2) (Fisher, 2007).

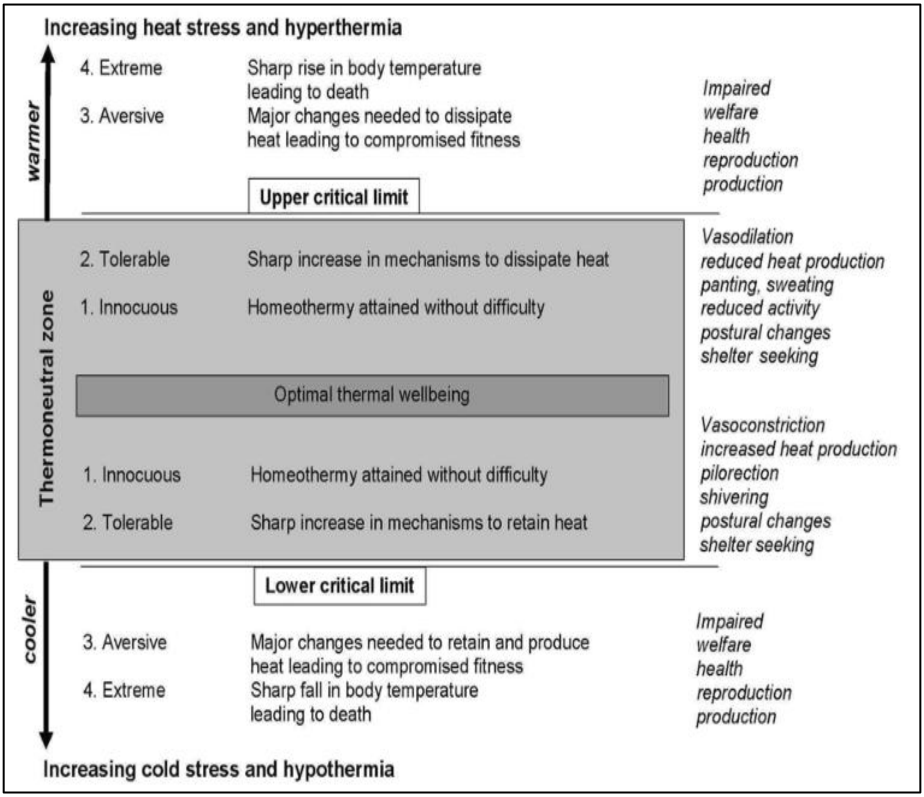

Figure 2. A summary of the thermal stages affecting livestock behaviour, physiology and survival.

In goat breeding, the shelter capacity must be sufficient for the number of animals available. There should be enough space in the shelter for each animal to stand, lie down, move and move around comfortably to reach feed and water. In addition, shelters should be high enough to prevent goats from escaping and should be protective from predators. The shelters should be well ventilated and conditions for natural light should be provided. Feeders should be at a certain height (at least 90 cm) so that they are easily accessible by animals and not contaminated. Goats are very active animals and are naturally capable of climbing and exploring. In general, they tend to chew everything they find. For this reason, care should be taken to ensure that elements such as fittings and electrical cables are not exposed in shelters. In addition, it should be kept in mind that goats can reach a height of 2 meters on their hind legs while placing these equipment in the shelter (Anonymous, 2023a; Anonymous, 2023b). Table 4 gives the recommended parameter values for small cattle shelters. (Sevi et al., 2009).

Table 4. Recommended parameter values in small ruminant shelters (Sevi vd., 2009).

Items	Recommended values
Space allowance:	
Young animals (15-25 kg body weight)	0.60 m^2/head
Young animals (25-40 kg body weight)	1 m^2/head
Adult animals (ewe and doe)	1.5-2 m^2/head
Adult animals (ram)	2.2-2.5 m^2/head
Feeder space	0.2 m/head
Airspace (adult animals)	7 m^3/head
Ventilation rate:	
Young animals (summer)	35 m^3/h/head
Young animals (winter)	20 m^3/h/head
Adult animals (summer)	70 m^3/h/head
Adult animals(winter)	45 m^3/h/head
Lighting:	
Glassed area	≥1/15 of total house area
Duration	≥8 hours a day
Intensity	≥100 lux
Air temperature:	
Maximum	25 ºC
Minimum	5 ºC
Relative humidity	≤70%
Dust	<1.6 mg/m^3 air
Airbone micro-organisms	<250 cfu/l air
Noxious gases;	
NH_3	<10 ppm
CO_2	<2500 ppm
H_2S	<2.5 ppm

The assessment of welfare quality is made by determining the result of the interaction between the animal and its environment (shelter design and management) (Sarı, 2021). The welfare principle of good housing is based on the comfort of resting and walking areas, thermal comfort and ease of movement (Welfare Quality 2009). Increasing the number of animals per unit area in intensive systems can negatively affect welfare, which can increase competition among animals in the herd, leading to more frequent agonistic behaviors and greater social stress (Veissier et al., 2008). In animal husbandry, agonistic behaviors (attacking and fleeing behaviors of animals during their interactions with each other) can cause injury to each other, herd unrest and stress (Barroso et al., 2000). In addition, increasing the number of animals per unit area in ruminant breeding systems may increase the risk of parasitic diseases due to exposure to pathogens (Taylor, 2012).

Resting is one of the basic behaviors of animals and a decrease in resting time causes stress (Huzzey et al., 2005). After performing their routine activities during the day, farm animals usually spend their time lying down and resting. For this reason, one of the issues that should be emphasized in animal shelters is the shelter floor. It is also known that the floor surface is a factor directly affecting hoof health and animal movements (Albright, 1995). The shelter floor should not cause injuries to the animals, should not cause contamination on their bodies and should provide comfort to the animals (Weerd and Day, 2009). Öztürk and Tölü (2016) reported in their study that lying down is the most important resting behavior for animals and that the shelter floor affects the duration of lying down behaviors, and that the use of rubber floors in sheep and goat shelters can increase the lying time of animals, which will have positive results in terms of animal welfare.

4. HEALTH AND WELFARE IN GOAT FARMING

Animal health and welfare can be defined using parameters such as animal behavior, physiology, clinical status and performance (Costa et al., 2014; Nasirahmadi et al., 2015). Many links between animal behavior, health and well-being have been demonstrated (Broom, 2006; Murphy et al, 2014). It has been reported that lying behavior is critical in determining animal health and welfare (Bewley et al., 2010; Porto et al., 2013) and can be associated with changes in animal mobility, welfare, health status and behavioral disorders (Brendle and Hoy, 2011). In addition, the health status of the herd can be assessed by scoring the body condition (BCS) of the animals, checking skin and coat condition, and detecting lameness and injuries (Caroprese et al., 2009).

Climate is one of many factors with the potential to alter disease states and is expected to have negative impacts on animal health (Rabinowitz and Conti, 2013). The impact of climate change on animal health can be direct or indirect, and may primarily result from changes in environmental conditions, including air temperature, relative humidity, precipitation, and the frequency and magnitude of extreme events. It has been noted that the factors leading to climate change impacts on health are highly complex, involving not only environmental forces, but also ecological and social aspects, economic outcomes, and individual and societal behaviors (Forastiere, 2010; Lacetera, 2019). An important way to ensure early detection of health and welfare violations in animals is to use behavioral changes. Such changes precede clinical signs of disease or injury and affect animal performance (Hulsen and Scheepens, 2006, González et al., 2008, Kyriazakis and Tolkamp, 2010).

Good animal health and welfare is central to sustainable livestock production as it promotes high productivity, adequate animal care and efficient use of natural resources. Good animal health and welfare can reduce greenhouse gas emissions per unit of output, reduce the need for antimicrobials, and protect farmers and consumers from foodborne diseases and other zoonoses. Opportunities to control and reduce the risk of animal diseases in livestock farming generally fall into five categories: technology, breeding, breeders' associations-cooperatives, national-international regulations and the market. Reasons for not implementing good animal health and welfare practices include lack of resources, lack of opportunity to improve the competence of producers or authorities, poor access to animal health services, traditions and cultural issues, or doubts about whether they contribute to increased profits (Magnusson et al., 2022).

5. CONCLUSION

Changes in animal production in recent years, increasing food demand, changes in production systems and the increase in integrated production activities. In addition to the increase in production, changes in existing housing, herd management, nutrition and environmental conditions have been inevitable. In studies, it is reported that animal diseases in adverse housing, nutrition and herd management practices can cause direct losses, deaths, decreased fertility and indirect losses, additional costs for medicines and veterinary services, additional labor time and costs. If an animal is healthy, safe, in a comfortable environment where it can exhibit its natural behaviors, is well fed, and does not suffer from undesirable conditions such as pain, fear and restlessness, it is at a good welfare level. Animal health is an important component of animal welfare, but animal welfare is broader than health alone. Assessing welfare is essential to clearly identify opportunities and risks to animal health and productivity. The development of global standards has had a positive impact on animal welfare and welfare assessment programs provide the tools to assess compliance.

REFERENCES

Abioja, M. O., Logunleko, M. O., Majekodunmi, B. C., Adekunle, E. O.,Shittu, O. O., Odeyemi, A. J., Nwosu, E. U., Oke, O. E., Iyasere, O. S.,Abiona, J. A., Williams, T. J., James, I. J., Smith, O. F., & Daramola, J. O. (2023). Roles of candidate genes in the adaptationof goats to heat stress: A review. Small Ruminant Research, 218,106878.

Albright, J.C. (1995). Flooring in dairy cattle facilities, in Proc. Int. Conf. Anim. Behav. Design. Livest. Poult. Syst., Indianapolis, IN, 168-182.

Aleena, J., Sejian, V., Bagath, M., Krishnan, G., Beena, V., Bhatta, R. (2018). Resilience of three indigenous goat breeds to heat stress based on phenotypic traits and PBMC HSP70 expression. International Journal of Biometeorology, 62(11): 1995-2005.

Alexandre, G.; Mandonnet, N. (2005). Goat meat production in harsh environments. Small Rumin. Res., 60, 53–66.

Anonymous, 2023a. Goat Standards & Application-Global Animal Partnership. https://globalanimalpartnership.org/standards/goat/.

Anonymous, 2023b. An introduction to goat keeping. https://www.animalwelfarefoundation.org.uk/wp-content/uploads/2017/06/An-Introduction-to-Goat-Keeping.pdf

AWIN, 2015. AWIN Welfare Assessment Protocol for Goats. doi:10.13130/AWIN goats 2015.

Barroso, F.G., Alados, C.L., Boza, J. (2000). Social hierarchy in the domestic goat: effect on food habits and production. Appl. Anim. Behav. Sci. 69, 35-53.

Baş, S., Kutlar, A., & Tunaz, A.T. (2023). Kilis Keçilerinde Süt Verimi ve Meme Sarkıklığı Arasındaki İlişkiler. Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi, 26(3), 692-701.

Battini, M., Barbieri, S., Fioni, L., Mattiello, S. (2016). Feasibility and validity of animal-based indicators for on-farm welfare assessment of thermal stress in dairy goats. Int. J. Biometeorol. 60(2): 289-296.

Battini, M., Vieira, A., Barbieri, S., Ajuda, I., Stilwell, G., Mattiello, S. (2014). Invited review: Animal-based indicators for on-farm welfare assessment for dairy goats. J. Dairy Sci., 97(11): 6625-6648.

Bell, F. R. (1959). Preference thresholds for taste discrimination in goats. J. Agric. Sci. 52:125–129. doi:10.1017/ S0021859600035759

Berman, T.S., M. Ben-Ari, T.A. Glasser, M. Gish, and M. Inbar. (2017). How goats avoid ingesting noxious insects while feeding. Sci. Rep. 7:14835. doi:10.1038/ s41598-017-14940-6

Bewley, J.M., Boyce, R.E., Hockin, J., Munksgaard, L., Eicher, S.D., Einstein, M.E., Schutz, M.M. (2010). Influence of milk yield, stage of lactation, and body condition on dairy cattle lying behaviour measured using an automated activity monitoring sensor. J. Dairy Res. 77 (01), 1–6.

Bøe, K.E., Ehrlenbruch, R. (2013). Thermoregulatory behavior of dairy goats at low temperatures and the use of outdoor yards. Can. J. Anim. Sci., 93(1): 35-41.

Brendle, J., Hoy, S. (2011). Investigation of distances covered by fattening pigs measured with VideoMotionTracker®. Appl. Anim. Behav. Sci. 132, 27–32.

Broom, D.M., (2006). Behaviour and welfare in relation to pathology. Appl. Anim. Behav. Sci. 97 (1), 73–83.

Broom, D.M. (2021). Farm Animal Welfare: a Key Component of the Sustainability of Farming Systems. Veterinarski Glasnik 75, 145–151. https://doi.org/10.2298/VETGL210514007B

Card, C., Epp, T., Lem, M. (2018). Exploring the Social Determinants of Animal Health. J. Vet. Med. Educ., 45, 437–447.

Caroprese, M., Casamassima, D., Pier Giacomo Rassu, S., Napolitano, F., & Sevi, A. (2009). Monitoring the on-farm welfare of sheep and goats. Italian Journal of Animal Science, 8(sup1), 343-354.

Caroprese, M., Napolitano, F., Mattiello, S., Fthenakis, G. C., Ribó, O., & Sevi, A. (2016). On-farm welfare monitoring of small ruminants. Small Ruminant Research, 135, 20-25.

Cellier, M., Nielsen, B. L., Duvaux-Ponter, C., Freeman, H. B., Hannaford, R., Murphy, B., Connor, E.O., Cote, K.R.L., Neave, H.W., Zobel, G. (2022). Browse or browsing: Investigating goat preferences for feeding posture, feeding height and feed type. Frontiers in Veterinary Science, 9, 1032631.

Chulayo, A.Y., Muchenje, V. (2017). Activities of some stress enzymes as indicators of slaughter cattle welfare and their relationship with physicochemical characteristics of beef. Animal, 11:1645–52. doi: 10.1017/S1751731117000222

Costa, A., Ismayilova, G., Borgonovo, F., Viazzi, S., Berckmans, D., Guarino, M., (2014). Image-processing technique to measure pig activity in response to climatic variation in a pig barn. Anim. Prod. Sci. 54 (8), 1075–1083.

Dias-Silva, T. P., Abdalla Filho, A. L. (2020). Sheep and goat feeding behavior profile in grazing systems. Acta Scientiarum. Animal Sciences, 43, e51265.

El Aich, A, El Assouli, N., Fathi, A., Morand-Fehr, P., Bourbouze, A. (2007). Ingestive behavior of goats grazing in the Southwestern Argan (Argania spinosa) forest of Morocco. Small Rumin Res. 248–56. doi: 10.1016/j.smallrumres.2006.03.011

Fabrile, M. P., Ghidini, S., Conter, M., Varrà, M. O., Ianieri, A., & Zanardi, E. (2023). Filling gaps in animal welfare assessment through metabolomics. Frontiers in Veterinary Science, 10, 1129741.

FAO, (2011). Impact of animal nutrition on animal welfare. Expert Consultation, 26-30 September 2011, FAO Headquarters, Rome, Italy. https://www.fao.org/3/i3148e/i3148e00.htm.

FAO, 2022. Dünya Gıda ve Tarım Örgütü. FAOSTAT, Livestock Primary. (Access Date: 01.04.2023).

Fisher, M. W. (2007). Shelter and welfare of pastoral animals in New Zealand. New Zealand Journal of Agricultural Research, 50(3), 347-359.

Forastiere, F. (2010). Climate change and health: a challenge for epidemiology and public health. Int. J. Public Health 55:83–84. doi:10.1007/ s00038-009-0096-9.

Garg, M.R., Sherasia, P.L. (2015). Ration balancing: A practical approach for reducing methanogenesis in tropical feeding systems. In: Sejian V, Gaughan J, Baumgard L, Prasad C, editors. Climate change impact on livestock: adaptation and mitigation. New Delhi Springer, 285-301.

Goetsch, A.L., Gipson, T.A., Askar, A.R., Puchala, R. (2010). Invited review: feeding behavior of goats. J Anim Sci. 88:361–73. doi: 10.2527/jas.2009-2332

González, L.A., Tolkamp, B.J., Coffey, M.P., Ferret, A., Kyriazakis, I. (2008). Changes in feeding behavior as possible indicators for the automatic monitoring of health disorders in dairy cows. Journal of Dairy Science 91, 1017–1028.

Hodgson, J. (1990). Grazing management: science into practice. Longman scientific and technical. London, UK: Longman Group.

Hulsen, J., Scheepens, K. (2006). Pig Signals: Look, Think and Act. 5M Publishing, UK, pp. 74–85.

Kyriazakis, I., Tolkamp, B.J. (2010). Disease. In: The Encyclopedia of Applied Animal Behaviour and Welfare. CAB International, Wallingford, Oxfordshire, pp. 176–177.

Lacetera, N. (2019). Impact of climate change on animal health and welfare. Animal Frontiers, 9(1), 26-31.

Laczo, E.; Pajor, F.; Poti, P. (2007). Goat place in the sustainable agriculture: Compare some growth traits of meat type and dual-purpose type goats in hungary. Cereal Res. Commun. 35, 701–704. [CrossRef]

Lanzoni, L., Whatford, L., Atzori, A., Chincarini, M., Giammarco, M., Fusaro, I., & Vignola, G. (2023). The challenge to integrate animal welfare indicators into the Life Cycle Assessment. Animal, 100794. https://doi.org/10.1016/j.animal.2023.100794

Magnusson, U.; Boqvist, S.; Doyle, R.; Robinson, T. (2022). Animal Health and Welfare for Sustainable Livestock Systems; Global Agenda for Sustainable Livestock: Rome, Italy.

Mazhangara, I.R., Chivandi, E., Mupangwa, J.F., Muchenje, V. (2019). The potential of goat meat in the red meat industry. Sustainability 11, 1–12

McDowall, S., Hazel, S. J., Chittleborough, C., Hamilton-Bruce, A., Stuckey, R., Howell, T. J. (2023). The Impact of the Social Determinants of Human Health on Companion Animal Welfare. Animals, 13(6), 1113.

Mellor, D.J., Beausoleil, N.J. (2015). Extending the ‘Five Domains’ model for animal welfare assessment to incorporate positive welfare states. Anim. Welf., 24, 241–253.

Mellor, D.J.; Beausoleil, N.J.; Littlewood, K.E.; McLean, A.N.; McGreevy, P.D.; Jones, B.; Wilkins, C. (2020). The 2020 five domains model: Including human–animal interactions in assessments of animal welfare. Animals 10, 1870.

Mene´ndez Buxadera, A., Mandonnet N. (2006). The importance of the genotype·environment interaction for selection and breeding programmes in tropical conditions. CAB Reviews: Perspectives in Agriculture Veterinary Science, Nutrition and Natural Resources 2006, Anim. Breed. Abstr. 2006, 74, 1–14.

Mioˇc, B., Prpi´c, Z., Vnuˇcec, I., Bara´c, Z., Suˇsi´c, V., Samarˇzija, D., Pavi´c, V. (2008). Factors affecting goat milk yield and composition. Mljekarstvo 58 (4), 305–313.

Miretti, S., Lecchi, C., Ceciliani, F., Baratta, M. (2020). MicroRNAs as biomarkers for animal health and welfare in livestock. Frontiers in veterinary science, 7, 578193.

Morand-Fehr, P. (2005). Recent developments in goat nutrition and application: A review. Small ruminant research, 60(1-2), 25-43.

Munoz, C.A, Campbell, A.J.D., Hemsworth, P.H, Doyle, R.E. (2019). Evaluating the welfare of extensively managed sheep. PLoS ONE. 14:e0218603. doi: 10.1371/journal.pone.0218603

Murphy, E., Nordquist, R.E., van der Staay, F.J. (2014). A review of behavioural methods to study emotion and mood in pigs, Sus scrofa. Appl. Anim. Behav. Sci. 159, 9–28.

Nasirahmadi, A., Richter, U., Hensel, O., Edwards, S., Sturm, B. (2015). Using machine vision for investigation of changes in pig group lying patterns. Comput. Electron. Agric. 119, 184–190.

Newman, J. A., Parsons, A. J., Penning, P. D. (1994). A note on the behavioural strategies used by grazing animals to alter their intake rates. Grass and forage science, 49(4), 502-505.

Ngwa, A. T., Pone, D. K., Mafeni, J. M. (2000). Feed selection and dietary preferences of forage by small ruminants grazing natural pastures in the Sahelian zone of Cameroon. Elsevier. 88:253–266. doi:10.1016/S0377-8401(00)00215-7

Ouédraogo-Koné, S., C. Kaboré-Zoungrana, Y., Ledin, I.. (2006). Behaviour of goats, sheep and cattle on natural pasture in the sub-humid zone of West Africa. Livest. Sci. 105:244–252. doi:10.1016/j.livsci.2006.06.010

Öztürk, S., Cemil, T. Ö. L. Ü. (2016). Keçi ve koyunlarda tahta, kauçuk ve izgara zemin tercihi. Hayvansal Üretim, 57(2), 28-34.

Porto, S.M., Arcidiacono, C., Anguzza, U., Cascone, G. (2013). A computer vision-based system for the automatic detection of lying behaviour of dairy cows in free-stall barns. Biosyst. Eng. 115 (2), 184–194.

Rabinowitz, P., L. Conti. (2013). Links among human health, animal health, and ecosystem health. Annu. Rev. Public Health 34:189–204. doi:10.1146/ annurev-publhealth-031912-114426.

Ramachandran, N., Sejian., V. (2022). "Climate resilience of goat breeds in India: A review." Small Ruminant Research 208: 106630.

Ramachandran, N., Singh, D., Jindal, S.K., Singh, M.K. (2019). Effect of quantitative feed restriction and realimentation on growth, carcass traits and economics in stallfed Barbari kids. Indian J. Anim. Sci. 89(3): 292-297.

Salehi, M., Kadim, I., Mahgoub, O., Negahdari, S.H., EshraghiNaeeni, R.S., (2013). Effects of type, sex, and age on goat skin and leather. Anim. Prod. Sci. 54 (5), 638–644.

Sánchez-Hidalgo, M,. Bravo, V., Gallo, C. (2020). Behavior and health indicators to assess cull cow's welfare in livestock markets. Front Vet Sci. 7:471. doi: 10.3389/fvets.2020.00471

Sanon, H.O., Kaboré-Zoungrana, C., Ledin, I. (2007). Behaviour of goats, sheep and cattle and their selection of browse species on natural pasture in a Sahelian area. Small Rumin Res. 67:64–74. doi: 10.1016/j.smallrumres.2005. 09.025

Sarı, M., Salman, H. (2021). Besi Sığırlarında Refah Kalitesinin Değerlendirilmesi: İyi Besleme, İyi Barındırma. Kırşehir Ahi Evran Üniversitesi Ziraat Fakültesi Dergisi, 1(2), 123-141.

Sevi, A., Casamassima, D., Pulina, G., Pazzona, A. (2009). Factors of welfare reduction in dairy sheep and goats. Italian Journal of Animal Science, 8(sup1), 81-101.

Shi, J., Dunbar, R.I.M., Buckland, D., Miller, D. (2003). Daytime activity budgets of feral goats (Capra hircus) on the Isle of Rum: Influence of season, age, and sex. Can J Zool. 81:803–15. doi: 10.1139/z03-055

Singh, A. K. (2018). Feeding management of goat. Indian Farmer, 5(09), 995-1000. Feeding-management-of-goat.pdf (researchgate.net)

Squires, J.E. (2003). Effect on animal behavior, health and welfare. In Applied Animal Endocrinology, 1st ed.; CAB International: Oxfordshire, UK, ss. 215- 217, ISBN 0-85199-594-2.

Taylor, M.A. (2012). Emerging parasitic diseases of sheep. Veterinary Parasitology 189, 2–7.

Tüfekci, H. (2023). Keçi sütü üretimi ve önemi. Osmaniye Korkut Ata Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 6(1): 970-981.

Vasdal, G., Granquist, E.G., Skjerve, E., De Jong, I.C., Berg, C., Michel, V., et al. (2019). Associations between carcass weight uniformity and production measures on farm and at slaughter in commercial broiler flocks. Poult Sci. 98:4261–8. doi: 10.3382/ps/pez252

Veissier, I., Butterworth, A., Bock, B., Roe, E. (2008). European approaches to ensure good animal welfare. Applied Animal. Behaviour Science.; 113:279-297.

Weerd HA, Day JEL. (2009). A review of environmental enrichment for pigs housed in intensive housing systems. Applied Animal Behaviour Science 116:1- 20.

Welfare Quality (2009). Welfare Quality Assessment Protocol for Cattle (Dairy and Beef Cattle). Erişim: https://edepot.wur.nl/233467. Erişim Tarihi: 10.09.2021. Welfare Quality Consortium: Lelystad, the Netherlands.

Zobel, G., Neave, H. W., Webster, J. (2019). Understanding natural behavior to improve dairy goat (Capra hircus) management systems. Translational animal science, 3(1), 212-224.

CHAPTER 10

EFFECTS OF LIGHTING ON WELFARE IN POULTRY

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1. INTRODUCTION

Since the early days of animal welfare science, it has been thought that there is an obvious relationship between welfare and stress and that measuring the stress response would be a good indicator of welfare (Wood-Gush et al., 1975). It soon became clear that if there was a relationship between stress and well-being, it was a complex one and well-being could not be defined in terms of stress alone. While using a broad definition of "animal welfare" may work at first, as more and more research has been done on animal welfare, some of these welfare descriptors have been found to contradict each other (Terlouw et al., 1991). The most important thing to know is whether the animal is feeling bad or good (Duncan, 2002).

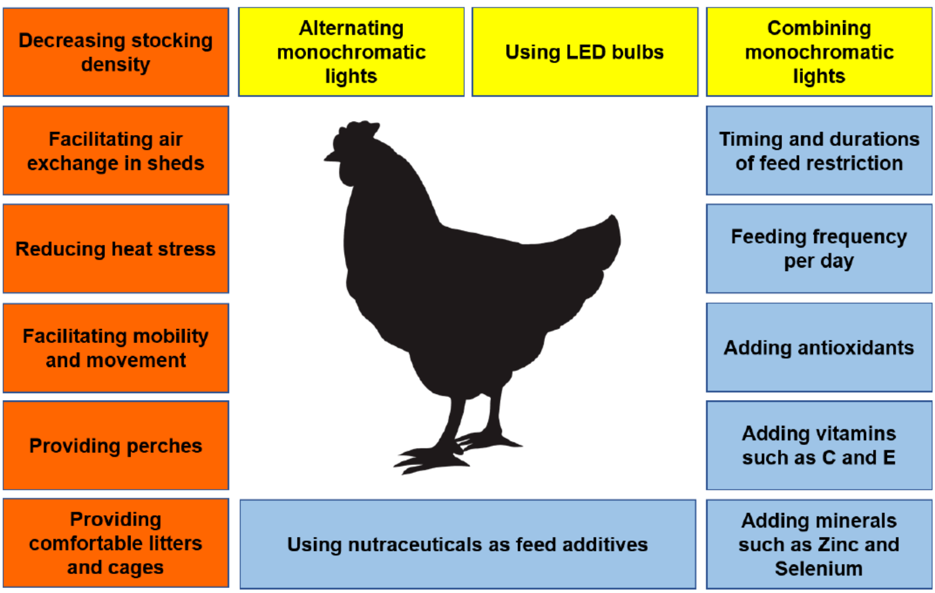

Figure 1. Rearing practices to improve behaviour, health and welfare (El-Sabrout et al., 2022).

What we need to know to assess welfare is whether the chicken experienced something aversive, and if possible, it would also be useful to know how aversive the experience was. It is also necessary to know how important any choice is for the animal. A consistent choice in one direction may actually be quite trivial, and the animal will not suffer if forced to choose the less preferred option. Therefore, as a continuation of the preference test, it is necessary to measure the strength of the preference. There are many different ways to do this, from operant conditioning techniques to inhibition methods (Dawkins and Beardsley, 1986; Nicol and Guilford, 1991). In general, the test of motivation in which the fowl tries to achieve a goal is quite simple. It has been used to test the strength of the bird's tendency to reach a nest, a dust bath, or a perch, among others (Dawkins and Beardsley, 1986; Olsson and Keeling, 2002). It is probably more difficult to show pain than to show fear in poultry species that have evolved to show few obvious signs of pain (Duncan, 2002). For decades, the effects of lighting on different aspects of poultry production, behavior, physiology and welfare have been studied. In fact, some directives recommend a maximum of 16 hours of lighting that lights at least 80% of the usable area and has an intensity of at least 20 lux at the eye level of the reared bird (CEU, 2007). There are four aspects of artificial lighting that can affect the behavior, physiology and welfare of housed poultry (Manser, 1996; Kristensen, 2008). These;

1- Photoperiodic regime (number of light and dark hours in each 24-hour period)
2- Light intensity (also the level of lighting)
3- Spectral composition (distribution of wavelengths of light varying between light sources)
4- Flickering of light (temporal modulations caused by electric current)

These factors are often manipulated to increase efficiency and streamline management practices. Data on birds' preferences for different lighting conditions are almost completely lacking, and most articles on lighting in poultry houses address its effects on performance rather than behavioral and health-related factors that may affect welfare (Manser, 1996). The visual system of domestic fowl has evolved in natural light environments that differ in many respects from the artificial light provided in chicken coops. Current lighting systems are primarily designed around human vision and poultry production. Therefore, ignoring the visual requirements of poultry and the functional development of visual abilities during rearing, the poor correlation between the light provided and the light required for effective vision can affect visually mediated behaviors such as feeding and social interaction, leading to distress and poor welfare (Prescott et al., 2003).

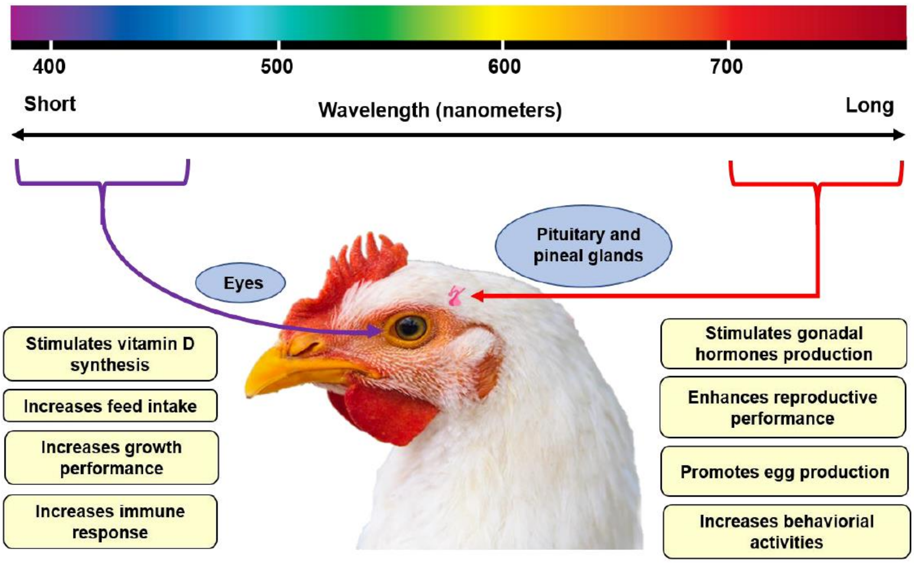

Figure 2. Potential behavioral, physiological and productive responses to light stimulus (El-Sabrout et al., 2022).

In birds, vision is the dominant sense as most of the total brain volume is devoted to the eyes and visual cortex (Güntürkün, 2000). Therefore, light is arguably the most important stimulus that poultry receive from their environment (Perry and Lewis, 1993). Bird species recognize their conspecifics through visual signals that require light, and they also use vision to search for food and explore their environment (Osorio et al. 2001; Maddocks et al. 2001; Houser and Huber-Eicher 2004). To determine the effects of the light environment on the behavior and welfare of domestic poultry; measuring the physical properties of the bright environment, determining the limits of visual abilities in the environment, questioning how the environment can disrupt functional vision development, and solving how visual abilities that affect visual behaviors interact with lighting (Prescott et al., 2003). Indeed, responding to light may have had an adaptive value for chickens, turkeys, and other farm birds through evolution, and may still influence visual perception and behavior in birds today. Eye abnormalities can develop when poultry are raised in dimly lit or overly bright environments (Kristensen, 2008).

Figure 3. An example of homogeneous lighting on cage floors (Uçar, 2020)

Light intensity can affect animal welfare in many ways in all farm poultry, especially broilers, laying hens and turkeys (Kristensen, 2008). For decades, there has been a focus on the effects of lighting on different aspects of poultry production, behavior, physiology and welfare. Although many effects of lighting on poultry are known, more studies are needed on some basic welfare-related issues (Morris, 1994; Nixey, 1994; Manser, 1996; Lewis and Morris, 1999; Prescott vd., 2003).

2. MEAT-TYPE CHICKENS

The light environment is known to have profound effects on broiler chickens. The photoperiodic regime in particular has been the focus of much research. It is now well known that broiler chickens benefit from a period of darkness in each 24-hour cycle, which increases their activity and reduces leg problems (Wilson et al., 1984; Kristensen, 1999; Kristensen, 2008). Lighting of 100 lux or more is important to encourage activity in broiler chickens, especially in the first week of life. Light intensity should be reduced with advancing age, but less than 20 lux creates problems with well-being (SCAHAW, 2000). The UK Farm Animal Welfare Council considers 20 lux to be a suitable average light intensity to enable all broilers to see clearly, but also determines the absolute lowest average intensity throughout the broiler house to be 10 lux (FAWC, 1992). Inappropriate lighting management, when combined with other environmental factors, can negatively affect the ability of chickens to rest with passive behaviors, as it facilitates increased behavioral synchrony (Alvino et al., 2009; Lucena et al., 2020; Abeyesinghe et al., 2021). Some scientific studies address optimization of light intensity and light color, or what combination supports animals' behavior (Blatchford et al., 2012; Huth and Archer, 2015).

It is known that changing light color and even changing light intensities in different colored lights influence pecking behavior. Pecking behavior tends to increase, especially as light intensity increases (Bowlby, 1957; Cave 1990; Prayitno et al., 1997). Broiler chicks experience stress because they are exposed to different light conditions, as well as the processes they encounter when leaving the hatchery, during transportation and placement in the coop. However, it is known that this stress situation is less in chicks hatched in the coop (Jessen et al., 2021).

Figure 4. An example of lighting in broiler breeder houses

Systems grown on the ground must have adequate resting areas. Especially slow-developing broiler chickens are more active and agile than fast-developing ones. Therefore, limited spaces can cause animals to compete more and harm each other. When incorrect lighting practices are added to this, the animals' fur quality and welfare parameters such as foot-pad dermatitis may be negatively affected (Forslind et al., 2021; Uçar et al., 2023). Exposure of chicks to a constant light regime in the first week disrupts the synchrony of the flock. Reasons such as high density of settlement, lack of elevated structures, and insufficient resting area negatively affect both the welfare and performance of the animals (Yngvesson et al., 2017; Boz et al., 2022).

Figure 5. An example of lighting in broiler houses

Broilers exhibit more comfort behavior under blue and green light, more aggression under white light, and more active behavior under red and yellow light (Sultana et al., 2013; Lucena et al., 2020). Blatchford et al. (2009) they reported that among the chickens they raised at 5, 50 and 200 lux light intensity, the ones at 5 lux intensity were less active. Rault et al. (2017) they did not detect any difference in terms of foot-leg health and welfare parameters between chickens raised at 5 and 20 lux light intensity. Although it varies depending on age, comfort and foraging behavior increase in broiler chickens at light intensity of 50-200 lux (Alvino et al., 2009; Raccoursier et al., 2019). Studies on light intensity show that broiler chickens exhibit more passive behavior as the intensity decreases and more active behavior as the intensity increases (Kristensen et al., 2006; Deep et al., 2010; Deep et al., 2012; Pan et al., 2019; Mohamed et al., 2020; EFSA, 2023). Temporarily reducing light intensity can reduce group stress (EFSA, 2023).

Different components of the light supply, such as daylight supply, can affect light intensity, photoperiod and vibration frequency, which can ultimately affect the welfare of broiler chickens. One of the detrimental effects on welfare will be reduced behavioral activity in broilers due to scotopic visual impairment (van der Eijk, 2022). In particular, natural light diversifies natural behaviors, increases activity and reduces lying down, and therefore positively affects leg health by improving broiler gait scores (Bailie et al., 2013; Rana and Campbell, 2021).

3. EGG-TYPE CHICKENS

Johnsen et al. (1998), found that environmental conditions in the first 4 weeks of life influence later feather pecking development in laying hens. White Leghorn chicks kept in the dark for incubation have been reported to show less feather pecking than chicks kept in the light (Riedstra and Groothuis 2004). Prescott and Wathes (2002), reported that brown laying hens showed more active behavior and were better fed when bright lighting was applied compared to dim lighting. Temporarily reducing light intensity may reduce feather pecking and cannibalism and thus reduce group stress (EFSA, 2023). An epidemiological study examining risk factors contributing to feather pecking in commercial pullet houses in Switzerland found that light intensity did not significantly affect the likelihood of feather pecking (Huber-Eicher and Audigé 1999).

Figure 6. An example of lighting in layer houses 1

The directive for laying hens states that "the hen house should have sufficient light levels to enable all hens to see each other and be seen clearly, to visually examine their environment and to indicate normal light conditions." In places where there is natural light, light openings should be arranged to ensure that the light is distributed evenly throughout the living space. Accordingly, a 24-hour rhythm should be followed and include a sufficient and uninterrupted period of darkness lasting approximately one-third of the day, indicatively, so that the chickens can rest and problems such as immunosuppression and eye anomalies can be avoided (CEU 1999). Farm Animal Welfare Council (FAWC 1997), While recommending a light intensity of 10 lux for laying hens and at least 5 lux for laying hens in cages, he reported that at least 10 lux light intensity should be provided to hens in alternative systems. Full daylight spectrum composition with UV can contribute to the well-being of laying hens (de Jong and Gunnink, 2019; Wichman et al., 2021). While light intensity does not affect pecking in some layer genotypes, it is reported to affect it in some genotypes (Martin 1989).

Figure 7. Application of different light intensity in houses A and B

Light intensity of 30 lux during the rearing and spawning period caused mortality rates higher than 3 lux during the spawning period, mainly due to cloacal cannibalism (Kjaer and Vestergaard 1999).

Figure 8. An example of lighting in layer houses 2

It has been reported that layer chickens do significantly better on the neck, chest, back, wings or tail when light intensity is low during the rearing period, but light intensity does not affect feather quality during the egg production period (Hughes and Black, 1974; Kjaer and Vestergaard 1999). Although the exact lux levels of high and low intensities vary over time between 0 and 21 weeks, laying hens in cages housed at high levels have more feather damage than hens housed at low light intensities (Hughes and Duncan 1972).

4. TURKEYS

Light intensity adjustments may be necessary to prevent feather pecking and cannibalism in turkeys (Nixey 1994). FAWC recommends a minimum light intensity of 5 lux for turkeys raised in indoor poultry houses (minimum 25 lux in the first few days after hatching) so that the turkeys can maintain their natural behavior and a dark rest period of at least 8 hours, as in laying hens (FAWC, 1995). Various studies report that young farm birds require fairly bright light to increase overall activity, exploratory behavior, and identification of feeding behavior. (Deaton et al., 1981; Siopes et al., 1983; Manser 1996; Kristensen et al., 2002). Most studies on the effect of light on eye morphology in turkeys and chickens show morphological changes in the structure of the eyes in turkeys and chickens raised under continuous or near-continuous light or dim lighting (Harrison et al., 1968; Lauber et al., 1970; Siopes et al., 1983).

Figure 9. An example of lighting in turkey breeder (left) and turkey broiler (right) houses

Female turkeys preferred to lay eggs in nest boxes illuminated with low or medium light intensity rather than high light intensity. Therefore, while dim light is used to continue laying eggs in the nest, high light is used to eliminate gurgling behavior (Millam, 1987).

Figure 10. An example of lighting in turkey broiler houses

Although it has been determined that it interacts with other environmental factors, different studies report that turkeys, like chickens, exhibit more aggressive behavior at high light intensity compared to low intensity (Leighton et al., 1989; Denbow et al., 1990; Sherwin et al. 1999; Moinard et al., 2001). Deviation of light intensity from the optimum level can cause foot and leg problems in turkeys, like broiler chickens (Lewis et al., 1998). Classen et al. (1994), they found that turkeys subjected to an increasing or decreasing photoperiodic regime had superior walking activity and were more active than the control groups that were constantly given the same brightness of light. This shows that not only density but also photoperiods are important.

Figure 11. An example of lighting in female turkey broilers (left) and male turkey broilers (right)

5. CONCLUSION

Light has various effects on the pineal physiology of birds by synchronizing the pineal circadian rhythm, inhibiting the release of melatonin (Hamm, 1983). It is unclear whether there is a single total darkness threshold for poultry. Darkness perception and illumination thresholds in poultry is an area in need of further research as this can affect many aspects of poultry behaviour, production, physiology and general welfare. Eye abnormalities have been found in persistent response to constant light and constant darkness (Lauber et al., 1970; Jenkins et al., 1979; Oishi and Murakami 1985). Overall, the studies reviewed here indicate that continuous or near-continuous light, as well as low-intensity light, can cause morphological ocular changes in broiler chickens, laying hens, and turkeys, which can affect their behavior and welfare.

It has been suggested that poultry genotypes raised in dim light levels for many years may experience difficulties in foraging and exploratory behavior, as well as morphological eye damage. It appears that providing poultry with adequate lighting and adequate darkness duration may prevent the development of eye abnormalities and therefore possibly improve the welfare of the birds (Kristensen, 2008). Inappropriate lighting conditions can pose a welfare hazard by preventing birds from displaying their natural behavior (EFSA, 2023). Regarding flock management, there is a balance between providing sufficient light to detect birds with welfare problems without causing fear reactions and stress in the animals. Feather pecking in chickens and turkeys is affected by the lighting environment, although most studies confound the effects of light intensity, light color, and light schedule.

REFERENCES

Abeyesinghe, S.M., Chancellor, N.M., Hernandez Moore, D., Chang, Y.M., Pearce, J., Demmers, T., Nicol, C.J. (2021). Associations between behaviour and health outcomes in conventional and slow-growing breeds of broiler chicken. Animal, 15, 100261.

Alvino, G.M., Archer, G.S., Mench, J.A. (2009). Behavioural time budgets of broiler chickens reared in varying Light intensities. Applied Animal Behaviour Science, 118, 54-61.

Bailie, C.L., Ball, M.E., O’Connell, N.E. (2013). Influence of the provision of natural light and straw bales on activity levels and leg health in commercial broiler chickens. Animal, 7, 618-626.

Blatchford, R.A., Klasing, K.C., Shivaprasad, H.L., Wakenell, P.S., Archer, G.S., Mench, J.A. (2009). The effect of Light intensity on the behavior, eye and leg health, and immune function of broiler chickens. Poultry Science, 88,20-28.

Blatchford, R., Archer, G., Mench, J. (2012). Contrast in light intensity, rather than day length, influences the behavior and health of broiler chickens. Poultry Science, 91, 1768-1774.

Bowlby, G.M.S. (1957). Some preliminary investigations into the effects of light on broilers. World’s Poultry Science Journal 13: 214-216.

Boz, M. A., Erensoy, K., Uçar, A. Sarıca, M. (2022). Beç tavuklarında yerleşim sıklığının büyüme, kesim ve karkas özelliklerine etkisi. Hayvansal Üretim, 63(1): 47-56.

Cave, N.A. (1990). Effects of feeding level during pullets-layer transition and pretransition lighting on performance of broiler breeders. Poultry Science 69, 1141-1146.

CEU, (1999). Council Directive 1999/74/EC of 19 July 1999. Laying down minimum standards for the protection of laying hens. Official journal of the European Communities. Available

CEU, (2007). Council of the European Union. 2007. Council Directive 2007/43/EC. Laying down minimum rules for the protection of chickens kept for meat production. Official Journal of the

Classen, H.L., Riddell, C., Robinson, F.E., Shand, P.J., McCurdy, A.R. (1994). Effect of lighting treatment on the productivity, health, behaviour and sexual maturity of heavy male turkeys. British Poultry Science 35, 215-225.

Dawkıns, M.S., Bearssley, T.M. (1986) Reinforcing properties of access to litter in hens. Applied Animal Behaviour Science, 15, 351-364.

Deaton, J.W., Reece, F.N., McNaughton, J.L., Lott, B.D. (1981). Effect of light intensity and low-level intermittent lighting on broiler performance during a high-density limited-area brooding period. Poultry Science 60, 2385-2387.

Deep, A., Schwean-Lardner, K., Crowe, T.G., Fancher, B.I., Classen, H.L. (2010). Effect of light intensity on broiler production, processing characteristics, and welfare. Poultry Science, 89, 2326-2333.

Deep, A., Schwean-Lardner, K., Crowe, T.G., Fancher, B.I., Classen, H.L. (2012). Effect of light intensity on broiler behaviour and diurnal rhythms. Applied Animal Behaviour Science, 136, 50–56.

de Jong, I.C., Gunnink, H. (2019). Effects of a commercial broiler enrichment programme with or without natural Light on behaviour and other welfare indicators. Animal, 13, 384–391

Denbow, D.M., Leighton, A.T. Hulet, R.M. (1990). Effect of light source and light intensity on growth, performance and behavior of female turkeys. British Poultry Science 31, 439-445.

Duncan, I. J. (2002). Poultry welfare: science or subjectivity?. British Poultry Science, 43(5): 643-652.

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), Nielsen, S. S., Alvarez, J., Bicout, D. J., Calistri, P., Canali, E., ... and Michel, V. (2023). Welfare of broilers on farm. *EFSA Journal*, *21*(2): e07788.

El-Sabrout, K., El-Deek, A., Ahmad, S., Usman, M., Dantas, M. R. T., Souza-Junior, J. B. F. (2022). Lighting, density, and dietary trategies to improve poultry behavior, health, and production. Journal of Animal Behaviour and Biometeorology, 10(1): 0-0.

Farm Animal Welfare Council, (1992). Report on the Welfare of Broiler chickens. Ministry for Agriculture, Fisheries and Food: London, UK.

Farm Animal Welfare Council, (1995). Report on the Welfare of Turkeys. Ministry for Agriculture, Fisheries and Food: London, UK.

Farm Animal Welfare Council, (1997). Report on the Welfare of Laying Hens. Ministry for Agriculture, Fisheries and Food: London, UK.

Forslind, S., Blokhuis, H.J., Riber, A.B. (2021). Disturbance of resting behaviour of broilers under different environmental conditions. Applied Animal Behaviour Science, 242, 105425.

Güntürkün, O. (2000). Sensory Physiology: Vision. Chapter 1 in Whittow GC (ed): Sturkie's Avian Physiology, Fifth Edition. Academic Press, San Diego. pp 1-19.

Hamm, H.E., Takahashi, J.S., Menaker, M. (1983). Light-induced decrease of serotonin N-Acetyltransferase activity and melatonin in the chicken pineal gland and retina. Brain Research 266, 287-293.

Harrison, P.C., Bercovitz, A.B., Leary, G.A. (1968). Development of eye enlargement of domestic fowl subjected to low intensity light. International Journal of Biometeorology 12, 351-358.

Houser, J., Huber-Eicher, B. (2004). Do domestic hens discriminate between familiar and unfamiliar conspecifics in the absence of visual cues? Applied Animal Behaviour Science 85, 65-76.

Huber-Eicher, B., Audige, L. (1999). Analysis of risk factors for the occurrence of feather pecking in laying hen growers. British Poultry Science 40, 599-604.

Hughes, B.O., Duncan, I.J.H. (1972). The influence of strain and environmental factors upon feather pecking and cannibalism in fowls. British Poultry Science 13, 525-547.

Huges, B.O., Black, A.J. (1973) The preference of domestic hens for different types of battery cage floor. British Poultry Science, 14, 615-619.

Huth, J.C., Archer, G.S. (2015). Comparison of two LED light bulbs to a dimmable CFL and their effects on broiler chicken growth, stress, and fear. Poultry Science, 94, 2027–2036.

Jenkins, R.L., Ivey, W.D., McDaniel, G.R., Albert, R.A. (1979). A darkness induced eye abnormality in the domestic chicken. Poultry Science 58, 55-59.

Jessen, C.T., Foldager, L., Riber, A.B. (2021). Effects of hatching on-farm on behaviour, first week performance, fear level and range use of organic broilers. Applied Animal Behaviour Science, 238, 105319.

Johnsen, P.F., Nørgaard-Nielsen, G., Vestergaard, K.S. (1998). Influence of early rearing conditions on the development of feather pecking and cannibalism in domestic fowl. Applied Animal Behaviour Science 60, 25-41.

Kjaer, J.B., Vestergaard, K.S. (1999). Development of feather pecking in relation to light intensity. Applied Animal Behaviour Science 62, 243-254.

Kristensen, H.H. (1999). Photoperiods and the behaviour and welfare of broiler chickens: a review. Technical Report Published (in Danish) by the Danish Society for the Protection of Animals, September 1999.

Kristensen, H.H., Prescott, N.B., Ladewig, J., Perry, G.C., Wathes, C.M. (2002). Light quality and the visual acuity in broiler chickens. Proceedings of the 36th International Congress of the ISAE, Egmond aan Zee, The Netherlands, 6-10th August 2002.

Kristensen, H.H., Perry, G.C., Prescott, N.B., Ladewig, J., Ersbøll, A.K., Wathes, C.M. (2006). Leg health and performance of broiler chickens reared in different light environments. British Poultry Sci., 47, 257-263.

Kristensen, H.H. (2008). The effects of light intensity, gradual changes between light and dark and definition of darkness for the behaviour and welfare of broiler chickens, laying hens, pullets and turkeys. Scientific Report for the Norwegian Scientific Committee for Food Safety, 1-44.

Lauber, J.K., Boyd, J.E., Boyd, T.A.S. (1970). Intraocular pressure and aqueous outflow facility in light-induced avian bupthalmos. Experimental Eye Research 9, 181-187.

Leighton, A.T., Hulet, R.M., Denbow, D.M. (1989). Effect of light source and light intensity on growth, performance and behavior of male turkeys. British Poultry Science 30, 563-574.

Lewis, P.S., Morris, T.R. (1999). Light intensity and performance of domestic pullets. World’s Poultry Science Journal 55, 241-250.

Lewis, P.S., Perry, G.C., Sherwin, C.M. (1998). Effect of photoperiod and light intensity on the performance of intact male turkeys. Animal Science 66, 759-767.

Lucena, A.C., Pandorfi, H., Almeida, G.L., Guiselini, C., Ara´ujo, J.E., Rodrigues, T.P.D.S. (2020). Behavior of broilers subjected to different light spectra and illuminances. Revista Brasileira de Engenharia Agr´ıcola e Ambiental, 24, 415-421.

Maddocks, S.A., Cuthill, I.C., Goldsmith, A.R., Sherwin, S.M. (2001). Behavioural and physiological effects of absence of ultraviolet wavelengths for domestic chicks. Animal Behaviour 62, 1013-1019.

Manser, C.E. (1996). Effects of lighting on the welfare of domestic poultry: a review. Animal Welfare, 5(4): 341-360.

Martin, G. (1989). Federpickhäufigkeit in Abhängigkeit von draht- und einstreuboden sowie von der lichtintensität (Influence of light intensity on feather pecking of hens on deep litter or wire floor). KTBL Schrift 342, 108-133.

Millam, J.R. (1987). Preference of turkey hens for nest boxes of different levels of interior illumination. Applied Animal Behaviour Science 18, 341-348.

Mohamed, R., Abou-Elnaga, A., Ghazy, E., Mohammed, H., Shukry, M., Farrag, F., Mohammed, G., Bahattab, O. (2020). Effect of different monochromatic LED light colour and intensity on growth performance, physiological response and fear reactions in broiler chicken. Italian Journal of Animal Science, 19, 1099–1107.

Moinard, C., Lewis, P.D., Perry, G.C., Sherwin, C.M. (2001). The effects of light intensity and light source on injuries due to pecking of male domestic turkeys (*Meleagris gallopavo*). Animal Welfare 10, 131-139.

Morris, T.R. (1994). Lighting for layers: What we know and what we need to know. World’s Poultry Science Journal 50, 283-287.

Nixey, C. (1994). Lighting for the production and welfare of turkeys. World’s Poultry Science Journal 50, 292-294.

Oishi, T., Murakami, N. (1985). Effects of duration and intensity of illumination on several parameters of the chick eye. Comparative Biochemistry and Physiology 81, 319-323.

Olssan, I.A.S., Keeling, L.J. (2002) The push-door for measuring motivation in hens: laying hens are motivated to perch at night. Animal Welfare, 11, 11-19.

Osorio, D., Miklósi, A., Gonda, Z. (2001). Visual ecology and perception of coloration patterns by domestic chicks. Evolutionary Ecology 13: 673-689.

Pan, C., Lu, M., Zhang, Y., Yu, Y., Liu, Q., Yang, Y., Pan, J. (2019). Unevenly distributed LED light produces distinct behavioral preferences and production performance of broilers. International Journal of Agricultural and Biological Engineering, 12, 49-53.

Prayitno, D.S., Phillips, C.J.C., Stokes, D.K. (1997). The effects of colour and intensity of light on behaviour and leg disorders in broiler chickens. Poultry Science 76, 1674-1681.

Perry, G., Lewis, P. (1993). Light perception and behaviour. In: Savory CJ and Hughes BO (eds). Fourth European Symposium on Poultry Welfare pp 27-38. Universities Federation for Animal Welfare: Wheathampstead, Hertfortshire, UK.

Prescott, N.B., Wathes, C.M. (2002). Preferences and motivation of laying hens to eat under different illuminances and the effect of illuminance on eating behaviour. British Poultry Science 43, 190-195.

Prescott, N.B., Wathes, C.M., Jarvis, J.R. (2003). Light, vision and the welfare of poultry. Animal welfare, 12(2): 269-288.

Raccoursier, M., Thaxton, Y.V., Christensen, K., Aldridge, D.J., Scanes, C.G. (2019). Light intensity preferences of broiler chickens: implications for welfare. Animal, 13, 2857-2863.

Rana, M.S., Campbell, D.L.M. (2021). Application of ultraviolet light for poultry production: a review of impacts on behavior, physiology, and production. Frontiers in Animal Science, 2.

Rault, J.L., Clark, K., Groves, P.J., Cronin, G.M. (2017). Light intensity of 5 or 20 lux on broiler behavior, welfare and productivity. Poultry Science, 96, 779-787.

Riedstra, B., Groothuis, T.G.G. (2004). Prenatal light exposure affects early feather-pecking behaviour in the domestic chick. Animal Behaviour 67: 1037-1042.

SCAHAW, (2000). The welfare of chickens kept for meat production (Broilers). Report of the European Commission Scientific Committee on Animal Health and Animal Welfare. SANCO.B.3/AH/R15/2000.

Sherwin, C.M., Lewis, P.S., Perry, G.C. (1999). Effects of environmental enrichment, fluorescent and intermittent lighting on injurious pecking amongst male turkey poults. British Poultry Science 40, 592-598

Siopes, T.D., Timmons, M.B., Baughman, G.S., Parkhurst, C.R. (1983). The effect of light-intensity on the turkey poult eye morphology. Poultry Science 62, 2486-2488.

Sultana, S., Hassan, M.R., Choe, H.S., Ryu, K.S. (2013). The effect of monochromatic and mixed LED light colour on the behaviour and fear responses of broiler chicken. Avian Biology Research, 6, 207-214.

Terlouw, E.M.C., Lawrence, A.B., Ladewıg, J., De Passıllé, A.M.B., Rushen, J., Schouten, W. (1991). A relationship between stereotypies and cortisol in sows. Behavioural Processes, 25, 133-153.

Uçar, A., Boz, M. A., Sarıca, M. (2023). The Effect of Rearing System on Plumage Quality and Foot-Pad Dermatitis in Guinea Fowls and Pheasants. Black Sea Journal of Agriculture, 3-4.

Uçar, A. (2020). Ebeveynlerin bazı özelliklerinin kuluçka ve etlik piliç performansına etkisi. Ankara Üniversitesi, Fen Bilimleri Enstitüsü, Zootekni Ana Bilim Dalı, Doktora Tezi.

van der Eijk, J.A.J., Melis, S., Izquierdo Garcia-Faria, T., van Riel, J., de Jong, I.C. (2022). Light intensity preference of broilers is affected by breed, age and behaviour. Proceedings of the Proceedings of the 55th Congress of the ISAE-Animal Behaviour and Beyond, Ohrid, North Macedonia, 65 pp.

Wichman, A., De Groot, R., Hastad, O., Wall, H., Rubene, D. (2021). Influence of different light spectrums on behaviour and welfare in laying hens. Animals, 11, 924.

Wilson, J.L., Weaver, W.D., Beane, W.L., Cherry, J.A. (1984). Effects of light and feeding space on leg abnormalities in broilers. Poultry Science 63, 565-567.

Wood-Gush, D.G.M. (1975). Nest Construction By The Domestic Hen: Some Comparative And Physiological Considerations, İn: Wrıght, P., Caryl, P.G., Vowles, D.M. (Eds) Neural And Endocrine Aspects Of Behaviour İn Birds, Pp. 35-49 (Amsterdam, Elsevier).

Yngvesson, J., Wedin, M., Gunnarsson, S., Jonsson, L., Blokhuis, H., Wallenbeck, A. (2017). Let me sleep! Welfare of broilers (Gallus gallus domesticus) with disrupted resting behaviour. Acta Agriculturae Scandinavica Section AAnimal Science, 67, 123-133.

CHAPTER 11

EGG QUALITY OF POULTRY REARED IN ALTERNATIVE PRODUCTION SYSTEMS

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1. INTRODUCTION

In recent years, animal welfare, animal rights, questioning of animal products in terms of health and environmental sustainability issues have brought more environmentally friendly production systems to the agenda. With the increasing consumer awareness, people want to know under which conditions the product is produced and what stages it goes through. Some consumers think that the eggs of poultry reared in cage-free (floor, free-range, organic, backyard etc.) systems are healthier, and they are increasingly interested in poultry products produced in these systems.

In EU countries, since 2012, laying hens can only be kept in enriched cages or alternative (cage-free) systems. The minimum standard for cage systems in the EU is enriched cages. Cage-free systems are barn, free-range and organic systems, and in these systems, birds are reared on littered floor or multi-tier (aviary). In Eastern and Southern European countries such as Poland, Spain, Portugal, Hungary, Bulgaria, Greece, Slovakia, Lithuania, Estonia and Malta, more than 70% of eggs are produced in enriched cages. In France, Austria and Ireland, there is mostly free-range as an alternative system and almost no barn system is used. The trend in many countries over the coming years is that there will be further progress towards alternative systems (van Horne and Bondt, 2023).

Production systems, which are generally an alternative to the production made in traditional cage systems, are called alternative systems and can generally be examined under two main headings (Altan, 2015; Altan and Bayraktar, 2018).

2. OUTDOOR ACCESS SYSTEMS

2. 1. Free-range

Hens are housed in a littered house and are allowed outside access at certain times of the day. The stocking density in the house is 6 birds/m^2, and a bird/4 m^2 in the outdoor area.

2. 2. Organic

The production conditions are the same as for the free-range system. It is a system in which only organic feeds are used, painful practices such as beak trimming are prohibited and veterinary practices are limited. In this system, the production firm is inspected by organic certification bodies and the products are certified.

Figure 1. Outdoor access production system (Anonymous, 2023a)

3. INDOOR (BARN) SYSTEMS

3. 1. Littered Barn Floor

Hens are housed in closed barns on a litter or in an aviary system. They do not have access to outdoor area. The stocking density should not be more than 9 birds/m^2, and the floor height should be at most 4 times.

Figure 2. a) Littered (barn) floor system (Yang et al., 2022), **b)** Anonymous (2016)

3. 2. Enriched Cages

These cages are also called furnished or modified cages. Although the cages are similar to battery cage systems, they are equipped with more space and height than battery cage systems and equipment that allows chickens to show some normal behaviors. Although there is no limitation for the size of the cage, today it is produced large enough to accommodate 60 hens. Enriched cage systems increase the welfare of laying hens with equipment such as nesting boxes, bedding materials and perches. At the same time, these systems provide 50 cm^2 more space per chicken compared to conventional cage systems. Hens are housed in cages with wire floors and at least 750 cm^2 of cage space should be provided per bird. These cages are enriched with appropriate equipment such as nesting boxes, perches, sand baths, nail grinding, etc., so that the birds can exhibit their natural behavior more easily (Baykalır and Şimşek, 2014; Altan ve Bayraktar, 2018).

4. EGG QUALITY

Egg quality is affected by many factors such as age and genetic structure of hen, nutrition, climatic environment and storage. Production systems are also included in environmental factors and can affect internal and external egg quality. The relationship between alternative production systems and egg quality has been studied in previous studies (Van den Brand et al., 2004; Wang et al., 2009; Samiullah et al., 2017). However, the results of these studies are contradictory and it is thought that this situation is due to the excess of environmental variation affecting egg quality. The high environmental variation makes it difficult to determine the direct effect of production systems on egg quality. For this reason, the effect of factors such as age, genotype, nutrition and lighting on egg quality seems to be more determinant than the production systems.

Van den Brand et al. (2004) stated that it is difficult to maintain a stable quality in eggs produced in a free-range system and the variation in quality increases with the advancing age of the hen. However, each rearing system has its own advantages and disadvantages. This chapter covers the discussion of egg weight, shell quality, albumin quality and yolk color characteristics of different alternative rearing systems used for egg production from different aspects.

4. 1. Egg Weight

Although there are many studies investigating the effect of hens raised in open and closed rearing systems on egg quality, the findings on this subject are contradictory. Egg weight varies greatly with the age and nutritional status of the hen, and the effect of rearing systems on egg weight is relatively less (Samiullah et al., 2014; 2017).

Samiullah et al. (2014) reported that cage eggs were heavier, but on the contrary, Wang et al. (2009) and Van den Brand et al. (2004) reported that eggs obtained from outdoor acces system were heavier. In addition, while Moorthy et al. (2000) and Leyendecker et al. (2001) reported that cage eggs are heavier than the others, Tůmova and Ebeid (2005), Pištěková et al. (2006) and Zemková et al. (2007) stated that the eggs produced in the littered floor system are heavier. Ayaz et al. (2022) determined that eggs obtained from the free-range system were lighter compared to those obtained from the cage and floor system. The weight of eggs obtained from chickens raised in village, free-range and cage systems was determined to be higher in the cage system, as 65.41 g, 61.96 g and 65.98 g, respectively (Artan and Durmuş, 2015). Çetin et al. (2016) found that eggs in the cage system were heavier than those obtained from free-range and organic rearing systems. Jones et al (2014) reported that the lowest egg weight was obtained from the cage system compared to organic and poultry eggs.

4. 2. Shell Quality

In determining egg shell quality, shell weight, shell thickness and shell breaking strength are important indicators in industry and marketing in terms of preventing economic losses that may occur due to cracking and breakage, especially during the collection, classification, packaging, storage and transportation stages of eggs. Egg shell quality depends primarily on genetic structure and age of the hen, and also varies depending on the amount of calcium, phosphorus, potassium, manganese and copper minerals taken with the feed, and the type and severity of the disease (Sarıca and Erensayın, 2018).

Figure 3. Egg shell quality problems (Anonymous, 2023b)

Egg shell is one of the most important external quality parameters that determine consumers' preferences in egg consumption. Poor shell quality causes it to be more affected by the external effects it is subjected to from the time it is laid until it is delivered to the consumer. Eggs with fragile shells have more cracks than eggs with strong shells. Therefore, eggs with poor shell quality affect the consumer's egg choice and are also an economic loss for the producer. For these reasons, it is important to know the relationship between rearing systems and shell quality and to determine quality-improving practices. It has been reported that rearing systems also have an effect on quality, and especially in systems where hens are more active during the advanced laying period, they can produce eggs with relatively heavier shells due to the activation of calcium metabolism (Singh et al., 2009).

Shell quality may vary depending on the hen’s age, nutritional level and environmental conditions. Previous studies show that the effect of rearing systems on egg shell quality varies. Van den Brand et al. (2004) reported that the shell quality of eggs produced in the traditional cage system deteriorates with age, while the shell quality of eggs produced in the pasture system is of relatively more stable quality. Broken-cracked eggs are more common in conventional and enriched cage systems than in the floor system (Mertens et al., 2006), and the shell strength of eggs obtained from the pasture system is better than those produced in conventional cages (Perić et al., 2016). Pavlovski et al. (2001) also stated that the rearing system affected the shell quality and that cage eggs had thicker shells than eggs obtained from pasture. However, Şekeroğlu et al. (2010) also stated that, unlike these findings, there was no significant difference between the shell thickness of conventionally produced eggs and pasture eggs. It is generally stated that the shell thickness of organic eggs is greater than that of cage eggs (Petek et al., 2009; Küçükyılmaz et al., 2012; Lolli et al., 2013). Many studies on this subject cannot reveal a definitive finding as to which rearing system can provide the best egg quality, and it is understood that each system has its own advantages and disadvantages.

It has been stated that thicker-shelled eggs are produced from the free range system than from the cage system (Đukić-Stojčić et al., 2009; Petek et al., 2009), and that thicker-shelled eggs are produced from the litter system compared to the free range and cage system (Varguez-Montero et al., 2012). However, there are also studies reporting that eggs obtained from the cage system have greater shell breaking strength (Hidalgo et al., 2008; Jones et al., 2014). Ahammed et al. (2014) and Artan and Durmuş (2015) stated that the effect of rearing systems on this quality trait is significant, Đukić-Stojčić et al. (2009), Pištěková et al (2006), Sokołowicz et al. (2018), and Şekeroğlu and Sarıca (2005) reported that it was not important.

4. 3. Albumen Quality

Albumin quality is under the influence of many factors such as the genetics age and nutritional and moulting status of the hen, medications, diseases, egg storage conditions and duration. For this reason, it is very difficult to determine the direct effect of the production system on albumin quality, and the findings obtained in previous studies on this subject are contradictory. Albumen height and Haugh unit are used to determine albumin quality (Altan, 2015).

Castellini et al. (2006) reported that the albumen height in organic eggs was higher than in conventional cage eggs, but contrary to this view, Minelli et al. (2007) stated that it was higher in cage eggs.

The air quality of the environment where chickens are kept is also an important environmental factor affecting egg quality. Castellini et al. (2006) found the albumen height in cage eggs to be lower than in organic eggs, and they reported that this situation may be due to insufficient ventilation in the house. However, some studies have also reported that the rearing system does not affect the albumen quality of the egg (Van den Brand., 2004; Hidalgo et al., 2008; Petek et al., 2009). Hidalgo et al. (2008) reported that the Haugh unit had a higher value in cage eggs than in organic eggs, but contrary to these findings, Minelli et al. (2007) stated that the Haugh unit was higher in organic eggs.

4. 4. Yolk Color

Egg yolk color is considered an important internal quality parameter that determines consumer preference and varies depending on the amount of xanthophyll consumed by the hen, and eggs obtained from rearing systems with ouutdoor access generally have a darker yolk color than cage eggs (Van den Brand et al., 2004; Castellini et al., 2006). Pasture quality and the length of time the hen stays on the pasture affect the hen's xanthophyll consumption (Altan, 2015). Therefore, in order to obtain the desired egg yolk color, hens should be provided with access to pasture at regular intervals. In hens that cannot reach the pasture for a sufficient period of time, the egg yolk color becomes lighter, which is an undesirable situation and directly affects consumer preference.

It is very difficult to maintain a stable yellow color in ooutdoor access rearing systems such as pasture and organic. In addition, the yellow color is also affected by the environmental temperature where the hen is kept, in which case the hens reduce their feed intake and as a result, yellow color may become lighther (Altan, 2015).

Hidalgo et al. (2008) reported that the yolk color was similar in eggs obtained from cage and pasture systems, but the yolk color of cage eggs were darker than organic eggs. Similarly; Samiullah et al. (2014) stated that the yolk color in cage eggs is darker and more stable than in organic eggs during the prodcution period.

The color of the egg yolk is also important for the food industry and and eggs with a Roche color score of 12-13 are generally preferred in our country. İlhan Tekin et al. (2020) determined that brown eggs had a darker yolk color compared to whites, and in white eggs, the eggs belonging to the cage system had the darkest yolk color (11.40), while the eggs belonging to the organic system had the lightest yellow color (9.55). Hidalgo et al. (2008) stated that eggs produced in the cage system have a darker yellow color.

5. CONCLUSIONS

Although eggs have a very important place in human nutrition, their main function is reproduction. The egg is a reproductive cell that contains all the nutrients the embryo needs for embriyonic development and protects the egg content from external factors thanks to its shell. The main goal in hatching or table egg production is to obtain the maximum number of good quality eggs with cheap, environmentally friendly and sustainable systems.

Different production systems have come to the fore in table egg production in line with consumer preferences and demands. However, these systems have positive and negative aspects, and there is not yet a production model that will fully meet all expectations. As we detailed in this chapter, the fact that many researchers obtain different results on the same quality parameter is a clear indication of this situation.

Sustainable and permanent production of quality eggs in alternative rearing systems depends on the producer's level of knowledge, experience and foresight, and largely on environmental factors. Production in open access systems, which is intertwined with the external environment, makes sustainability difficult. Previous studies show that there is no significant difference in the quality and nutritional content of eggs whether the rearing systems are outdoor or indoor. In fact, the hygiene, quality and sustainability of eggs produced in outdoor access systems are more affected by environmental conditions, and practices that require additional costs are needed for the success of production in these systems. For the egg industry, it is a necessity to develop a more environmentally friendly, animal welfare and sustainable production model. Consumers will determine their own preferences in line with their preferences, beliefs and income level.

It shows that there cannot be a definitive judgment that a single production system is superior to another, and that each system may have advantages and/or disadvantages over the other in terms of different quality characteristics. Retail egg quality is influenced not only by the production system but also by other factors that are not directly dependent on the production system but can significantly affect quality, such as storage, transportation, retail practices and time to sale.

REFERENCES

Ahammed, M., Chae, B. J., Lohakare, J., Keohavong, B., Lee, M. H., Lee, S. J., Kim, D. M., Lee, J. Y., Ohh, S. J. (2014). Comparison of aviary, barn and conventional cage raising of chickens on laying performance and egg quality. Asian-Australasian Journal of Animal Sciences, 27(8): 1196.

Altan, A., Bayraktar, H. (2018). Kümesler ve Donanımları. Tavukçuluk Bilimi, Yetiştirme, Besleme, Hastalıklar, 207-261, Edit., M. Türkoğlu, M. Sarıca, Ankara: Bey Ofset.

Altan, Ö. (2015). Yumurta: Oluşumu kalitesi ve biyoaktif komponentleri. Ege Üniversitesi.

Anonymous, (2016). Enriched cage system. https://www.eggfarmers.ca/2016/08/the-5-things-you-find-in-enriched-housing/ (Access date: 01.09.2023).

Anonymous, (2023a). Outdoor access production system. https://skapoultryequipment.com/en/poultry-equipment/poultry-houses/ (Access date: 01.09.2023).

Anonymous, (2023b). Egg shell quality problems. https://celticseaminerals.com/eggshell-quality-problems/ (Access date: 01.09.2023).

Artan, S., Durmuş, İ. (2015). Comparison of egg quality characteristics of produced in village, free range and cage systems. Akademik Ziraat Dergisi, 4(2): 89-97.

Ayaz, E., Baylan, M., Kurşun, K. (2022). Atak-S Tavuklarda Farklı Yetiştirme Sisteminin Verim Özellikleri, Kalite Kriterleri ve Yumurta Kabuğu Mikrobiyal Yükü Üzerine Etkileri. Kadirli Uygulamalı Bilimler Fakültesi Dergisi, 2(2), 216-229.

Baykalır, Y., Şimşek, Ü. G. (2014). Breeding systems used in laying hens. Sağlık Bilimleri Veteriner Dergisi, Fırat Üniversitesi, 28(2): 93-98.

Castellini, C., Perella, F., Mugnai, C. and Dal Bosco, A. (2006) Welfare, productivity and qualitative traits of egg in laying hens reared under different rearing systems. Poster at: XII European Poultry Conference, Verona, 10-14 September.

Çetin, E., Temelli, S., Eyigör, A. (2016). Effect of rearing systems and shell color on some egg quality parameters. Uludağ Üniversitesi Veteriner Fakültesi Dergisi, 35(1-2): 11-16.

Đukić-Stojčić, M., Perić, L., Bjedov, S., Milošević, N. (2009). The quality of table eggs produced in different housing systems. Biotechnology in Animal Husbandry, 25(5-6-2): 1103-1108.

Hidalgo, A., Rossi, M., Clerici, F., Ratti, S. (2008). A market study on the quality characteristics of eggs from different housing systems. Food chemistry, 106(3): 1031-1038.

İlhan Tekin, E., Çetin, E., Temelli, S., Eyigör, A. (2019). Alternatif ve kafes yetiştirme sistemleri ile üretilen perakende yumurtaların kalite özellikleri. Veteriner Hekimler Derneği Dergisi, 90(2): 143-151.

Jones, D. R., Karcher, D. M., Abdo, Z. (2014). Effect of a commercial housing system on egg quality during extended storage. Poultry Science, 93(5): 1282-1288.

Jones, D. R., Karcher, D. M., Abdo, Z. (2014). Effect of a commercial housing system on egg quality during extended storage. Poultry Science, 93(5): 1282-1288.

Küçükyılmaz, K., Bozkurt, M., Herken, E. N., Çınar, M., Çatlı, A. U., Bintaş, E., Çöven, F. (2012). Effects of rearing systems on performance, egg characteristics and immune response in two layer hen genotype. Asian-Australasian Journal of Animal Sciences, 25(4): 559.

Leyendecker, M., Hamann, H., Hartung, J., Kamphues, J., Ring, C., Gluender, G., Ahlers, C., Sander, I., Neumann, U., Distl, O. (2001). Analysis of genotype-environment interactions between layer lines and housing systems for performance traits, egg quality and bone breaking strength-2nd communication: Egg quality traits. Züchtungskunde, 73: 308-323.

Lolli, S., Hidalgo, A., Alamprese, C., Ferrante, V., Rossi, M. (2013). Layer performances, eggshell characteristics and bone strength in three different housing systems. Biotechnology in Animal Husbandry, 29(4): 591-606.

Mertens, K., Bamelis, F., Kemps, B., Kamers, B., Verhoelst, E., De Ketelaere, B., Bain, M., Decuypere, E., De Baerdemaeker, J. (2006). Monitoring of eggshell breakage and eggshell strength in different production chains of consumption eggs. Poultry Science, 85(9): 1670-1677.

Minelli, G., Sirri, F., Folegatti, E., Meluzzi, A., Franchini, A. (2007). Egg quality traits of laying hens reared in organic and conventional systems. Italian Journal of Animal Science, 6(1): 728-730.

Moorthy, M., Sundaresan, K., Viswanathan, K. (2000). Effect of feed and system of management on egg quality parameters of commercial white leghorn layers. Indian Veterinary Journal, 77(3): 233-236.

Pavlovski, Z., Hopic, S., Lukic, M. (2001). Housing systems for layers and egg quality. Biotechnology in Animal Husbandry, 17: 197-201.

Perić, L., Stojčić, M. Đ., Bjedov, S. (2016). Effect of production systems on quality and chemical composition of table eggs. Contemporary Agriculture, 65(3-4): 27-31.

Petek, M., Alpay, F., Cengiz, Ş. Ş., Çibik, R. (2009). Effects of housing system and age on early stage egg production and quality in commercial laying hens. Kafkas Üniversitesi Veteriner Fakültesi Dergisi, 15(1).

Pištěková, V., Hovorka, M., Večerek, V., Strakova, E., Suchý, P. (2006). The quality comparison of eggs laid by laying hens kept in battery cages and in a deep litter system. Czech Journal of Animal Science, 51(7): 318-325.

Samiullah, S., Omar, A. S., Roberts, J. R., Chousalkar, K. (2014). Effect of production system and flock age on egg quality. In Proceedings of the 27th Annual Australian Poultry Science Symposium, Sydney, New South Wales (pp. 133-136).

Samiullah, S., Omar, A. S., Roberts, J., Chousalkar, K. (2017). Effect of production system and flock age on eggshell and egg internal quality measurements. Poultry Science, 96(1): 246-258.

Sarıca, M., Erensayın, C. 2018. Tavukçuluk Ürünleri. Tavukçuluk Bilimi, Yetiştirme, Besleme, Hastalıklar. Edit., M. Türkoğlu, M. Sarıca, Ankara: Bey Ofset, pp. 110-164.

Şekeroğlu, A., Sarıca, M. (2005). The effects of free range system on egg productions and egg quality of brown and white layer genotypes. Journal of Poultry Research, 6(1): 10-16.

Şekeroğlu, A., Sarıca, M., Demir, E., Ulutaş, Z., Tilki, M., Saatci, M., Omed, H. (2010). Effects of different housing systems on some performance traits and egg qualities of laying hens. Journal of Animal and Veterinary Advances, 9(12).

Singh, R., Cheng, K. M., Silversides, F. G. (2009). Production performance and egg quality of four strains of laying hens kept in conventional cages and floor pens. Poultry Science, 88(2): 256-264.

Sokołowicz, Z., Krawczyk, J., Dykiel, M. (2018). The effect of the type of alternative housing system, genotype and age of laying hens on egg quality. Annals of Animal Science, 18(2), 541.

Tůmová, E., Ebeid, T. (2005). Effect of time of oviposition on egg quality characteristics in cages and in a litter housing system. Czech Journal of Animal Science, 50(3): 129-134.

Van Den Brand, H., Parmentier, H. K., Kemp, A. B. (2004). Effects of housing system (outdoor vs cages) and age of laying hens on egg characteristics. British Poultry Science, 45(6): 745-752.

Van Horne, P. L. M., Bondt, N. (2023). Competitiveness of the EU egg sector, base year 2021: international comparison of production costs of eggs and egg products (No. 2023-006). Wageningen Economic Research.

Varguez-Montero, G., Sarmiento-Franco, L., Santos-Ricalde, R., Segura-Correa, J. (2012). Egg production and quality under three housing systems in the tropics. Tropical Animal Health and Production, 44: 201-204.

Wang, X. L., Zheng, J. X., Ning, Z. H., Qu, L. J., Xu, G. Y., Yang, N. (2009). Laying performance and egg quality of blue-shelled layers as affected by different housing systems. Poultry Science, 88(7): 1485-1492.

Yang, X., Chai, L., Bist, R. B., Subedi, S., Wu, Z. (2022). A deep learning model for detecting cage-free hens on the litter floor. Animals, 12(15), 1983.

Zemková, Ľ., Simeonovová, J., Lichovníková, M., Somerlíková, K. (2007). The effects of housing systems and age of hens on the weight and cholesterol concentration of the egg. Czech Journal of Animal Science. 52(4): 110-115.

CHAPTER 12

FEATHER AND FATTY LIVER PRODUCTION IN WATERFOWL

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1. INTRODUCTION

Animal welfare is a very important issue in terms of agricultural development, sustainable agriculture and policies and ensuring food safety. In order to create a sustainable mechanism in animal production, it must be environmentally, economically and ecologically sustainable. It must also be ethically and socially acceptable (Buller et al., 2018; Dwyer, 2020; Broom, 2021).

In the current century, the welfare of animal species is one of the most scrutinized and attention-grabbing issues on a global scale. Unfortunately, if this demand for animal welfare is not met, the sustainable animal product chain will not be completed in its entirety (Marchant-Forde, 2015; Papageorgiou et al., 2023).

People have started to make more efforts to include animal species welfare in national and international legislation (Mellor, 2016; Dwyer, 2020; Papageorgiou et al., 2023). This behavior of humans also attracts the attention of scientists at the universal level and forms the basis for their studies.

The Council of Europe ratified the Convention on the Protection of Animals in 1976. One of the most important articles in this convention is "Animals shall be housed and provided with feed, water and care in accordance with their physiological and ethological needs, taking into account their species and development, adaptation and domestication". Subsequent amendments and regulations aim to make decisions on animal welfare based on scientific evidence (Anonymous, 1998).

The most important problem in the world, especially in underdeveloped and developing countries, is inadequate and unbalanced feeding. The world population is constantly increasing and the need for nutrients is increasing in parallel with this situation. It is an important advantage and potential to provide animal protein from poultry in a shorter time compared to the protein obtained from red meat group. However, goose and duck production has been increasing in recent years as an alternative to chicken and turkey production due to the short production processes and the fact that they can be obtained with less cost (Demir et al., 2010).

Human beings have benefited from waterfowl in various ways for thousands of years. These ways of utilization can be counted as consuming their meat, consuming their eggs, using their fat for lighting and heating, and using their feathers for heating (Kozak, 2021).

Waterfowl farming in the world is generally carried out in countries with cold climates. Goose and duck meat and products have an important place in East and Southeast Asian countries and some Eastern European countries (Pingel, 2011).

The majority of poultry meat and eggs produced in the world are obtained from chickens. However, in certain regions and areas, the amount of products obtained from geese and ducks has reached significant levels (Pingel, 2004). Products such as meat, feathers and fatty liver produced as a result of breeding activities have a significant market potential in all parts of the world, especially in France, USA and Japan. There are also export opportunities for producer countries (Aral and Aydın, 2007).

Unfortunately, the purchase of foods containing proteins of animal origin is difficult for consumers as a result of price increases. Easy intake of animal-derived protein depends on abundant production (İşgüzar, 2006). There are many animal-derived proteins in our world that can provide this. Aquatic poultry is one of the most important of these alternative sources.

Recently, due to the high costs of infrastructure inputs and costs, the possibilities of obtaining more products from the unit area are very much on the agenda. For producers, this situation (more yield per square meter) is important in terms of reducing costs (İşgüzar, 2006). However, this situation may cause significant negative situations in terms of animal welfare.

2. GOOSE BREEDING

Goose is considered to be among the first domesticated animals. It is reported that goose domestication was carried out in Egypt around 3000 BC and some researchers believe that this information may be even earlier (Holderread, 1981; Buckland and Guy, 2002). In today's world, there is a higher proportion of domestic geese than wild geese. There are two main origins of domestic geese. Geese of European origin constitute the first group and are reported to have originated from wild Greylag geese (Anser anser) (Pingel, 2011). Geese of Asian origin are reported to have originated from wild Swan geese (Anser cygnoides) (Buckland and Guy, 2002; Pingel, 2011).

Geese are among the most intelligent group of poultry. They have a very good memory and do not forget the events they have experienced, other animals and people they have seen. Behaviorally, pecking or cannibalism is not seen in normal situations. They tend to live in harmony with other animals (Buckland and Guy, 2002).

Considering other poultry, geese are able to digest raw materials with high cellulose and hemicellulose content, as well as wild plants. In addition, geese are resistant to harsh environmental conditions and more resistant to diseases. Shelter demand is low. It is an animal with high fattening ability and performance (Labatut, 2002).

Goose breeding is mostly practiced in northern countries. One of the main reasons for this is that the climate of these regions is quite cold. Because geese are better adapted to cool climates rather than hot environments (Selçuk et al, 1983). Geese can be raised all over the world. Geese have the ability to resist northern winters with minimum shelter conditions. When shade is provided, they can adapt to hot climates at the same rate. Despite this wide adaptability, commercial breeding is important in a few countries in Asia and Europe (Buckland and Guy, 2002).

Geese are between ducks and swans in terms of body size and appearance. Since the feather colors of male and female geese are similar, it is difficult to distinguish the sexes without capturing and examining them (Gleaves, 1984; Tilki, 1999). The life span of geese varies between 20-60 years. However, they are not kept by breeders for a long time. Geese raised for meat are kept for 3-5 years, while in traditional breeding, this period can extend up to 10 years (Tilki vand İnal, 2004).

3. DUCK BREEDING

Ducks are one of the oldest poultry species, thought to have been domesticated around 2000 years ago. Ducks are primarily produced for egg and meat production and are the second most important poultry species in some countries after chickens (Jalaludeen and Churchil, 2022). Domestic ducks belong to the family Anatidae (duck family) of the order Anseriformes (goose-shaped birds). There are two commercially and economically important genus within this fauna. These are Cairina and Anas. The Muscovy duck is structurally and functionally distinct from the others and Cairina Moschta originates from the wild duck. All other domestic ducks originate from the European wild duck (Anas platyrhyncos) (Koçak and Yalçın, 1993.

Ducks have a high rate of conversion of the feed they consume into meat and have a high growth rate. Similar to geese, they are easy to care for, easier to feed and have a low risk of getting sick (Demir et al., 2010). Ducks have short legs and webbed feet and because of this structure, they are named as waterfowl together with geese (Koçak and Yalçın, 1993).

Ducks can be raised for meat and egg production, but their fatty liver and feathers are also used in commercial production. They are resistant to various environmental conditions and natural water resources and pastures provide advantages to producers in terms of feeding and labor force. Although they are aquatic poultry, ducks and geese do not need lakes or ponds. They are also suitable for closed rearing systems (Koçak and Yalçın, 1993; Anonymous, 1998). However, when animal welfare is taken into consideration, free-range production systems and the use of ponds are considered.

Ducks have an important place in terms of meeting the protein requirement of animal origin. Although the protein value of meat is low compared to other poultry, the energy level is high. Carbohydrate and cellulose levels are very low. Thiamine and riboflavim vitamins, iron and phosphorus mineral levels are high (Koçak and Yalçın, 1993).

Asia contributes significantly to the world duck population. Asian countries such as China, Vietnam, Indonesia, Malaysia and Bangladesh have high numbers of ducks. Cambodia is the most dominant country with 40.5% of ducks in total poultry. Bangladesh has the highest number of ducks in the world with 438.8 ducks per square kilometer. Although France is not among the top countries in duck numbers, it ranks second after China in duck meat production. About 80% of down and feathers are produced in China. In addition, Europe is the largest exporter of live ducks. Within Europe, France alone accounts for more than half (Jalaludeen and Churchil, 2022).

4. THE RELATIONSHIP BETWEEN FEATHER PRODUCTION AND WELFARE

The feathers obtained from waterfowl have a more valuable structure than other poultry. For this reason, it has been serving for human use for a very long time.

Goose and duck feather is a value-added material used as raw material especially in textile industry and other fields. It is a material that has been used for various purposes since ancient times. In particular, goose feather was used as a basic writing instrument in the western world from the 6th century to the 16th century (experiencing its most popular period in the 16th century). Apart from these, feathers are used in the following areas (Oral and Dirgar, 2017).

- Pillow and quilt production,
- In the production of sleeping bags and overalls,
- As an internal filling material in the sofa construction process,
- Fishing hooks, archery, paint industry production,
- Coats and jackets as insulation material,
- Souvenir making,
- Feather knife production.

When feathers are evaluated in terms of human health and life, it is stated that they maintain body temperature, do not prevent moisture and perspiration as they provide air circulation, remain healthy and clean, and are comfortable (Anonymous 2023a).

Due to all these properties and areas of use, its production and consumption are constantly increasing. It is thought that production and consumption will increase in terms of future projections.

Feather and down feathers are obtained from geese and ducks by two methods. The first one is the feather obtained from slaughtered waterfowl. In this method, feathers are obtained by dry plucking method and wet plucking method (manual or mechanical plucking) after slaughtering (Pingel, 2000; IDFL, 2009).

The second method of obtaining feathers is feather and down feathers obtained from live geese (Pingel, 2000). Feathers obtained live are of better quality than feathers obtained after slaughter. Because it will not be affected by the harmful heat and mechanical factors of boiled water (Kozak et al., 2010). However, mechanical processing is not allowed in the feather harvesting process obtained live. Feathers are manually harvested from live waterfowl from the abdomen, chest, back, flanks and lower neck (Pingel 2000; Kozak 2011). The other method is live plumage, which is obtained from waterfowl at natural molting times (Pingel 2000; IDFL, 2009).

The most controversial issue in feather production is the feather obtained from live waterfowl. Here, the skin of the waterfowl is damaged and the animals become susceptible to diseases. This is a negative process for animal health and welfare. Consumers who use feather-derived products have concerns about the plucking process in the products they buy. For this reason, some companies indicate the methods of feather extraction on the products.

Feather and down, which is a high value-added product, contains problems related to animal welfare in terms of obtaining methods. Products obtained during post-slaughter harvesting and natural molting period do not pose any problems in terms of animal welfare and health. However, obtaining feathers from live waterfowl in a planned manner (at certain periods and ages) is an important welfare and health problem.

Figure 1. Plucked goose (Anonymous, 2023b)

Methods and practices to address consumers' concerns are also an important parameter in terms of animal health and welfare. It is positive that these concerns have recently been taken into account.

5. THE RELATIONSHIP BETWEEN FATTY LIVER PRODUCTION AND WELFARE

Looking at the data for 2021, approximately 17,979 tons of fatty liver production was realized in the European Union countries. Of this fatty liver production, 16,717 tons were obtained from duck and 1,262 tons from goose. The fatty liver production sector provides direct employment opportunities for more than 50,000 people in the European Union. The EU also supplies around 90% of the world's fatty liver. The most important producing countries outside the EU are China, the USA and Canada. Total fatty liver production in 2021 is 21,640 tons (Euro Foie Gras, 2023; Statista, 2023).

In 2021, there was a 139 million euro fatty liver market in the European Union. Exports from the European Union to third countries amounted to 67.2 million euros. The fatty liver obtained from fattened geese raised under certain rules must be at least 400 grams for geese and 300 grams for ducks (Euro Foie Gras, 2023).

Many methods have been tried to obtain fatty liver from geese and ducks and basically 4 applications have come to the fore. Although not all of these methods are recommended for fatty liver production, they are explained below (Koçak and Özkan, 1988; Anonymous, 1998).

5.1. Hypothalamus Intervention Method

There are hunger and satiety centers in the hypothalamus, which is related to appetite on the central nervous system. Feed consumption values can be changed by destroying these centers with electrodes in order to produce fatty liver. With this method, feed consumption consumes three times more feed than normal. In this way, fatty liver production can be realized (Koçak and Özkan, 1988)

5.2. Method of Hormone Administration

Hormones that control lipid metabolism in the body also have an effect on fatty liver disease. If thyroxine secretion is increased in adult poultry or iodized proteins that replace thyroxine are given to animals, metabolic activity increases and fat stored in the body decreases. In this case, if the poultry are not given enough nutrients, the stored fat in the body is used. As a result, the amount of fatty acids transported to the liver increases too much and fatty liver is formed.

In case of insulin deficiency, body blood sugar levels increase. In this case, the energy required is mostly supplied by triglycerides, which are transported from adipose tissue to the liver and oxidized. However, some of the triglycerides that are not oxidized in the liver during oxidation are added to the liver cells and cause fatty liver (Koçak and Özkan, 1988; Anonymous, 1998).

5.3. Nutrient Deficiency Method

If the essential fatty acids alpha-Linolenic acid (an omega-3 fatty acid), linoleic acid (an omega-6 fatty acid) and arachidonic fatty acids are not present in the required amounts in the feed fed to the animals, fatty liver is observed).

In case of protein deficiency and deficiency of some amino acids (methionine, threonine), liver weight increases and liver health deteriorates.

Deficiency of choline, which is involved in the structure of phospholipids, also causes fat accumulation in the liver. Fatty liver may also occur in B12 and folic acid deficiency (Koçak and Özkan, 1988; Anonymous, 1998).

5.4. Nutrient Surplus Method

High doses of cysteine from the amino acids group, thiamine, biotin, riboflavi and pyridoxine from the vitamin group, especially in geese, cause an increase in fat content in the liver. In addition, high levels of salt and magnesium sulphate are also used in the production of fatty liver.

Poultry are fed with feed raw materials rich in carbohydrates. These carbohydrates taken in with the feed consumed are used for the energy export of the animal. Carbohydrates in excess of the need are converted into triglycerides in the liver and stored in adipose tissue. For this reason, a feeding program rich in carbohydrates and low in protein and fat allows triglycerides to accumulate in the liver. As a result, fatty liver disease occurs (Koçak and Özkan, 1988; Anonymous, 1998).

The most commonly used method in fatty liver production is force feeding-cramming. In this method, animals are forced to consume a large amount of boiled corn (about 1 kilogram per day). As a result, liver weight increases and fatty liver is formed. While the average liver weight is normally 80 grams, at the end of force feeding-cramming, 600 to 1000 grams of liver is obtained (Aral and Aydın 2007).

Lines subjected to force feeding-cramming are developed to be used in production. For example, Oie du Gers and Oie Grise du Sud-oiest lines with high fatty liver production capacity obtained by selection in geese. In ducks, mulard and muscovy duck lines are used (Euro Foie Gras, 2023). Although force feeding-cramming is not approved by FAO (Food and Agriculture

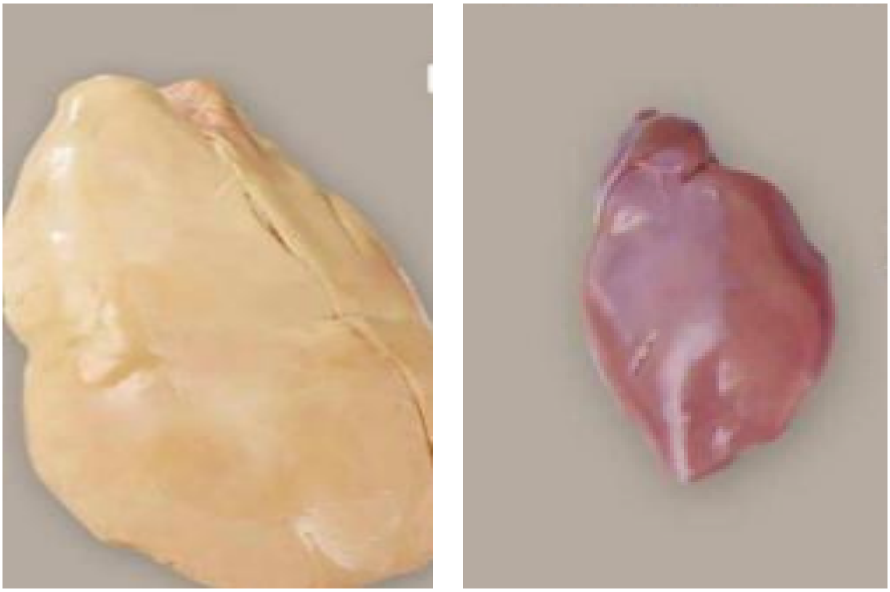
Organization of the United Nations) in practice, it is considered traditional by the EU and is only allowed in certain regions (Buckland and Guy, 2002; Rochlitz and Broom, 2017).

During this production and pre-production rearing period, animals are exposed to unfavorable conditions in terms of rehoming due to practices such as full confinement, beak trimming, and intensive feeding.

Ducks and geese are animals that are suitable for breeding in free-range and extensive systems and show better active behavior characteristics in these environments. However, in foie gras production, even if they are outdoors, they lose the motivation to forage due to the rations that are forced into their digestive system more than normal. In addition, geese and ducks are raised in individual cages in a force feeding procedure (Anonymous, 1998). This alone is a significant stress factor for web-footed waterfowl. In a system that produces food for human consumption and not as a scientific experiment, these stress conditions do not seem to be favorable for welfare.

Studies have shown that waterfowl retract themselves and their heads when workers come to the cages where force feeding is carried out. This shows that waterfowl are uncomfortable with this situation (Anonymous, 1998; Rochlitz and Broom, 2017).

High feed intake through force-feeding causes excess fat accumulation in the liver. However, it does not cause fat degeneration in the liver. Especially geese can physiologically tolerate excessive feed input. However, this situation should be considered not only from a physiological point of view but also in terms of animal welfare and behavior (Rochlitz and Broom, 2017; Kozak, 2019; Wei et al., 2022). If this feed intake is against the animal's will and forced, it is not appropriate in terms of welfare practices.



A B

Figure 2. View of fatty liver (A) and normal liver (B)

The production of fatty goose liver, the production process of which has already been mentioned, is already negative in terms of animal welfare and animal rights. It is already impossible to consider a forced process as welfare. Therefore, fatty goose liver production is not suitable for animal welfare. Although organic fatty liver production has recently been tried to be brought to the forefront, as a result, any production other than normal will have a negative impact on welfare.

Fatty liver production from ducks and geese is banned in many European and world countries. Although production is prohibited, fatty liver imports continue even in the prohibiting countries. This is an issue that needs to be considered and examined.

6. CONCLUSION

Any forced production outside the nature of the animal has a negative impact on animal welfare. This also applies to fatty liver production and live feather plucking. Both products are sold in the world market as high value-added products. Both products have high demand in certain countries and regions. Although the production of these products continues in response to demand, it is clear that animal welfare is not taken into consideration.

People's consumption habits and preferences guide producers. However, even if there is a demand for a product, care should be taken if the production of this product harms the animal. Here we have to ask the question, what kind of deficiency or problem would there be in our lives without this product? According to the answer, we can direct production that ignores animal welfare.

In the production of demanded products, it is important that they are made in accordance with animal welfare and in a way that respects animal rights. Production conditions and circumstances should also be evaluated within the supply-demand balance. Recently, it is obvious that the demand for products produced from production models that respect animal welfare has increased. Considering this situation, the issue of fatty liver production and forced hair plucking from live animals should be re-evaluated.

It should be explained and implemented by all authorities that production processes should be managed on the basis of animal welfare and that they should be sensitive in this regard.

REFERENCES

Anonymous (1998). Welfare aspects of the production of foie gras in ducks and geese. report of the scientific committee on animal health and animal welfare. (Access Date: 10.06.2023). chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://food.ec.europa.eu/system/files/2020-12/sci-com_scah_out17_en.pdf.

Anonymous (2023a). https://standardfiber.com/down-feather. (Access Date: 10.06.2023).

Anonymous (2023b). https://www.veganpeace.com/animal_cruelty/downandfeathers.htm. (Access Date: 10.06.2023).

Aral, Y., Aydın, E. (2007). Türkiye'de kaz yetiştiriciliğinin Ekonomik önemi ve kaz ürünlerinin değerlendirme olanağı. Vet. Hek. Der. Derg., 78 (3): 31-38.

Broom, D.M. (2021). Farm animal welfare: A key component of the sustainability of farming systems. Vet. Glas., 75: 145–151.

Buckland, R., Guy, G. (2002). Geese for meat production, Feather and Down Production, Fatty liver or foise gras production. Goose Production, FAO Animal Production and Health Paper No: 154, Roma, İtaly.

Buller, H., Blokhuis, H., Jensen, P., Keeling, L. (2018). Towards farm animal welfare and sustainability. Animals, 8: 81.

Pınar, D., Erişir, Z., Poyraz, Ö., Onbaşilar, E.E., Erdem, E. (2010). Cost-Benefit Analyses of Pekin Duck Fattening According to Various Housing Systems and Slaughter Age. Kafkas Univ Vet Fak Derg., 16 (3): 493-496. DOI:10.9775/kvfd.2009.1162.

Dwyer, C.M. (2020). Can improving animal welfare contribute to sustainability and productivity? BSJ Agric., 3: 61–65.

Euro Foie Gras, 2023. The production. https://www.eurofoiegras.com/en/the-production/. (Access Date: 01.08.2023).

Holderread, D. (1981). The Book of Geese: A Complete Guide to Raising the Home Flock. Hen House Publishing, Co., Oregon State University, U.S.A.

Gleaves, W.E. (1984). Brooding and Rearing the Home Goose Flock. http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=2288&context=extensionhist). (Access Date: 23.06.2023).

IDFL, (2009). Finding the truth about “live-plucking” & “harvesting”. https://idfl.com/info/harvesting-and-live-plucking-truth/. (Access Date: 23.08.2023).

İşgüzar, E. (2006). Effects of stocking density on growth and carcass traits of mixed local duck genotypes and pekin ducks in Isparta Region of Turkey. Süleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 10(1): 56-60.

Jalaludeen, A., Churchil, R.R. (2022). Duck Production: An Overview. In: Jalaludeen, A., Churchil, R.R., Baéza, E. (eds) Duck Production and Management Strategies. Springer, Singapore. doi.org/10.1007/978-981-16-6100-6_1.

Koçak, Ç., Özkan, K. (1988). Kaz ciğeri üretimi. Hayvansal Üretim, Sayı; 29-30, ayrı baskı, Ege Üniversitesi, Ziraat Fakültesi. (in Turkish)

Koçak, Ç., Yalçın, S. (1993). Ördek yetiştirme. Ege Üniversitesi basım evi. Bornova, İzmir, pp. 40. (in Turkish)

Kozak, J., Gara, I., Kawada, T. (2010). Production and welfare aspescts of goose down and feathers harvesting. World’s Poultry Science Journal 66: 767-777. doi:10.1017/s0043933910000723.

Kozak, J. (2011). A Tollszedés Szervezési Kérdései [Organisation Question of Harvesting Feathers from Live Geese]. Baromfiágazat 11 (2): 64-68.

Kozak, J. (2019). Variations of geese under domestication. World's Poultry Science Journal, 75:2, 247-260, doi: 10.1017/S0043933919000023.

Kozak, J. (2021) Goose production and goose products, World's Poultry Science Journal, 77:2, 403-414, doi: 10.1080/00439339.2021.1885002.

Labatut, M.C. (2002). Goose production in Chile and South America. Goose Production, FAO Animal Production and Health paper No: 154, Roma, İtaly.

Marchant-Forde, J.N. (2015). The science of animal behavior and welfare: Challenges, opportunities, and global perspective. Front. Vet. Sci., 2: 16.

Mellor, D.J. (2016). Updating animal welfare thinking: Moving beyond the “Five Freedoms” towards “a LifeWorth Living”. Animals, 6: 21.

Oral, O., Dirgar, E. (2017). Usage areas and properties of goose down as a fill material (A review). Düzce Üniversitesi Bilim ve Teknoloji Dergisi, 5: 10-14.

Papageorgiou, M., Goliomytis, M., Tzamaloukas, O., Miltiadou, D., Simitzis, P. (2023). Positive welfare indicators and their association with sustainable management systems in poultry. Sustainability, 15: 10890.

Pingel, H. (2000). Enten Und Gänse [Ducks and Geese]. Stuttgart (Hohenheim): Ulmer.

Pingel, H. (2004). Duck and geese production. World Poultry, 20 (8), 26-28.

Pingel, H. (2011). Waterfowl production for food security. Lohmann İnformation, 46(2): 32-42.

Rochlitz, I., Broom, D.M. (2017). The welfare of ducks during foie gras production. Animal Welfare, 26: 135-149.

Statista, (2023). Production volume of foie gras worldwide from 2013 to 2021. https://www.statista.com/statistics/770709/foie-gras-production-worldwide/. (Access Date: 01.08.2023).

Selçuk, E., Aykurt, İ., Geliyi, C. (1983). Kaz yetiştiriciliği. Tarım ve Orman Bakanlığı, Ziraat İşleri Genel Müdürlüğü, Ankara, 27 s. (in Turkish)

Tilki, M. (1999). Kaz yetiştiriciliği. Selçuk Üni. Sağlık Bilimleri Enstitüsü, Doktora Semineri, Konya, 15 s. (in Turkish)

Tilki, M., İnal, Ş. (2004). Yield traits of geese of different origins reared in Turkey III. slaughter and carcass traits. Türk J. Vet. Anim. Sci., 28: 165-171.

Wei, R., Deng, D., Teng, Y., Lu, C., Luo, Z., Abdulai, M., Liu, H., Xu, H., Li, L., Hu, S., Hu, J., Wei, S., Zeng, X., Han, C. (2022). Study on the effect of different types of sugar on lipid deposition in goose fatty liver. Poult. Sci., 101: 101729.

CHAPTER 13

A REVIEW ON HONEYBEES *(Apis mellifera)* WELFARE

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1. INTRODUCTION

Insect pollinators make an invaluable contribution to the ecosystem by ensuring the sustainable development and conservation of different plant species globally (Klein et al., 2007). Apis mellifera has a long history of domestication and the intercontinental movement by humans has resulted in its spread to many areas around the world (Aebi et al., 2012; Butz Huryn, 1997). However, habitat loss, climate change, declining floral resources and intensive use of pesticides are some major problems leading to the decline of this insect population (Klein et al., 2007; Potts et al., 2016; Main et al., 2020). Globally, there are around twenty thousand identified bee species and honey bees are the most intensively reared insect pollinator (Gösterit and Gürel, 2005; Buluş et al., 2020). It has been estimated that around 87.5% of the flowering plant species are pollinated by animals (Ollerton et al., 2011). Human-animal interaction is an ancient phenomenon and humans have for a very long time studying the behavior of the animals they hunted or domesticated. During this time, domestication was based according to human needs such as meat or products or honey (Slater, 1989). As the interaction between humans and animals progressed, the lives of animals and various animal behaviors have been questioned or under scrutiny. As a result of this, the comfort zones of animals have been debated and investigated leading to discovery of the term welfare.

2. DEFINITION OF WELFARE

It means ensuring that all animals (farm, pet, laboratory, wild, etc.) are healthy and happy without suffering during their lifetime on the farm, lab, during feeding, housing, treatment or when they are used as animal materials for scientific research (Yaşar, 2005). Although animal welfare has been described in several terms by different authors, it is generally based on the behavior, biological functions, and emotions of animals (Ünal, 2010). The welfare of honey bees is not very old in the history of scientific studies on the similarities and differences between the concept of welfare defined in farm, pet and laboratory animals and that of honey bees (Horvath et al., 2013; Elwood, 2019; Garrido and Nanetti, 2019). It has been emphasized that the term welfare applies to all living things other than plants and inanimate objects and that the welfare of invertebrates such as bees and spiders should be defined and its limits should be determined (Broom, 2013). For sustainable crop production, the production of bees should be practiced with the highest level of bee welfare or maximum bee welfare should be taken into consideration. Bee welfare includes factors around and inside the hive as well as the entire bee population in the region (Garrido and Nanetti, 2019). To achieve high welfare, honey bees should be healthy, be given a well-balanced diet, be able to exhibit their natural behaviors in their natural habitat, and be kept away from all environmental threats, farmer should have better management and effective breeding techniques as well (Bozkurt, 2019). Garrido and Nanetti (2019), reported that bees will be considered small livestock if bee farming is carried out with the principles of intensive production. However, despite the requirement of knowledge and skills from human beings to obtain more products from honeybees, these creatures have not yet undergone domestication (Seeley, 2019).

3. CAN BEES RECOGNIZE THE FACE OF BEEKEEPERS?

There is considerable interest in mechanisms to facilitate the recognition of human faces (Duchaine et al., 2004; Dyer et al., 2005). It has been suggested that some special regions of the human brain process face (Kanwisher, 2000). Invertebrate and vertebrate animals can recognize identical faces (Tibbetts and Dale, 2004). Wasps recognize the faces of other wild bees (Tibbetts, 2002). Dyer et al (2005), reported that more than 80% of human faces can be distinguished by bees.

4. DO BEES FEEL PAIN?

Insects have specialized sensory nociceptors design they have small nervous systems consisting of several ganglia (Bullock et al., 1977). Insects can regulate their nociceptive input (Johnson and Carder, 2012). This is evidence that the creature experiences pain (Sneddon et al., 2014). Elwood (2011), reported that there is no neurobiological method to determine whether insects feel pain. Sherwin (2001), reported that the fact that insect brains have a different neuroanatomical structure than mammalian brains does not mean that they are incapable of an emotional response to pain. When attacked or threatened, honey bees release alarm pheromones through vocal and behavioral changes, similar to the responses of more advanced organisms to pain (Eisemann et al., 1984). According to Broom (2013), the scientific data available today is insufficient to clarify whether bees feel pain. We think that when bees are exposed to an overdose of any toxic substance (pesticides, foods), their contraction or writhing during death is an indication that they are in pain.

5. RELATIONSHIP BETWEEN WELFARE AND THE STRUCTURE OF BEE HIVES

Some factors lead to higher yields of honey bees. These factors can be listed as genotype, in-hive factors, temperature control, humidity and ventilation (Abou-Shaara et al., 2017). The hive can be made more comfortable for bees by leaving sufficient spaces for ventilation coupled with the use of materials that can isolate heat and humidity during the construction of the hive. İn these circumstances, it means that bee welfare will be improved. For healthy production during incubation, it is important to maintain the hive's internal temperature between 33-36 ºC. In some regions, there is a high-temperature difference between day and night, and in such cases, worker-bees move from the outer frames to the incubation frames and consume the stock honey to maintain a stable heat or balanced temperature (Petz et al., 2004). It has been stated by researchers that changes in the internal temperature of a hive reduce the incubation rate, change the color of bees and negatively affect the brain development of adult bees (Groh et al., 2004; Ken et et al., 2005). Taha (2014), reported that incubation performance, honey and pollen stock were higher in hives made from foam and wood materials. Erdoğan (2019), compared characteristics such as development during development, hive weight gain, flight activity and honey yield in three different hive models made of wood, polyester and composite insulated material. The results indicated that composite insulated hives were superior for all the measured parameters compared to the rest of the other materials used in the study. A healthy hive structure indicates increased productivity and welfare. Itinerant beekeeping is an important method to increase productivity per colony (Akyol et al., 2019). In regions where itinerant beekeeping is common, beekeeping is usually carried out in high-altitude areas during the summer months. Since there is a temperature difference between day and night in high-altitude areas, there is a change in in-hive activities. Also, bee mortalities are observed during the transportation of beehives to different places. The construction of beehives according to environmental factors will have a positive effect on bee welfare.

6. REPRODUCTION-YIELD-WELFARE RELATIONSHIP

In the production of bees, multiple harvests are made to increase the yield per colony. To increase the number of harvests, bees are forced to work through migratory beekeeping or extra supplementary feeding (Akyol et al., 2019). In beekeeping, hives are constantly moved to temperate regions for the continuous production of offspring. Forcing bees to continuously produce offspring and honey poses risks to bee health and welfare. Swarming is the natural method of reproduction in honey bees and is generally undesirable in beekeeping and honey bees do not produce offspring for some time after swarming, which is said to increase bee welfare (Doublet et al., 2015; Simone-Finstrom et al., 2016).

7. CLIMATE CHANGE-WELFARE RELATIONSHIP

Insects are the most important pollinator organisms of many plant species. Except for cereals, many food crops are almost completely dependent on insects for pollination (Buchmann and Nabhan, 1996; Klein et al., 2007; Ricketts et al., 2008; FAO, 2009). Approximately 73% of the world's cultivated plants are pollinated by bees, 19% by flies, 4% by birds and 4% by other factors (Abrol, 2009). Climatic changes can affect the larval and pupal development stages of bees (Niederegger et al., 2010). Climate change can significantly affect the foraging of honey bees, reproductive cycles and mortality (Switanek et al., 2015). The water content of the soil affects the density of flowering species (Gao et al., 2014; Güneşdoğdu and Şekeroğlu, 2022). Kiming et al. (2020), reported that beekeepers acknowledge the existence of climate change and also indicated a decrease in yield as a result of changes in the climate. In addition, they reported a reduction in plant growth and flowering time. Stockstad (2007), stated that drought and deforestation will increase stress among bees due to insufficient access to their nutrients requirement. Yıldız and Özilgen (2019), reported that a 1°C increase in hive internal temperature due to climate change increased the production of entropy in the body of bees by 1.9 times. This means that increased environmental temperature will cause stress in worker bees. Sudden fluctuations in environmental temperature as a result of climate change caused mortality among forager bees (Giannini et al., 2012). Sudden temperature changes caused paralysis among forager bees (Lighton and Lovegrove, 1990). There is an increase in the adult bee population due to the increase in temperatures during the winter months. Accordingly, early decrease in honey stock and colony losses increase in winter (Fründ et al., 2013).

8. DISEASES/PESTS-WELFARE RELATIONSHIP

Many factors negatively affect honey and the health of bees. Among these factors are parasites and pathogens, which play an important role in scientific research and discussions. The cause of colony losses is a result of multiple factors or reasons. Honeybees are susceptible to various types of pathogens, parasites and pests. Varroa destructor is one of the most difficult external parasites used to control the population of bees and also the most difficult parasite for beekeepers. Today this parasite is present in many countries around the world (Rosenkranz et al., 2010; Nazzi and Le Conte, 2016), and the parasite has no clinical symptoms. However, the disorganization in the enclosed incubation area, crawling and crippling among bees are the main symptoms (Shimanuki et al., 1994). Deformed wing virus (DWV) causes broken wings, a symptom of the varroa parasite. The parasite is very effective in spreading this virus and the virus causes non-fatal infection (Highfield et al., 2009). Nosema ceranae is a health problem underestimated by beekeepers as this endoparasitic microsporidian often has no clear symptoms (vanEngelsdorp and Meixner, 2010). Depending on climate change, the spread and reproduction of these pests may increase or decrease (Le Conte and Navadas, 2008). Pests such as candle moths, wasps, and wax moth may show their effects throughout the year due to the increase in air temperature caused by climate change (Solignac et al., 2005). The effect of climate change on honey yield was compared between 1998 and 2005. It was reported that honey yield decreased by 5.3 kg/colony between these years (Delgado et al., 2012). Flores et al. (2019), reported that the flowering cycle of plants was shortened by three weeks in 2017 compared to 2016. The factors of climate change that will negatively affect the welfare of bees need to be acknowledged and addressed. The factors that cause health problems in honey bees are often interrelated. It is necessary to control these agents without harming or causing stress to the bees. Otherwise, intense disease agents will negatively affect bee welfare.

9. PESTICIDES-WELFARE RELATIONSHIP

Pesticides are chemicals that are used worldwide to prevent or control pests, diseases and weeds in agricultural production (Damalas and Eleftherohorinos, 2011; Çakmak Sancar et al., 2022). The purpose of using these products is to reduce or eliminate yield loss or to maintain product quality. These chemicals cause various harm to the environment, animals and humans. Over the past decade, the effects of pesticides on insect pollinators have been the focus of researchers worldwide (Goulson et al., 2008; Blacquière et al., 2012; Woodcock et al., 2017). The conservation of pollinators is currently of worldwide concern due to the intensive use of pesticides in crop production and the effects of global climate change (Tabur et al., 2022). Insecticides are among the most damaging plant protection products to bees. Neonicotinoids are semi-systematic, neurotoxic and long-active/effective pesticides among the insecticides group (Laurino et al., 2011; Buluş et al., 2020). Neonicotinoids are used extensively against insects that damage crops however, they harm beneficial insects as well (bees, butterflies, etc.) (El Hassani et al., 2008; Elbert et al., 2008). When honey bees are exposed to sub-lethal doses of neonicotinoids, they are known to have side effects such as reduced locomotion and learning abilities (Decourtye et al., 2003; El Hassani et al., 2008). Karahan and Karaca (2016), reported that the main cause of bee mortality is intensive pesticide applications in agricultural production.

10. NUTRITION-WELFARE RELATIONSHIP

Nutrients in the hive are very effective on the health of the individual honey bees and colony development. Honey bees meet all their nutrient needs, especially protein, from nectar, carbohydrate and pollen (Brodschneider et al., 2009). Knowing the nutrient requirements of honey bees (Apis mellifera) and establishing colony populations that are more resistant to diseases by making colony management strategies according to the correct feeding models provide significant benefits in obtaining high yields and preventing colony losses (Sabir et al., 2000). In recent years, the shrinking of plant biodiversity due to climate change has resulted in a prolonged dry season for bees and thus a decrease in colony populations as well as insufficient fatty tissue and a short life span of bees in winter due to protein starvation. Bees need large and suitable pastures. Drought-induced shrinkage of pasture areas will lead to a reduction in bee foraging activities, population development and available food resources (Varol and Yücel, 2019). Water is a very important nutrient in beekeeping for rearing bee larvae or pupa and stabilizing the internal temperature of the hive (Winston, 1987), however, sources of clean water are continuously decreasing due to global climate change. Frizzera et al. (2022), honey bees collect nectar and pollen to meet their nutritional needs. Pollen in particular has a direct impact on the lifespan of bees, the development of the hypopharyngeal glands and the immune system. El Ghbawy et al. (2022), examined the in-colony biological activities of bee candy made with Azolla pinnata seaweed meal and corn pollen. They reported that Azolla pinnata moss was the most effective in terms of brood development, adult bee abdominal fat, development of hypopharyngeal glands, royal jelly production and longevity. Hoover et al. (2022), examined the effect of five commercial pollen substitutes (Global 15% pollen, Global 0% pollen, Bee Pollen-Ate, FeedBee, and HealthyBees) on colonies during the spring season. According to their results, proper protein supplementation before the summer season increases brood rearing. According to Palmer-Young et al. (2023), the increase in sunflower cultivation areas reduced varroa parasites by 28%. In addition, they reported that sunflower pollen and pollen substitute candy were effective in reducing the parasite. The positive effects of bee nutrition products prepared with the right formulation at the right time on colony physiology have been reported by many researchers (DeGrandi-Hoffman et al., 2010; Höcherl et al., 2012; Ullah et al., 2021; Corby-Harris et al., 2022; Dirandeh et al., 2022; Khan et al., 2022; Khan and Ghramh, 2022; Kim et al., 2022).

The biotic and abiotic stress factors of the immune system are enhanced by good nutrition and improve the welfare of honey bees by increasing resistance to diseases and pests (Alaux et al., 2010; Smart et al., 2018). According to studies, it is necessary to prepare liquid or solid feeding methods in honey bees on time and with appropriate formulations. As a result, there is an increase in yield per colony and an increase in excess substances such as vitollegenin in the body of adult bees. Based on previous studies, it is possible to say that good nutrition increases bee welfare however, poor nutrition will negatively affect welfare.

11. HONEYBEES WELFARE-LEGAL ASPECTS

In accordance with Art. 4 point 2 of the Act on the Protection of Animals, “humane treatment of animals” means treatment that takes into account the animal’s needs and provides care and protection (Anonymous, 2010). The welfare laws of most countries do not cover insects. Therefore, no legal regulation on the welfare of bees has been found in the literature.

12. CONCLUSION AND ROCOMMENDATIONS

Honey bees are considered to be super-organisms because of their marvelous regular and efficient activities inside and outside the colony. These activities create complexity in the assessment of well-being. The following suggestions were made regarding bee welfare;

1. Beekeeping practices between countries should be given much attention,
2. The most suitable hive model for bee welfare worldwide should be determined and a standard should be established,
3. Reduction in the use of pesticides in crop production that kill bees,
4. The intensity of bee-related diseases and pests in colonies should be kept under control and the control methods should not consist of products that cause stress or death in bees,
5. Bees should not be forced into intensive production,
6. Supplementary feeds that are very suitable for the physiology of bees should be produced,
7. Long-term transportation of colonies should be avoided,
8. Measures should be developed to eliminate the negative effects of global warming,
9. Beekeepers should be trained in welfare and management practices,
10. There should be an increase in bee flora resources.

REFERENCES

Abrol, D.P. (2009). Plant-pollinator interactions inthe context of climate change - an endangered mutualism. Journal of Palynology, 45:1-25.

Abou-Shaara, H.F., Owayss, A.A., Ibrahim, Y.Y., Basuny, N.K. (2017). A review of impacts of temperature and relative humidity on various activities of honey bees. Insectes Sociaux, 64:455.463.

Aebi, A., Vaissie`re, B.E., vanEngelsdorp, D., Delaplane, K.S., Roubik, D.W., Neumann, P. (2012). Back to the future: Apis versus non-Apis pollination: a response to Ollerton et al. Trends Ecol. Evol., 27: 142–143. doi:10.1016/j.tree.2011.11.017.

Akyol, E., Güneşdoğdu, M., Ceyhan, A. (2019). A new hive model that increases the colony productivity. Turkish J. Agric. – Food Sci. Tech., 7(sp1): 183-185.

Alaux, C., Ducloz, F., Crauser, D., Le Conte, Y. (2010). Diet effects on honeybee immunocompetence. Biology letters, 6(4): 562-565.

Anonymous, 2010. Journal of Laws of 2010, No. 56, pos. 344, as amended.

Blacquière, T., Smagghe, G., van Gestel, C.A.M., Mommaerts, V. (2012). Neonicotinoids in bees: a review on concentrations. side-effects and risk assessment. Ecotoxicology, 21: 973–992. https://doi.org/10.1007/s10646-012-0863-x.

Bozkurt, Z. (2019). The walfare of honey bees'', J. Bahri Dagdas Anim. Res., 8(2): 96-108.

Brodshneider, R., Reissberger-Galle, U., Crailsheim, K. (2009). Flight performance of artificially reared honeybees (Apis mellifera). Apidologie, 40: 441-449.

Broom, D.M. (2013). The welfare of invertebrate animals such as insects, spiders, snails and worms. In animal suffering: From science to law, intern. 4 Symp., ed. Kemp, T.A., van der and Lachance, M., 135-152.

Buchmann, S.L., Nabhan, G.P. (1996). The forgotten pollinators, Island Press, Shearwater books, Washington DC.

Bullock, T.H., Orkand, R., Grinnell, A. (1977). Introduction to nervous systems. San Francisco, CA: W. H. Freeman.

Buluş, İ.Y., Uzun, A., Demirözer, O., Gösterit, A. (2020). Effects of Acetamiprid on Brood Development in Bumblebees. Bombus terrestris. J. Faculty Agric., 15(1): 91-99.

Butz Huryn, V.M. (1997). Ecological impacts of introduced honey bees. Q. Rev. Biol., 72: 275–297. doi:10.1086/419860.

Corby-Harris, V., Snyder, L., Meador, C., Watkins-DeJong, E., Obernesser, B.T., Brown, N., Carroll, M. (2022). Diet and pheromones interact to shape honey bee (Apis mellifera) worker physiology. J. Insect Phys., 143: 104442.

Çakmak Sancar, B., Akhan, M., Öztürk, M., Ergün, Ö. (2022). Pesticide residues in vegetables and fruits from Istanbul by LCMS/MS. Harran Tarım ve Gıda Bilimleri Dergisi, 26(3): 302-315. DOI:10.29050/harranziraat.1063811.

Damalas, C.A., Eleftherohorinos, I.G. (2011). Pesticide exposure, safety issues and risk assessment indicators. Inter. J. Envir. Res. Public Health, 8:1402-1419. DOİ: https://doi.org/10.3390/ijerph8051402.

Decourtye, A., Lacassie, E., Pham- Delegue, M.H. (2003). Learning performances of honeybees (Apis mellifera L.) are differentially affected by imidacloprid according to the season. Pest Management Science, 3: 269–278.

DeGrandi-Hoffman, G., Chen, Y., Huang, E., Huang, M.H. (2010). The effect of diet on protein concentration, hypopharyngeal gland development and virus load in worker honey bees (Apis mellifera L.). J. Insect Phys., 56: 1184-1191.

Delgado, D.L., Perez, M.E., Galindo-Cardona, A., Giray, T., Restrepo, C. (2012). Forecasting the influence of climate change on agroecosystem services: Potential Impacts on Honey Yields in a Small-Island Developing State. Psyche, 1-10.

Dirandeh, E., Mahtabi, M, Jafari Satadi, A., Dadgostar S.H. (2022). The effect of egg yolk powder on functional, biological and pathogenic traits in bee colonies. Veterinary Researches & Biological Products, 136: 86-91.

Doublet, V., Labarussias, M., de Miranda, J.R., Moritz, R.F.A., Paxton, R.J. (2015). Bees under stress: Sublethal doses of a neonicotinoid pesticide and pathogens interact to elevate honey bee mortality across the life cycle. Environmental Microbiology, 17: 969–983.

Duchaine, B.C., Dingle, K., Butterworth, E. Nakayama, K. (2004). Normal greeble learning in a case of development prosopagnosia. Neuron., 43: 469-473.

Dyer, A.G., Neumeyer, C., Chittka, L. (2005). Honeybee (Apis mellifera) vision can discriminate between and recognise images of human faces, J. Exper. Biol., 208: 4709-4714.

Eisemann, C.H., Jorgensen, W.K., Merritt, D.J., Rice, M.J., Cribb, B.W., Webb, P.D., Zalucki M.P. (1984). Do insects feel pain? A biological view. Experientia, 40:164-167.

El Ghbawy, I.A., Omar, R.E., Khattab, M.M., Nowar, E.E. (2022). The novelty of azolla pinnata as a promising alternative feed for honeybee, Apis mellifera (L.). Egypt. Acad. J. Biolog. Sci. (A. Entomology), 15(2): 35-49. doi: 10.21608/EAJBSA.2022.241766.

El Hassani, A.K., Dacher, M., Gary, V., Lambin, M., Gauthier, M., Armengaud, C. (2008). Effects of sublethal doses of acetamiprid and thiamethoxam on the behavior of the honeybee (Apis mellifera). archives of environmental contamination and toxicology, 4: 653–661.

Elbert, A., Haas, M., Springer, B., Thielert, W., Nauen, R. (2008). Applied aspects of neonicotinoid uses in crop protection. Pest Management Science, 11: 1099– 1105.

Elwood, R.W. (2011). Pain and suffering in invertebrates? ILAR Journal, 52: 175-184.

Elwood, R.W. (2019). Assessing the potential for pain in crustaceans and other invertebrates. In The Welfare of Invertebrate Animals. Springer, Cham.

Erdoğan, Y. (2019). Comparison of colony performances of honeybee (Apis mellifera L.) housed in hives made of different materials. Italian J. Anim. Sci., 18(1):934-940.

FAO. (2009). Bees and their role in forest livelihoods: A guide to the services provided by bees and the sustainable harvesting, processing and marketing of their products Rome.

Flores, J.M., Gil-Lebrero, S., Gamiz, V., Rodriguez, M.I., Ortiz, M.A., Quiles. F.J. (2019). Effect of the climate change on honey bee colonies in a temperate mediterranean zone assessed through remote hive weight monitoring system in conjunction with exhaustive colonies assessment. Science of the Total Environment, 653: 1111–1119.

Frizzera, D., Ray, A.M., Seffin, E., Zanni, V., Annoscia, D., Grozinger, C.M., Nazzi, F. (2022). The beneficial effect of pollen on varroa infested bees depends on its influence on behavioral maturation genes. Front. Insect Sci. 2:864238. doi: 10.3389/finsc.2022.864238.

Fründ, J., Zieger, S.L., Tscharntke, T. (2013). Response diversity of wild bees to overwintering temperatures. Oecologia, 173(4): 1639-1648.

Gao, X.,Wu, P., Zhao, X., Wang, J., Shi, Y. (2014). Effects of land use on soil moisture variations in a semi-arid catchment: implications for land and agricultural water management. Land Degradation & Development, 25(2): 163-172.

Garrido, C., Nanetti, A. (2019). Welfare of managed honey bees. In The Welfare of Invertebrate Animals. Springer, Cham.

Giannini, T.C., Acosta, A.L., Garófalo, C.A., Saraiva, A.M., Alves-dos-Santos, I., Imperatriz-Fonseca, V.L. (2012). Pollination services at risk: Bee habitats will decrease owing to climate change in Brazil. Ecol. Model, 244: 127–131.

Goulson, D., Lye, G.C., Darvill, B. (2008). Decline and conservation of bumble bees. Annual Review of Entomology, 53: 191–208.

Gösterit, A., Gürel, F. (2005). Effects of the spread of bombus terrestris (Hymenoptera: Apidae) Bees on the ecosystem. U. Bee. J., 5(3): 115–121.

Groh, C., Tautz, J., Rossler, W. (2004). Synaptic organization in the adult honey bee brain is influenced by brood-temperature control during pupal development. Proc. Natl. Acad. Sci. USA. 101: 4268–4273.

Güneşdoğdu, M., Şekeroğlu, A. (2022). Interaction between honeybee and global climate change. Practical Agriculture and Reflections of Sustainability, Çavuşoğlu Ş., Uzun Y. (ed.), İksad Publishing House, 287-311, Ankara/TURKEY.

Highfield, A.C., El Nagar, A., Mackinder, L.C.M. et al. (2009). Deformed wing virus implicated in overwintering honeybee colony losses. Appl. Environ. Microbiol., 75:7212–7220. https://doi.org/10.1128/AEM.02227-09.

Hoover, S.E., Ovinge, L.P., Kearns, J.D. (2022). Consumption of supplemental spring protein feeds by western honey bee (Hymenoptera: Apidae) colonies: Effects on colony growth and pollination potential. J. Eco. Entom., 115(2): 417-429.

Horvath, K., Angeletti, D., Nascetti, G., Carere, C. (2013). Invertebrate welfare: an overlooked issue. Ann. Ist. Super. Sanità., 49(1): 9-17.

Höcherl, N., Siede, R., Illies, I., Gatschenberger, H., Tautz, J. (2012). Evaluation of the nutritive value of maize for honey bees. J. Insect Phys., 58: 278-285.

Johnson, W.A., Carder, J.W. (2012). Drosophila nociceptors mediate larval aversion to dry surface environments utilizing both the painless TRP channel and the DEG/ENaC subunit, PPK1. PLoS One, 7: e32878.

Kanwisher, N. (2000). Domain specificity in face recognition. Nat. Neurosci., 3: 759-763.

Karahan, A., Karaca, İ. (2016). Beekeeping activities and honey bee colony loses in Adana and Konya Provinces. Süleyman Demirel Uni. J. Natural and Applied Sciences, 20(2): 226-235. DOI: 10.19113/sdufbed.07632.

Ken, T., Bock, F., Fuchs, S., Streit, S., Brockmann, A., Tautz, J. (2005). Effects of brood temperature on honey bee Apis mellifera wing morphology. Acta Zool. Sin., 51: 768–771.

Khan, K.A., Ghramh, H.A. (2022). Nutritional efficacy of different diets supplemented with microalga arthrospira platensis (spirulina) in honey bees (Apis mellifera). J. King Saud Uni.-Sci., 34: 101819.

Khan, K.A., Ghramh, H.A., Ahmad, Z. (2022). Honey bee (Apis mellifera jemenitica) colony performance and queen fecundity in response to different nutritional practices. Saudi J. Biolog. Sci., 29: 3151-3156.

Kim, H.J., Hwang, J., Ullah, Z., Mustafa, B., Kwon, H.W. (2022). Comparison of physicochemical properties of pollen substitute diet for honey bee (Apis mellifera). J. Asia-Pacific Entm., 25: 101967.

Kiming, I.N., Moye, E.K., Jude, K., (2020). Mountain apiculture and environmental dynamics: Impact of climate variability on bee farming in OKU, Cameroon. International Journal of Environmental, Sustainability, and Social Science, 1(3), 01-11. https://doi.org/10.38142/ijesss.v1i1.33.

Klein, A.M., Vaissière, B., Cane, J.H., Steffan-Dewenter, I., Cunningham, S.A., Kremer, C., Tscharntcke, T. (2007). Importance of pollinators in changing landscapes for world crops. Proc. R. Soc. London B., 274: 303–313.

Klein, A.M., Vaissière, B.E., Cane, J.H., Steffan-Dewenter, I., Cunningham, S.A., Kremen, C., Tscharntke, T. (2007). Importance of pollinators in changing landscapes for world. Crops. Proc. R. Soc. B Biol. Sci., 274: 303–313. https://doi.org/10.1098/rspb.2006.3721.

Laurino, D., Porporato, M., Patetta, A., Manino, A. (2011). Toxicity of neonicotinoid insecticides to honey bees: Laboratory Tests. Bulletin of Insectology. 64(1): 107–113.

Le Conte, Y., Navajas, M. (2008). Climate change: impact on honey bee populations and diseases. Rev. Sci. Tech. Off. Int. Epiz., 27 (2) :499-510.

Lighton, J.R.B., Lovegrove, B.G. (1990). A temperature-induced switch from diffusive to diversity in Europe. proceedings of national academy of sciences USA, 102 (23) :8245-8250.

Main, A.R., Hladik, M.L., Webb, E.B., Goyne, K.W., Mengel, D. (2020). Beyond neonicotinoids – wild pollinators are exposed to a range of pesticides while foraging in agroecosystems. Science of the Total Environment, 742: 140436.

Nazzi, F., Le Conte, Y. (2016). Ecology of varroa destructor, the major ectoparasite of the western honey bee, Apis mellifera. Annu. Rev. Entomol., 61:417–432. https://doi.org/10.1146/annurevento-010715-023731.

Niederegger, S, Pastuschek, J, Mall, G. (2010). Preliminary studies of the influence of fluctuating temperatures on the development of various forensically relevant flies. Forensic Science International 199(1–3): 72–78.

Ollerton, J., Winfree, R., Tarrant, S. (2011). How many flowering plants are pollinated by animals? Oikos, 120: 321–326. doi:10.1111/j.1600-0706.2010.18644.x.

Palmer-Young, E.C., Malfi, R., Zhou, Y., Joyce, B., Whitehead, H., Van Wyk. J.I., Baylis, K., Grubbs, K., Boncristiani, D.L., Evans, J.D., Irwin, R.E., Adler, L.S. (2023). Sunflower-associated reductions in varroa mite infestation of honey bee colonies, J. Eco. Entom., 116(1): 68-77.

Petz, M., Stabentheiner, A., Crailsheim, K. (2004). Respiration of individual honeybee larvae in relation to age and ambient temperature. J. Compar. Physiol. B., 174: 511–518.

Potts, S.G., Imperatriz-Fonseca, V., Ngo, H.T., Aizen, M.A., Biesmeijer, J.C., Breeze, T.D., Dicks, L.V., Garibaldi, L.A., Hill, R., Settele, J., Vanbergen, A.J. (2016). Safeguarding pollinators and their values to human well-being. Nature, 540: 220–229. https://doi.org/10.1038/nature20588.

Ricketts, T.H., Regetz, J., Steffan-Dewenter, I., Cunningham, S.A., Kremen, C., Bogdanski, A., Gemmill-Herren, B., Greenleaf, S.S., Klein, A.M., Mayfield, M.M., Morandin, L.A., Ochieng, A., Viana, B.F. (2008). Landscape effects on crop pollination services: are there general patterns? Ecol. Lett. 11(5): 499–515.

Rosenkranz, P., Aumeier, P., Ziegelmann, B. (2010). Biology and control of varroa destructor. J. Invertebr. Pathol., 103: 96-119. https://doi.org/10.1016/j.jip.2009.07.016.

Sabir, A.M., Suhail, A. Akram, W., Sarwar, G., Saleem, M. (2000). Effect of some pollen substitute diets on the development of Apis mellifera L. colonies. Pakistan Journal of Biological Sciences, 3(5): 890-891.

Seeley, T.D. (2019). The lives of bees: the untold story of the honey bee in the wild. Princeton University Press.

Sherwin, C.M. (2001). Can invertebrates suffer? Or, how robust is argument-byanalogy. Animal Welfare, 10(Suppl.): 103-118.

Shimanuki, H., Calderone, N.W., Knox, D.A. (1994). The parasitic mite syndrome: the symptoms. Am. Bee J., 134:117–119.

Simone-Finstrom, M., Li-Byarlay, H., Huang, M.H., Strand, M.K., Rueppell, O., Tarpy, D.R. (2016). Migratory management and environmental conditions affect lifespan and oxidative stress in honey bees. Scientific Reports, 6:32023.

Slater, P.J.B. (1989). The encyclopedia of animal behavior, 2nd ed. New York: Facts on File, pp. 2-10.

Smart, M., Otto, C., Cornman, R., Iwanowicz, D. (2018). Using colony monitoring devices to evaluate the impacts of land use and nutritional value of forage on honey bee health. Agriculture, 8(1): 2.

Sneddon, L.U., Elwood, R.W., Adamo, S.A., Leach, M.C. (2014). Defining and assessing animal pain. Animal Behaviour, 97: 201-212.

Solignac, M., Cornuet, J.M., Vautrin, D., Le Conte, Y., Anderson, D., Evans, J., Cros-Arteil, S., Navajas, M. (2005). The invasive Korea and Japan types of varroa destructor, ectoparasitic mites of the western honeybee (Apis mellifera), are two par tly isolated clones. Proceedings of Royal Society of London, Biological Sciences, 272 (1561): 411-419.

Stockstad, E. (2007). The case of the empty hives. Science, 316 (5827): 970-972.

Switanek, M., Brodschneider, R., Crailsheim, K., Truhetz, H. (2015). Impacts of Austrian climate variability on honey bee mortality. Geophysical research abstracts, 17: 9575-1.

Tabur, Z., Ceritoğlu, F., Güneşdoğdu, M., Gül, A., Şekeroğlu, A. (2022). Analysis of citrus (Citrus Spp.) farmer's susceptibility to honey bees (Apis mellifera L.) in flowering period pesticide use. Academic studies on the sustainable dynamics of agriculture and livestock, Kökten K., İnci H. (ed.), İksad Publishing House, 431-452, Ankara/TURKEY.

Taha, A.A. (2014). Effect of hive type on strength and activity rate of honeybee colonies (Apis mellifera L.) in Egypt. J. Plant. Prot. Path. Mansoura Univ., 5: 773–784.

Tibbetts, E.A. (2002). Visual signals of individual identity in the wasp polistes fuscatus. Proc. R. Soc. Lond. B., 269: 1423-1428.

Tibbetts, E.A., Dale, J. (2004). A socially enforced signal of quality in a paper wasp. Nature, 432: 218-222.

Ullah, A., Shahzad, M.F., Iqbal, J., Baloch, M.S. (2021). Nutritional effects of supplementary diets on brood development, biological activities and honey production of Apis mellifera L. Saudi J. Biolog. Sci., 28: 6861-6868.

Ünal, N. (2010). Measuring animal welfare in aquaculture. III. National Veterinary Animal Science Congress, Afyon/TURKEY, pp. 100.

van Engelsdorp, D., Meixner, M.D. (2010). A historical review of managed honey bee populations in Europe and the United States and the factors that may affect them. J. Invertebr. Pathol., 103:80–95. https://doi.org/10.1016/j.jip.2009.06.011.

Varol, E., Yücel, B. (2019). The effects of environmental problems on honey bees in view of sustainable life. Mellifera, 19(2): 23-32.

Winston, M.L. (1987). The biology of the honey bee. Harvard University Press, Cambridge.

Woodcock, B.A., Bullock, J.M., Shore, R.F., Heard, M.S., Pereira, M.G., Redhead, J., Ridding, L., Dean, H., Sleep, D., Henrys, P., Peyton, J., Hulmes, S., Hulmes, L., Sárospataki, M., Saure, C., Edwards, M., Genersch, E., Knäbe, S., Pywell, R.F. (2017). Country-specific effects of neonicotinoid pesticides on honey bees and wild bees. Science, 356: 1393-1395.

Yaşar, A. (2005). Animal welfare education at Selcuk University Faculty of Veterinary Medicine. First Animal Welfare and Veterinary Medicine Education Conference in Turkey, Ankara/TURKEY, pp. 37.

Yildiz, C., Özilgen, M. (2019). Thermodynamic assessment of the impact of the climate change on the honeybees. Int. J. Global Warming, 17(2): 185–218.

CHAPTER 14

PRINCIPLES OF ANIMAL WELFARE AND RECENT DEVELOPMENTS

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1. INTRODUCTION

In hunter-gatherer life, societies used animals to meet their fundamental needs, such as nutrition and protection, carry loads, and benefit from labour. Over time, human-animal interaction has changed direction, and animals have become more understandable. In this period, better observation of animal manners led to increased interaction in animal communication. Thus, interest and questions about the lifestyles and behaviour of animals have increased (Akbaş, 2013). As a result of a better understanding of their manners over time, the domestication process began with animals, and according to their behaviour, animals were divided into categories such as wild animals, farm animals, and pets.

As part of human history, it is known that our relationship with animals has changed over time. Until the 20th century, the interaction between humans and farm animals was more important in using animal labour and meeting people's nutrition needs. Wild animals, on the other hand, have been the subject of hunting activities as a means of entertainment and sports. The adoption of domestic animals and the increasing importance given to farm animals has evolved from when animals were only served to humans to a modern understanding that animals should have their own rights. Like humans, the increased sensitivity to animals' rights has led to the criticism of some livestock practices and studies to improve these implementations. (Külcü, 2022).

Regardless of the purpose of animal breeding, rights protection and improvement are possible with animal welfare regulations. For this reason, the concept of animal welfare, its origin, and welfare practices is an important issue that needs to be examined in detail.

2. THE CONCEPT AND ORIGIN OF ANIMAL WELFARE

The meaning of the word welfare, according to the Turkish Language Association, is “living in abundance and comfort”; according to the Cambridge dictionary “health, well-being, happiness,” and according to economists, it is “responding to an existing demand and meeting the needs” (Erdal, 2012; TDK, 2023; Cambridge Dictionary, 2023). On the other hand, animal welfare can be defined as the situation in which the morphological and physical structure of animals adapts to their environment, and their emotional behaviour can be sustained without showing any signs of stress in the background. Additionally, animal welfare is defined as "providing the health, happiness, and well-being of all kinds of animals without suffering during the care, feeding, animal housings, reproduction, transportation, slaughter or use for scientific purposes" (Şanlı, 2018). Animal welfare is defined in the Brambell Report (1965) as "the physical and mental well-being of animals," and by Broom (1986) as the ability of animals to cope with their environment, and by Fraser (1998) as the "state of well-being" of animals. It is known that animal behaviour is of great importance in improving animal welfare (Akbaş, 2013).

The first recorded meaningful expression of the concept of animal welfare was stated by Sir W. Blackstone in 1822 as "the flogging and torture of animals should not be allowed" (Blackstone, 1822). However, the term animal welfare was later included in the Brambell Report in 1965 and gained a broader definition (Brambell, 1965). The Brambell Report emphasizes that not only the physical needs of animals but also their emotional and behavioural entails should be considered; five essential points presented in the Brambell report, a big step towards ensuring animal rights and welfare, have made this report an internationally accepted discipline. Essential items to be considered to eliminate the bad conditions that animals are exposed to;

- Not to suffer from hunger and thirst, to reach clean water and healthy forages,
- Providing barns or other animal housings, resting areas created under appropriate conditions,
- Keeping animals free of pain, injury, and disease through prevention and prompt treatment,
- To ensure that animals interact with animals of their species and have adequate opportunities for their lives,
- Consideration should be given to factors keeping animals away from fear and stress (Brambell, 1965; Antalyalı, 2007).

3. FUNDAMENTAL CONDITIONS FOR ANIMAL WELFARE

There are different criteria determined to ensure animal welfare. These criteria come together to form animal welfare. Welfare Quality (2009) states that "good housing, good nutrition, being healthy and appropriate behavioural factors should be provided for animal welfare to be in question". In more detail, the study by Capucchio et al. (2019) states that climatic changes, breeding techniques, animal herd management, feeding and animal accommodation environments may affect animal welfare positively or negatively (Capuchio et al., 2019).

Table. 1. Essential Factors For Animal Welfare (Welfare Quality, 2009; Sert and Uzmay, 2017; Külcü, 2022)

Good Housing	• The barns and other housings areas where animals rest must be comfortable. • The Animal housing environment must be at a suitable temperature. • Animals' movements should be comfortable in the housing area without being restricted. • Animals must have barns and other animal housings environments where animals will not be injured
Good nutrition	• Animals must not be left famishment for a long time • Must not leave animals without water for a long time
Good Health	• Animals must not be harmed. • Animals must not be injured or harmed due to farm management • Precautions must be taken to prevent animals from getting the illness.
Appropriate Behaviour	• Expression of social behaviors • A good human-animal relationship • Positive emotional state • Other behaviors

3. 1. Fundamental Requirements in Animal Welfare

3. 1. 1. Animal housing

Inadequate animal housing conditions cause harmful effects on animal welfare and stress in animals and thus yield losses (Altınçekiç and Koyuncu, 2012a). In order to ensure animal welfare, issues such as habitat, movements, and the effectiveness of breeding activities should be given importance (Koyuncu and Altınçekiç, 2007; Yener et al., 2013; Özdemir and Singin, 2016).

Bovine, small ruminants, poultry fish and other sea creatures are essential to provide raw materials for the nutrition, agriculture, and textile sectors. It helps to provide suitable housing conditions for the animals in question, for the animals to live on welfare, and, therefore, to increase the yield and quality of the products.

Due to their nature, farm animals such as cattle, sheep, and goats can live in closed areas or wide and open spaces. For this reason, secure barns and sheep pens must be sheltered, clean, dry, and ventilated. The temperature also must be suitable for the animal's needs to provide sunbathing. For instance, for cattle barn construction, the airflow should be 0.2-0.5 m/s, and the lighting should be 20-25 Watts per square meter (Akbay, 2010; Usta, 2011). Sheep pens should be built in the east, south, or southeast direction so the sheep and goats can get the necessary lighting.

The condition of the barns and sheep pens floor is another factor that affects animal welfare. The most common ailment in farm animals is foot problems. Using comfortable and clean materials on the barn floor positively affects animal welfare by reducing the sleeping behaviour of animals, lameness, and other foot problems (Elmore et al. 2010.) It is known that rubber floors affect the behaviour and health of animals positively, and cattle, sheep, and goats prefer rubber floors (Vanegas et al., 2006; Absmanner et al., 2009; Elmore et al., 2010; Usta, 2011). In environments where breeding is carried out in accordance with animal welfare conditions, providing a comfortable living space for animals also protects against infectious diseases. In addition, rest areas where animals can move comfortably, feeders and temperature requirements are important factors supporting animal welfare.

Table 2. Environmental Demands of Small Ruminant and Bovine (Cemek and 2011; MEGEP, 2015; Göncü et al., 2016; Claffey, 2017; Ward and Mckague, 2023)

	Housing area	Temperature Requirements
Sheep	• Suckling lamb: 0,3m²-0,4m² • Yearing lamb: 0,5m²-0,6m² • Sheep: 0,8m²-1m² • Ram: 1,2m²-1,5m² • Pregnant ewe: 2m²-2,5m²	• +13°C – (+14) °C
Goat	• Goat: 0,75m²-1m² • Goat and kid: 1,25m2- 1,5m2 • Male goat: 3m²-4m²	• Closed area: +6°C-+12 °C • Gestation: 10°C–(+14) °C
Calf	• 150kg < 1,5 m² • 150 < kg < 220: 1,7m² • < 220 kg: 1,8m²	• 10°C - +26 °C
Bovine	• Lactation Period: 2,5m2- 3m2 • After Lactation: 1,2m2-1,5m2 • 275kg < : 1,2m²-1,5m² • < 275 kg: 2m²-4m²	• -18 °C-24+ °C • Dairy Cattle:+5°C-(+20) °C

In environments where aquaculture is carried out under animal welfare conditions, animals must be provided with a comfortable living space and protection against infectious diseases. In order to improve the welfare of aquatic products, especially those grown in cages, it is important to take precautions by paying attention to factors that significantly affect the health and shelter of marine creatures, such as ammonia, CO_2 and nitrite concentration in water (Bildirici and Bildirici, 2021). It is important to note that stocking fish species grown in aquaponic environments significantly affects the welfare of fish and other aquatic products, and therefore, care should be taken to prepare the housing environment in line with the needs of each stocked fish species (Giménez-Candela et al. 2020; Bildirici ve Bildirici, 2021). Sensitivity and studies on animal welfare are increasing and developing day by day. Although studies are mostly carried out for the welfare of land creatures, in recent years, studies have also been carried out to increase the welfare of aquatic products (Toni et al. 2018). So, it is aimed to protect the population and environment in the underwater world.

3.1.2. Animal Nutrition

Bovine and small ruminants need to have a balanced and nutritious ration so that they can develop healthily and be productive.

Since sheep, goats, cattle and buffalos are herbivores, sufficient amounts of fresh grass, hay and feed must be provided. At the same time, sufficient grazing land is needed. However, forcing animals to graze in inadequate meadow-pasture conditions, insufficient time allocated to grazing, and decreasing nutritional value of grasses depending on the vegetation period of meadow-pasture plants reduce the efficiency that animals can obtain from the grazing system (Kaya et al. 2011). For this reason, ruminant animals, which need high-quality protein and energy, must be fed with appropriate feed and benefit from meadows and pastures at the most efficient time, depending on the species' needs. When we evaluate it in terms of farm animals, It is known that feeds should contain sufficient protein, carbohydrates, fat, minerals, vitamins and water for ruminant animals (Mayulu et al. 2019). Quality animal feed is crucial in increasing meat yield, especially in cattle, and in making profits for cattle breeding enterprises (Yakin et al. 2012). Although meadow grass is the most suitable grass for the health and welfare of cattle, 60% roughage and 40% concentrated feed should be used (HAYGEM, 2017). Sheep should be fed high-quality meals with low copper levels (Antalyalı, 2007; Çavuşoğlu and Akyürek, 2017). On the other hand, it is known that goats, unlike sheep and cattle, consume more bushes and weeds than quality feed (Koyuncu, 2006).

It is known that ruminant animals such as cattle, sheep and goats need time to digest the feed they eat. For this reason, they need comfortable environments and feeders with sufficient space. In cattle, the feed path is expected to be 80 cm-100 cm, and the feed trough width is expected to be 60 cm-80 cm (Kurç and Kocaman, 2016). The length and width of the trough for suckling lambs should be 18 cm; for one-year-old lambs, the length and width of the trough should be 30 cm and 30-35 cm, respectively; and for ewes, the length and width of the trough should be 35-45 cm and 35-40 cm, respectively (Alkan, 1972). In addition, the length and width of the trough for pregnant ewes should be 60 cm and 40-45 cm, respectively, and for breeding rams, the length and width of the trough should be 80 cm (Alkan, 1972). Otherwise, nutritional problems occur, negatively affecting the animals' welfare.

As in all living things, nutrition is the most basic need for survival in small and large animals. Nutrition in the right amount and form is the main factor in protecting against diseases and avoiding other harmful situations. Animal feeding programs should be arranged according to their age, whether they are male or female, reproduction and physical activity. In addition to nutrition, water is the most essential substance that supports the digestion of animals, provides hydration and regulates the metabolic functions of animals. Animals such as cattle, sheep and goats are herbivores, so they have mobile bodies, and their bodies consume approximately 5% of their body weight in water per day (Hogan et al. 2007). Determining the appropriate amount of feed and clean water required for feeding will keep animals away from stress and reduce nutritional stress factors, and animal welfare will increase accordingly.

On the other hand, the water quality in which fish and other edible aquatic organisms thrive, being rich in omega-3 and protein, holds a significant place at the dinner table. This ensures the maintenance of adequate nitrogen-oxygen balance, monitoring of growth cycles, determination of the correct feed formulation required for nutrition, and providing necessary welfare conditions (Yıldız et al., 2017). Underfeeding or overfeeding fish negatively affects their well-being. It is known that food residues in the feeding and sheltering environments of overfed aquatic products will negatively affect the health and, therefore, the welfare of aquatic products. It is stated that, especially in some fish species, the welfare and health of fish are negatively affected due to lipid accumulation due to overfeeding in the livers (Giménez-Candela et al. 2020).

Table 3. Water Demands and Nutrition Times of Small Ruminants and Bovine (Lyons and Machan, 2007; Arslan, 2007; Cemek et al., 2011; Göncü et al., 2016; HAYGEM, 2016; Çavuşoğşu and Akyürek, 2017; Ward and Mckague, 2023)

	Daily Water Consumption Need	Daily Feeding Times
Sheep	• Suckling lamb: 3,6 kg -5 kg • Pregnant ewe: 4 kg- 6.5 kg • Lactating sheep: 9 kg -10.5 kg • Ram and sheep: 7,6 kg	• 3-5 hours in the morning • 3 hours in the afternoon • 9-11 hours in total with intermediate grazing
Goat	• 1,4 kg – 3,5 kg	• Twice a day • 4-7 hours
Calf	• 1-4 months: 5kg -13kg • 5- 24 months: 14kg-36kg	• Up to 5% of body weight (BW) immediately after birth • 5% of BW 6 hours after birth • 6% of BW from birth to day 5 (three times a day) • Between Day 5 and Day 14 10 kg calf starter 2 times a day • 15th day - until weaning 10 kg of calf starter 2 times a day • After the 60th day, 1% of the calf's weight is starter feed and grain crushing.
Cattle	• In lactation period: 90 kg-100 kg • Bull: 36 kg -54 kg	• 3-5 hours in the morning • 3 hours in the afternoon • Average between 6.6 hours and 10.8 hours

3. 1. 3. Health

The health of farm animals such as cattle, sheep, and goats directly affects their welfare. Just like in almost all animals, regular veterinary checks are essential for large and small ruminants, fish, and other aquatic organisms to understand their health status and reduce or eliminate stress factors depending on their conditions. Implementing necessary quarantine measures for sick animals helps prevent the spread of diseases within the operation and the stress experienced by other animals. Establishing a regular parasite control and vaccination schedule is fundamental to ensuring animal health.

Additionally, hygiene measures that directly impact animal welfare must be taken. Cleaning housing areas and animal bedding reduces the risk of disease and improves animal welfare.

Like cattle and sheep, fish also experience pain, distress, and stress (Yıldız and Veske, 2007). It has been observed that stress leads to changes in fish behaviour, such as alterations in activity, avoidance, and feeding (Schreck et al., 1997). Vaccination, tagging, and chemical exposure can adversely affect fish health and welfare (Yıldız and Veske, 2007). Therefore, considering all these factors, improving the welfare of farm animals and aquatic organisms reduces the risk of disease and enhances animal welfare.

Another health factor affecting animal welfare is keeping animals free from stress. Many factors trigger stress, including but not limited to food scarcity, thirst, illness, extreme temperature values, unexpected noises, air pollution, and inadequate shelter. For instance, water and food scarcity are significant sources of stress in farm animals (Akbaş, 2013). In fish, the absence of water quality, vaccination, and classification practices can cause pain and stress, negatively affecting fish welfare. Additionally, heat stress disrupts the reproduction, productivity, and metabolism of cattle, adversely impacting animal welfare (Alkoyak and Çetin, 2016). It is also known that inappropriate treatment by farmers reduces milk yield in dairy animals (Rushen et al., 1999). Furthermore, keeping animals away from stressful and noisy environments and promoting social interactions within the herd reduces stress. Supporting the natural behaviours of animals is essential for their welfare and health. Healthy animals are more resilient to diseases and are more productive. This, in turn, contributes to the health of both animals and humans by producing healthy animal products.

3. 1. 4. Appropriate Behaviour

Socializing is not a behaviour unique to human communities. Meeting the environmental needs of animals increases their welfare and therefore their productivity. Since cattle and sheep are social creatures, they live more efficiently in areas where they feel comfortable and safe.

It is important for them to live in flocks or groups, play among themselves, and maintain social communication. Each herd has a leader who is responsible for its safety and movements (Özdemir and Kaptan, 2013;

Brunberg et al. 2020). Living in a herd allows animals to feel safe and live stress-free. When animals exhibit their natural behaviour, it supports an increase in their welfare level. Play behaviour in animals is one of them. It is known that play behaviour positively affects animal welfare (Boissy et al. 2007; Held and Špinka, 2011).

While animal welfare is evaluated under the light of science, it is evaluated in biological, natural life and sensory situations (Fraser, 2003). Some factors must exist for the positive sensory states of animals to positively affect their well-being (Duncan, 2002). Important environmental conditions such as temperature, humidity, ventilation, light, radiation, feeding, access to clean water, the social structure of the herd, and sound and smell can be considered as factors that support the positive sensory state (Ekmekyapar, 2001). Providing these conditions is absolutely necessary factor to ensure the appropriate behaviour of animals and contribute to sustainable animal breeding activities as well as ensuring animal welfare.

Developing good relationships between animals and humans plays an important role in increasing animal rights, comfort and welfare. The fact that animals perceive humans as a threat and act accordingly makes both humans and animals uneasy. Therefore, understanding how animals perceive humans helps them develop good relationships by regulating their behaviour towards them. Regarding the way animals perceive humans if humans and animals do not communicate or communicate negatively, animals feel fear and perceive humans as ordinary objects that only provide food and water (Estep and Hetts, 1992). In environments where people behave attentively towards animals, sensitive animals exhibit more relaxed behaviour (Vaarst et al., 2004). Establishing a correct relationship between animal caretakers and farm animals positively affects animal behaviour and welfare (Altınçekiç and Koyuncu, 2012b).

Animals, like humans, have need hierarchies. Since shelter, nutrition, health and environmental factors are the main factors that directly affect animal welfare, all kinds of improvement efforts in these factors serve to increase animal welfare.

4. PSYCHOLOGICAL AND BEHAVIORAL PRACTICES TO IMPROVE ANIMAL WELFARE

In addition to the legal framework to ensure animal welfare, it is seen that scientific studies have started. Measures are being increased to study more positive sensory and behavioural states in animal welfare and to prevent animals from experiencing physiological distress and physical bullying (Miller et al., 2020). In 1994, five freedom sections to improve animal welfare were determined to increase current animal needs and welfare (Mellor and Reid, 1994). While the first four chapters focus on physical animal welfare, which includes prevention of hunger and thirst, relief from the physical discomfort of the animal, freedom from injury, suffering, or illness, and freedom to express their natural behaviour, the last chapter focuses on mental animal welfare is freedom from fear and stress (Mellor and Reid, 1994; FAWC, 2012; Mellor, 2016; Cornish et al., 2016; Miller et al., 2020).

Animals' behaviour and emotions can be analyzed in more detail regarding new scientific developments. Scientific studies on animal welfare are carried out to prevent animals from suffering and increase the quality of the animal's relationship with its environment (Fraser, 1998; Hewson, 2003; Fraser, 2008; Green and Mellor, 2011; Cornish et al., 2016).

On animal welfare, the biological states of animals about forty years ago, animal psychology in the 1990s and 2000s, and today, studies under the science of ethology, which examines the behaviour of animals, have gained momentum (Broom, 1991; Fraser, 1998; Fraser, 2003; Cornish, 2016). In recent years, studies have been carried out on animal welfare that focus on being healthy and providing emotional happiness. One of these studies is "Positive Animal Welfare." This concept was first introduced by Alain Boissy et al. (Boissy et al., 2007). Positive animal welfare is a phenomenon that includes the positive mental activities of animals and the state of happiness they bring and allows animals to show their natural behaviours (Bracke and Hopster, 2006; Boissy, 2007; Rault et al., 2022). Within the framework of the positive animal welfare phenomenon, it is thought that the diversity of natural behaviour observed in animals positively affects animal welfare (Miller et al., 2020). In addition to the studies carried out to increase animal welfare, more detailed studies that include cognitive, neurological measurements, and psychological factors for a better understanding of animals have started a new era in animal welfare studies. However, little research can show the effects of these new practices on farm animals as well as many animals. Also, very few studies on this subject for fish and other aquatic products exist. Studies on this subject may be more helpful in understanding animals better and improving their welfare.

5. LEGAL REGULATIONS ON ANIMAL WELFARE

Efforts have been made to improve animal rights and welfare from the recent past to the present. In recent years, scientific, psychological, and behavioural practices and legal regulations have been gaining momentum to improve animal welfare. Although scientific studies are carried out to make animals comfortable in their environment, it is only possible to ensure this validity and sanction with a legal basis. For this reason, it is necessary to know the legal studies for improving animal rights and welfare and to complete the missing aspects. Therefore, examining the direct and indirect legal sanctions to improve animal welfare is essential.

5. 1. Developments in Animal Welfare in The World

Thanks to the awareness initiated with the Brambell Report in 1965 in order to prevent animal abuse, the Treaty of Rome published by the European Union in 1957, the "Convention on the Prevention of Abuse of Animals," and the issue of animal welfare took its place in the legal regulations. The Protection of Animals Held for Agricultural Purposes" published by the Council of Europe in 1976, and the Universal Declaration of Animal Rights, published in 1978, are other significant developments in this field (Veissier et al., 2008; Fidan, 2012). Then in 1979, the "EU Convention for the Protection of Slaughtered Animals" was adopted (Council of Europe, 1979). The World Organization for Animal Health (OIE) published the first international guidelines on animal welfare in 2008 (OIE, 2008).

The European Committee publishes recommendations for the welfare of many animal species. Recommendations were prepared for cattle in 1988, sheep and goats in 1992, and calves in 1993, and these texts are renewed in line with the needs for animal welfare (Veissier, 2008). Also, many European countries have established animal breeding, transfer, and slaughter legislation to ensure and improve animal welfare (Fraser, 2008). For example, Sweden added practices for grazing cattle to its animal welfare law in 1988 (Ludnmark Hedman et al., 2021). Animal welfare regulations were made with the Amsterdam Treaty in 1999 (Fidan, 2012). The United Kingdom, Argentina, and Spain have developed practices for the ethical evaluation of animal welfare (Behdadi, 2012; Lundmark et al., 2014). Animal welfare was included in the German constitution in 2002 (Yaşar and İzmirli, 2006). In addition, Italy has been implementing the law of the European Council for farm animals since 2001. Also, it enacted a law to protect animals and nature and pass it on to future generations in 2022 (Frost, 2022). Societies, conscious of improving the living conditions, rights, and welfare conditions of animals, are making legal arrangements daily and taking animals under protection. It is seen that concrete steps have been taken primarily in European countries and some other countries in this regard.

5. 2. Developments in Animal Welfare in Turkiye

In Turkiye, the law on the "Protection of Pets" was approved in 2003, and the "Animal Protection Law" came into effect in 2004 (Anonymus, 2011; Official Gazette, 2004). In 2007, the EU conventions "On the Protection of Animals Kept for Breeding Purposes and Animals During Slaughter" were signed (Anonymus, 2011). Also, a regulation on "Measures to be Taken to Protect the Health and Welfare of Aquaculture" was issued, which came into force 26556 in 2007 (Official Gazette, 2007). In addition, the "Regulation on the Welfare of Farm Animals" numbered 28151 in 2011, the regulation on providing the ideal conditions needed by the animals in the process of raising farm animals and the follow-up of the works and procedures, and the "Regulation on the General Provisions on the Welfare of Farm Animals" were issued in 2014 (Official Gazette, 2011; Official Gazette, 2014). In addition, the Circular on the Welfare of Breeding Fish (2018/3) has been published, and Article 9 of the Veterinary Services, Plant Health, Food and Feed Law No. 5996 dated 11/6/2010, published in the Official Gazette under issue number 25507 and dated 29.06.2004. Furthermore, for compliance with paragraph j of article 21 of the "Aquaculture Regulation" and article 24, European Union Council Directive No. 98/58/EC on the Protection of

Animals Raised for Farming Purposes and the Permanent Committee of the European Convention for the Protection of Animals Raised for Farming Purposes, "Concerning Fish Breeding" "Recommendations" provided the basis for legislative studies.

Like many EU countries, Turkiye makes various legal regulations on animal rights and welfare and updates these regulations in line with the current needs of animals. Additionally, with the increasing public awareness in recent years, it has increased its criminal practices in animal cruelty cases.

6. CONCLUSION

The distance taken from the past to the present to improve the living conditions of animals has increased considerably. However, in our world, where industrial production is rising, the industrialization of animals also makes it difficult to maintain effective animal welfare practices. In this regard, it is pleasing to give importance to the feelings of animals and to concentrate on scientific studies on this subject, in addition to improving their habitats to provide them with a more comfortable environment. The fact that many factors are necessary to ensure welfare creates the need to increase, update and improve the work to be done on this subject. In particular, the welfare of farm animals, which are subject to industrialization, needs to be improved physically, behaviorally, and emotionally in innovative practices. The fact that the situations that land animals are exposed to are more common than those that marine creatures are exposed to has led to steps being taken to improve the welfare of these animals, especially farm animals. However, it is a fact that there are very few studies in the literature and government policies on improving the welfare of aquatic products. It is crucial to eliminate the deficiencies in this area. Legislative arrangements to enhance the welfare of all farm animals and fisheries are lacking, and many countries outside the EU need to focus more on this issue. In Turkiye, legal and practical improvement studies on animal welfare have been carried out in recent years. However, alongside existing studies, more work is needed to improve animal welfare, especially in modern animal husbandry. Determining the standards for animal welfare, analyzing animal wishes and needs correctly, and new studies to be carried out with the help of other disciplines will contribute positively to improving animal health, productivity, and welfare.

REFERENCES

Absmanner, E., Rouha-Mülleder, C., Scharl, T., Leisch, F., Troxler, J. (2009). Effects of different housing systems on the behaviour of beef bulls: an on-farm assessment on Austrian farms. Applied Animal Behaviour Science 118,12-19.

Akbaş, A.A. (2013). Farm animal behaviour and welfare relationship. Mehmet Akif Ersoy University Journal of Health Sciences Institute, 1 (1): 42-49.

Akbay, A. H. (2010). Accordance of dairy farm in Tekirday province to animal welfare. Namık Kemal University, (Postgraduate Dissertation).

Alkoyak, K. and Çetin, O. (2016). Heat stress and prevention ways in dairy cattle. Journal of Bahri Dagdas Animal Research 5 (1):40-55.

Alkan, Z. (1972). Ağılların planlanması (Planning of the corrals). Atatürk Üniversity, Faculty of Agricultural Press. 245(71): 103.

Altınçekiç, Ş.Ö. and Koyuncu, M. (2007). Çiftlik hayvanlarında refah. Journal of Agricultural Faculty of Bursa Uludag University, 21(2), 57-64.

Altınçekiç Ş.Ö. and Koyuncu, M. (2012a). Farm animals and stress. Journal of Animal Production, 53(1): 27- 37.

Altınçekiç, Ö. Ş. and Koyuncu, M. (2012b). The role of breeders in ımprovement of welfare in livestock. Journal of Agricultural Faculty of Uludag University, 26 (1): 31-141.

Anonymus, (2011). Hayvan hakları, hayvanların korunması ve Refahı (Animal rights, animal protection and welfare). Republic of Türkiye Ministry of European Union, 11 March 2011, Ankara, Turkiye. [Online]: Available at: https://www.ab.gov.tr/files/Tar%C4%B1m%20ve%20Bal%C4%B1k%C3%A7%C4%B1l%C4%B1k%20Ba%C5%9Fkanl%C4%B1%C4%9F%C4%B1/hayvan_haklari__hayvanlarin_korunmasi_ve_refahi.pdf (Accessed: 22.06.2023).

Antalyalı, A.A. (2007). (Animal welfare practices in the European Union and Turkey) Avrupa Birliği ve Türkiye’de hayvan refahı uygulamaları. EU Specialist Thesis, Republic of Turkiye Ministry of Agriculture and Rural Affairs.

Arslan, C. (2007). Feeding behaviors of sheep and goats, Journal of Faculty of Veterinary Medicine, Istanbul University, 33 (3): 77-88.

Behdadi, D. (2012). The compassionate stock-keeper' and other virtous ıdeals. values and definitions in the animal welfare legislations of the United Kingdom, Spain and Argentina. Report 32. Swedish University of Agricultural Sciences. Skara.

Bildirici, Ö.Ü.N., and Bildirici, D.E. (2021). Sağlıklı Bir Gelecek İçin Aquaponik Sistemler (Aquaponic Systems for a Healthy Future). İksad Publications–2021©, Press No, 1, 84.

Blackstone, W. (1822). Commentaries on the laws of England. University of Chicago Press.

Boissy, A., Manteuffel, G., Jensen, M. B., Moe, R. O., Spruijt, B., Keeling, L. J., ... and Aubert, A. (2007). Assessment of positive emotions in animals to improve their welfare. Physiology and behavior, 92(3): 375-397.

Bracke, M. B. and Hopster, H. (2006). Assessing the importance of natural behavior for animal welfare. Journal of agricultural and environmental ethics, 19, 77-89.

Brambell Report (1964). Report of the Technical Committee to enquire into the welfare of animals kept under intensive livestock husbandry systems. Her Majesty's Stationery Office, London, UK.

Brambell, F.W.R. (1965). Brambell Report: Conditions for the welfare and husbandry of animals.

Broom, D.M. (1991). Animal welfare: Concepts and measurement. Journal of Animal Science, 69: 4167–4175. https://doi.org/10.2527/1991.69104167x

Broom, D.M. (1986). Indicators of poor welfare. British Veterinary Journal, 142 (6):524-526.

Brunberg, E., Eythórsdóttir, E., Dýrmundsson, Ó. R., and Grova, L. (2020). The presence of Icelandic leadersheep affects flock behaviour when exposed to a predator test. Applied Animal Behaviour Science, 232, 105128.

Cambridge Dictionary (2023). Refah-welfare. [Online]: https://dictionary.cambridge.org/tr/s%C3%B6zl%C3%BCk/ingilizce-t%C3%BCrk%C3%A7e/welfare. (Accessed: 17.05.2023).

Capucchio, T., Colombino, M., Tarantola, E., Biagini, D., Giovanni Alborali, A. L., Marco Maisano, L., A., ... and Guarda, F. (2019). The disturbed habitat and its effects on the animal population. In The Disturbed Habitat and Its Effects on the Animal Population (pp. 1-21). IntechOpen.

Cemek, B., Çetin, S., and Yıldırım, D. (2011). Livestock and poultry production, water consumption and water quality features. Research Journal of Agricultural Sciences, (1), 57-67.

Claffey, N. (2017). Do you have enough space for your cattle this winter. [Online] Available at: https://www.agriland.ie/farming-news/do-you-have-enough-space-for-your-cattle-this-winter/(Accessed: 19.06.2023).

Cornish, A., Raubenheimer, D., and McGreevy, P. (2016). What we know about the public's level of concern for farm animal welfare in food production in developed countries. Animals, 6(11), 74.

Council of Europe (1979). European Convention for the Protection of Animals for Slaughter. European Treaty Series-No. 102, Strasbourg, France. [Online] Available at: https://rm.coe.int/1680077d98 (Accessed: 22.06.2023).

Çavuşoğlu, Y.S. and Akyürek, H. (2018). Nutritional behaviour in sheep and goats. Harran Journal of Agricultural and Food Science, 22(1): 137-151.

Duncan, I.J.H. (2002). Poultry welfare: Science or Subjectivity? British Poultry Science, 43 (5):643-652.

Elmore, M.R.P., Gamer, J.P., Johnson, A.K., Richert, B.T., Pajor, E.A., (2010). A flooring comparison: the impact of rubber mats on the health, behavior, and welfare of group-housed sows at breeding. Applied Animal Behaviour Science 123:7-15.

Ekmekyapar, T. (2001). Agricultural Structures (Tarımsal Yapılar), Atatürk University Faculty of Agriculture Lecture Publications No: 204, Erzurum, Turkiye.

Erdal, S. (2012). Evaluation of the Swedish model in terms of welfare state ımplementations in the globalization process. Dokuz Eylül University Graduate School of Social Sciences, Department of Public Finance Program, (PhD Thesis).

Estep, E. Q., and Hett, S. (1995). Interactions, Relationships and Bonds: The Conceptual Basis for Scientist-Animal Interactions. Cambridge University Press: Cambridge, UK

Fidan, E. D. (2012). Welfare applications related to livestocks in Turkey. Animal Health Production and Hygiene, 1(1): 39-46.

FAWC (Farm Animal Welfare Comitte) (2012). Economics and Farm Animal Welfare, London The UK.

Fraser, D. (1998). Encyclopedia of animal rights and animal welfare. Greenwood Press, Westport, CT, USA.

Fraser, D. (2003). Assessing animal welfare at the farm and group level: The ınterplay of science and values. Animal Welfare, 12:(433-443).

Fraser, D. (2008a). Toward a global perspective on farm animal welfare. Applied Animal Behaviour Science, 113(4), 330-339.

Fraser, D. (2008b). Understanding animal welfare: the science in ıts cultural context; Wiley-Blackwell: Oxford, UK, 2008.

Frost, R. (2022). Historic's vote means Italian state must now protect animals and ecosystems. [Online] Available at: https://www.euronews.com/green/2022/02/09/historic-vote-sees-animals-and-the-environment-included-in-italian-constitution (Accessed: 22.06.2023).

Giménez-Candela, M., Saraiva, J. L., and Bauer, H. (2020). The legal protection of farmed fish in Europe: analysing the range of EU legislation and the impact of international animal welfare standards for the fishes in European aquaculture. In dA Derecho Animal: Forum of Animal Law Studies (Vol. 11, No. 1, pp. 0065-118).

Göncü, S., Koluman, N., Serbester, U., and Görgülü, M. (2016). Animal welfare ıssues and critical control points in dairy cattle farming. Çukurova Journal of Agricultural and Food Science, 31(1): 9-20.

Göncü, S., Önder, D., Koluman, N., and Mevliyaoğulları, E. (2015). Animal shelter features suitable for hot and humid conditions. Tüsedad, 5(30), 42-47.

Green, T.C., Mellor, D.J. (2011). Extending ideas about animal welfare assessment to include 'quality of life' and related concepts. New Zealand Veterinary Journal, 59, 263-271.

HAYGEM, (2016). Hayvancılık Genel Müdürlüğü, Buzağı Bakım ve Besleme. [Online] Available at: https://www.tarimorman.gov.tr/HAYGEM/Belgeler/Hayvanc%C4%B1l%C4%B1k/B%C3%BCy%C3%BCkba%C5%9F%20Hayvanc%C4%B

1l%C4%B1k/2016%20Y%C4%B1l%C4%B1/Buza%C4%9F%C4%B1%20Bak%C4%B1m%20ve%20Beslenmesi.pdf (Accessed: 20.09.2023)

HAYGEM (2017). Hayvancılık Genel Müdürlüğü, Büyükbaş hayvancılık (Sığırcılık). [Online] Available at: https://www.tarimorman.gov.tr/HAYGEM/Belgeler/Hayvanc%C4%B1l%C4%B1k/B%C3%BCy%C3%BCkba%C5%9F%20Hayvanc%C4%B1l%C4%B1k/2017%20Y%C4%B1l%C4%B1/B%C3%BCy%C3%BCkba%C5%9F%20Hayvan%20Yeti%C5%9Ftiricili%C4%9Fi.pdf(Accessed: 20.06.2023).

Held, S. D., and Špinka, M. (2011). Animal play and animal welfare. Animal behaviour, 81(5): 891-899.

Hewson, C.J. (2003). What is animal welfare? Common definitions and their practical consequences. The Canadian Veterinary Journal, 44,496–499.

Hogan, J. P., Petherick, J. C., and Phillips, C. J. (2007). The physiological and metabolic impacts on sheep and cattle of feed and water deprivation before and during transport. Nutrition research reviews, 20(1): 17-28.

Sert, H. and Uzmay, A. (2017). Assessment of economical aspects and sustainability of global animal welfare practices. Adnan Menderes University Journal of Social Sciences Sosyal Bilimler Enstitüsü Dergisi, 4(4): 263-276.

Kaya, İ., Sahin, T., and Unal, Y. (2011). The effects of grazing and concentrate supplementation at pasture on performance and rumen parameters in lambs. The Journal of The Faculty of Veterinary Medicine University of Kafkas, 17(5): 693-697.

Koyuncu, M. (2006). Contribution of sheep and goat to ecology System. Turkey III. Organic Agriculture Symposium, 1-4 November 2006, Yalova, 2-8.

Kurç, H. C., and Kocaman, İ. (2016). Examination of Cattle Animal Farms Based On Structural Properties in The Tekirdag-Malkara Region. Journal of Tekirdag Agricultural Faculty, 13(4): 84-90

Külcü, R. (2022). Hayvan refahı kavramı ve uygulamalarının etik eksende sorgulanması (Ethical investigation of animal welfare concept and practices. International studies in social humanities and administrative sciences). International studies in social humanities and administrative sciences XII; Öztürkçü Akçay, A. (ed.). Eğitim Press, Konya, 165-180.

In the Official Gazette of Turkiye (Resmî Gazete), (2004). The “5199 Sayılı Hayvanları Koruma Kanunu” (Animal Protection Law) was published on 1st July 2004 under issue number 25509. [Online] Available at: https://www.mevzuat.gov.tr/mevzuatmetin/1.5.5199-20100611.pdf. (Accessed: 19.06.2023)

In the Official Gazette of Turkiye (Resmî Gazete), (2007). The “Su Ürünleri Yetiştiriciliği Yönetmeliğinde Değişiklik Yapilmasina Dair Yönetmelik” (Measures to be Taken to Protect the Health and Welfare of Aquaculture) was published on 18 July 2007 under issue number 26556. [Online] Available at: https://www.resmigazete.gov.tr/eskiler/2007/06/20070618-4.htm (Accessed:03.10.2023).

In the Official Gazette of Turkiye (Resmî Gazete), (2011). The “Çiftlik Hayvanlarının Refahına İlişkin Yönetmelik” (Regulation on the Welfare of Farm Animals) was published on 23 November 2011 under issue number 28151. [Online] Available at: https://www.resmigazete.gov.tr/eskiler/2011/12/20111223-3.htm. (Accessed: 13.07.2023).

Lundmark, F., Berg, C., Schmid, O., Behdadi, D. and Röcklinsberg, H. (2014). Intentions and Values in Animal Welfare Legislation and Standards. Journal of Agricultural and Environ Ethics 27, 991–1017. https://doi.org/10.1007/s10806-014-9512-0

Lundmark Hedman, F., Veggeland, F., Vågsholm, I., and Berg, C. (2021). Managing animal welfare in food governance in Norway and Sweden: Challenges in implementation and coordination. Animals, 11 (7), 1899. https://doi.org/10.3390/ani11071899

Lyons, R.K. and Machan, R.V. (2000). Interpreting grazing behavior. Agrilife Extention Texas AandM [Online] Available at: https://animalscience.tamu.edu/wp- (Accessed:20.06.2023).

Mayulu, H., Fauziah, N., Christiyanto, M., Sunarso, S., and Haris, M. I. (2019). Digestibility value and fermentation level of local feed-based ration for sheep. Animal Production, 20 (2): 95-102.

MEGEP (Strengthening Vocational Technical Education Project) (2015). Shelter Types. [Online]: Available at: http://www.megep.meb.gov.tr/mtel/moduller/Bar%C4%B1nak%20Tipleri.pdf (Accessed: 19.06.2023).

Mellor, D.J. and Reid, C.S. (1994). Concepts of animal well-being and predicting the impact of procedures on experimental animals. In Improving the Well-Being of Animals in the Research Environment; Baker, R., Jenkin, G., Mellor, D.J., Eds.; Australian and New Zealand Council for the Care of Animals in Research and Teaching: Glen Osmond, Australia, pp. 3–18.

Mellor, D.J. (2016). Updating animal welfare thinking: Moving beyond the "Five Freedoms" towards "A life worth living". Animals, 6 (3): 21.

Miller, L. J., Vicino, G. A., Sheftel, J., and Lauderdale, L. K. (2020). Behavioral diversity as a potential indicator of positive animal welfare. Animals, 10(7): 1211.

Özdemir, C. and Kaplan, D. (2013). Shepherdıng and lands from shephers'perspectıve: Mikail Kaplan And an Instance of Aşağı Çamlı Vıllage. The Journal of International Social Research, 6 (27): 442-459.

Özdemir, G. and Singin, E. (2016). The effects on animal welfare of some factors such as shelter, transportation and human-animal ınteractions in cattle. Journal of Faculty of Veterinary Medicine Erciyes University, 13(3): 215-222.

Rault, J. L., Sandøe, P., Sonntag, Q., and Stuardo, L. (2022). Positive animal welfare: bridging the gap or raising inequalities worldwide? Frontiers in Animal Science, 3, 825379.

Rushen, J., de Passille, A.M. B. and Munksgaard, L. (1999). Fear of people by cows and effects on milk yield, behaviour and heart rate at milking. Journal of Dairy Science, 82, 720- 727

Schreck, C. B., Olla, B. L., and Davis, M. W. (1997). Behavioral responses to stress. Fish stress and health in aquaculture, 62, 145-170.

Şanlı, E. R. (2018). Küçükbaş hayvan nakillerinde hayvan refahı (Animal welfare in small ruminants transport). 1st International Symposium on Silvopastoral Systems and Nomadic Societies in Mediterranean Countries 2018, 341-347.

TDK (2023). Türk Dil Kurumu Sözlükleri. [Online] Available at: https://sozluk.gov.tr/. (Accessed: 17.05.2023).

Toni, M., Manciocco, A., Angiulli, E., Alleva, E., Cioni, C and Malavasi, S. (2018). Review: Assessing fish welfare in research and aquaculture, with a focus on European directives. Animal, 13:1, pp 161–170.

Usta, S. (2011). Free stall dairy cattle farms architectural layout plan principles and suggestions for the nature of manufacturer type residential development plans. Suleyman Demirel University Journal of Technical Science, 1(2):29-42.

Vanegas, J., Overton, M., Berry, S. L., and Sischo, W. M. (2006). Effect of rubber flooring on claw health in lactating dairy cows housed in free-stall barns. Journal of dairy science, 89(11): 4251-4258.

Veissier, I., Butterworth, A., Bock, B., and Roe, E. (2008). European approaches to ensure good animal welfare. Applied animal behaviour science, 113(4): 279-297.

Ward, D. and McKague, K. (2023). Water requirements of livestock. [Online] Available at: https://files.ontario.ca/omafra-water-requirements-livestock-23-023-en-2023-04-25.pdf (Accessed: 19.06.2023).

Welfare Quality (2009). Assesment Protocol for Cattle. Welfare Quality Project Office, The Netherlands, 1 October 2009. [Online] Available at: https://edepot.wur.nl/233467 (Accessed: 07.06.2023).

Vaarst, M., Lund, V., Roderick, S., and Lockeretz, W. (Eds.). (2004). Animal health and welfare in organic agriculture. CABI.

Yakin. E.A., Ngadiyono, N. and Utomo, R. (2012). Effect of silage substitution fill in cattle rumen on basal grass feed and concentrate on beef cattle performance, Buletin Peternakan Animal Science Bulletin, 36 (3): 174-180.

Yaşar, A., and İzmirli, S. (2006). Legal arrangements related to animal welfare in Turkey. Eurasian Journal of Veterinary Sciences, 22(3-4), 51-56.

Yener, H., Atalar, B., and Mundan, D. (2013). Evaluation of the Cattle Farms for Biosecurity and Animal Welfare in Sanliurfa Province. Harran Journal of The Faculty of Veterinary Medicine, 2(2): 87-93.

Yıldız, H.Y., Robaina, L., Pirhonen, J., Mente, E., Dominguez, D. and Parisi, G. (2017). Fish welfare in aquaponic systems: Its relation to water quality with an emphasis on feed and faeces- A review. Water, 9, 13; doi:10.3390/w9010013

Yıldız, H.Y. and Veske, E. (2007). Pain in fish: Study on pain in guppy (Poecilia reticulata) with a painkiller. Journal of Fisherie, 1(4):188-190.

CHAPTER 15

WELFARE AND SUSTAINABILITY IN LIVESTOCK

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1. INTRODUCTION

Although there are various definitions of the concept of sustainability today, in this section, the concept of sustainable animal production in general terms can be defined as an environmentally healthy, economically profitable and socially acceptable animal production (Darnhofer et al. 2010). In this context, according to Koyuncu and Nageye (1984), researchers argue that there are three different dimensions of sustainable agriculture and each of them should be built on a different idea or view. Accordingly, there are 3 elements of sustainable agriculture and these can be summarized as follows:

- **Food security and profitability:** Agricultural activities generate income for owners, workers and organizations involved in farm-related inputs and outputs, but also require the production of sufficient quantities of healthy food that can be consumed by people. This essentially implies the need for sustainability based on market arrangements of supply and demand, profitability and technological progress to ensure continuous increases in productivity.
- **Resource (Environmental) Management:** Where food security and profitability in the previous dimension are based on maximizing output over input, a time variable is added to the management dimension and sustainable agriculture is considered as "resource management". More precisely, it explains that production has an environmental cost and that neither resources nor the environment can be consumed to ensure food and environmental security.
- **Social dimension:** In this philosophy, agriculture does not stand alone, but is based on a larger system of other subsystems, all based on the same finite resources. Abstractly, the dimension of sustainable animal production is expressed as efficient food production for society by using available resources efficiently without harming the environment (Koyuncu and Nageye 2020).

The interactions of these 3 dimensions with each other are shown in Figure 1. Within the scope of these components, the sustainability of welfare-oriented animal husbandry practices will be evaluated through environmental sustainability and economic sustainability.

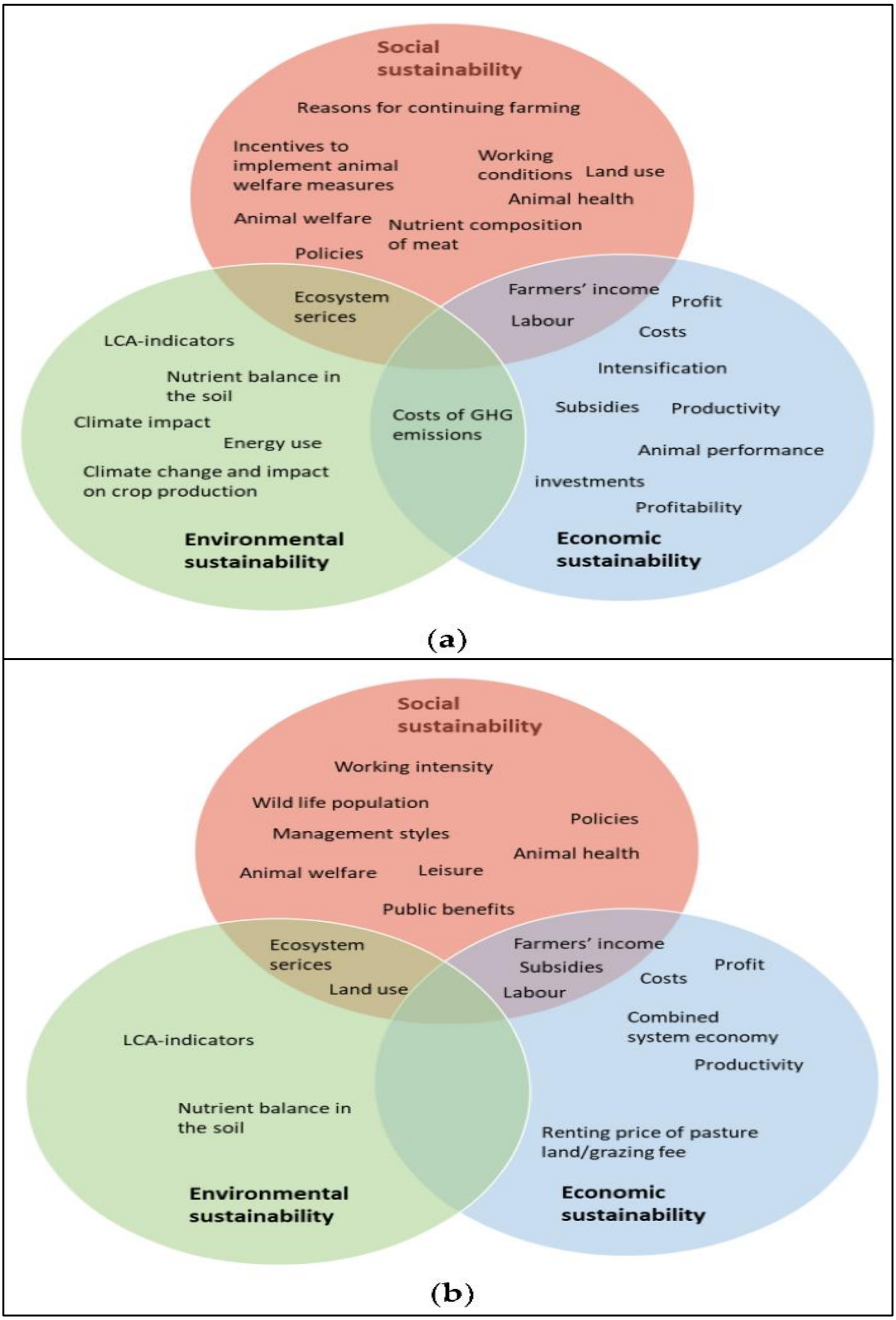

Figure 1. Keywords identified from articles evaluating aspects of environmental, economic and social sustainability in (a) cattle and (b) sheep meat farming. Keywords in the intersections of dimensions refer to sustainability aspects that were related to more than one sustainability dimension (Arvidsson Segerkvist et al., 2021).

2. ENVIRONMENTAL DIMENSION

Increases in anthropogenic greenhouse gas emissions occur as a result of livestock activities. The main sources of green house gases (GHG) from these activities are CH_4 from animal respiration and manure management, CO_2 from land use and changes, and N_2O from manure management (Shibata and Terada, 2010). Nitrogen excretion to nature through manure by animal species is shown in Table 1. Ruminants have a high impact on GHG production due to their higher biomass and digestive products compared to other farm animals. Beef and milk production accounts for 20-41% of GHG emissions, compared to 8-9% for pigs and poultry and 6.5% for small ruminants (FAO, 2013).

Table 1. Annual nitrogen excretion as a percentage of live weight in different animals (Rotz, 2004)

Animal Type	**Annual N Excretion (% of Body Weight)**
Dairy Cattle	
Milking cow (20 kg milk/day)	18
Milking cow (33 kg milk/day)	22
Milking cow (45 kg milk/day)	27
Cow in dry	11
Beef Cattle	11
Poultry	
Layer	30
Scarf	23
Broiler	40
Pig	
Lactating	22
Grower	15
Finisher	15

Although enteric fermentation is considered to be the primary source of anthropogenic CH_4 emissions, it was reported to have a 30-40% share in emissions from livestock farming activities worldwide in 2010 (Akça and Yetişgin, 2023). Enteric fermentation is by far the largest source of GHG emissions from agricultural activities in Turkey since the 1990s. In 2019, it contributed negatively to 49.4% of all CH_4 emissions. Fertilizer management has a 13% share in enteric fermentation occurrences and N_2O emissions have a

7.5% share in GHG emissions in Turkey (Akça and Yetişgin, 2023). Enteric fermentation is associated with 32.06 kt CO_2 eq of annual CH_4 emissions in Turkey, with ruminants being the primary source (FAOSTAT, 2018).

While anthropogenic greenhouse gases released as a result of livestock activities negatively affect the atmosphere and change the climate globally, they cause negative impacts on livestock. These negative effects are manifested in decreases in animal productivity, difficulty in adapting to environmental conditions, and a decrease in animal welfare conditions due to these conditions. Animal welfare has been defined in various ways using criteria such as biological functions, ecological behaviors or emotional state. There is a simple approach that brings all these aspects of animal welfare together; when animals are healthy, they have everything they need. This definition emphasizes the needs of animals and the importance of their health (or physical or emotional) to achieve good welfare standards. Animal welfare is considered an essential element for sustainable livestock production (Broom et al., 2013).

The environmental sustainability approach primarily emphasizes reducing greenhouse gas emissions and resource use. For this purpose, it is necessary to reduce the amount of land, energy and water needed to produce the same or higher amount of food. While minimizing the environmental impact for each unit of production, more opportunities for improved ecosystems and biodiversity should be created. For example, to meet demand by 2050 at current production levels in broiler production, it is estimated that a 134% increase in capacity from the current 56 billion to 131 billion will be required globally (Koyuncu and Nageye, 2020). This means using more land, water, energy and feed. Alternatively, adopting innovative approaches that increase the efficiency with which animals convert natural resources into edible animal products without pushing their biological limits is another prominent issue. Such an approach could minimize the growth in the number of animals and consumption of related resources required to meet future global demand, while maintaining animal welfare standards (Knapp and Cady, 2015). Regarding climate change mitigation, although it has been reported that the amount of emissions per kilogram of meat or milk produced on farms has decreased by 38-76% from the 1960s to the 2000s (for different animal products) (Andeweg and Reisinger, 2013), innovative practices need to be disseminated to further reduce emissions.

Table 2 summarizes the environmental problems associated with animal production systems.

Table 2. Issues and pollutants related to environmental sustainability and their origin in animal agricultural systems (Place, 2018).

Environmental issue or pollutant	Description and sources from animal agriculture
Particulate matter (PM) emissions	Can cause animal, human, and ecosystem health concerns. Soil, manure, feed, skin, down feathers, and bedding materials can be sources of PM from animal housing. Prescribed burning of livestock pasturelands can lead to both direct emissions of PM and PM precursors. Ammonia emissions can be a precursor for PM formation. Steroid hormones used for growth promotion, antimicrobial resistant genes, and microorganisms have all been observed in PM downwind from animal facilities
Methane emissions	A greenhouse gas 28 times more potent than carbon dioxide at trapping heat in the earth's atmosphere. Derived from methanogenic archaea (methane-producing microorganisms). Sources include the gastrointestinal tracts of animals, particularly ruminant species, and anaerobically stored manure
Nitrous oxide emissions	A greenhouse gas 265 times more potent than carbon dioxide at trapping heat in the earth's atmosphere. Derived from nitrification and denitrification processes undertaken by soil bacteria. Sources include soils that have been fertilized with synthetic N or organic N sources (manure). Considered a form of reactive nitrogen
Ammonia emissions	Odorous compound primarily derived from the mixing of animal feces and urine. Sources include confinement housing systems, open dry lot corrals, and soils amended with manure or nitrogen fertilizer. Considered a form of reactive nitrogen
Volatile organic compound emissions	Large class of compounds that have different potentials to drive tropospheric ozone formation. Main sources in animal agriculture include fermented feedstuffs (i.e., silages) and to a lesser extent, manure
Ecosystem acidification	Acidification of soils and freshwater system that can be driven in part by wet and dry depositions of reactive nitrogen emissions originating from animal agricultural systems
Eutrophication	Excessive nutrient loading (particularly N and P) in surface waters that can be sourced from either manure application to lands or the use of synthetic fertilizers on lands used to grow animal feedstuffs

3. ECONOMIC DIMENSION

Climate change increases the operating cost of farms, such as decreased yields, increased treatment costs, increased feed and energy prices, and new infrastructure investments for redesigning shelters such as building cooling, evaporation, irrigation, misting systems, sprinklers and fans. In a study conducted by Koç and Uzmay (2019) to reveal the economic impacts of climate change in Turkey, it was determined that this impact will lead to a 10-50% cost increase in dairy cattle farms until 2044. They state that 48-71% of the increase in production cost is due to heat stress and 24-52% is due to the increase in feed prices. This situation reveals the fact that climate change and climate change issues should be taken into consideration in future agricultural supports and investment projects.

In another assessment regarding the increase in the costs of livestock activities due to climate change, it is stated that especially the production of feed raw materials will be seriously affected and this will lead to an increase in ration costs, which will be reflected in the final product. For example, while beef prices are expected to increase by 33% by 2050 without climate change, it is estimated that this value will increase by 60% with climate change (Nelson et al. 2009).

Animal production is directly or indirectly affected by climate change. With the increase in temperature, the balance between heat production and heat utilization in animals may be disrupted, which may affect mortality rate, feed consumption rate, live weight gain, milk production and pregnancy rate. At the same time, changes in the amount of animal production can directly or indirectly affect costs (Koyuncu and Nageye, 2020).

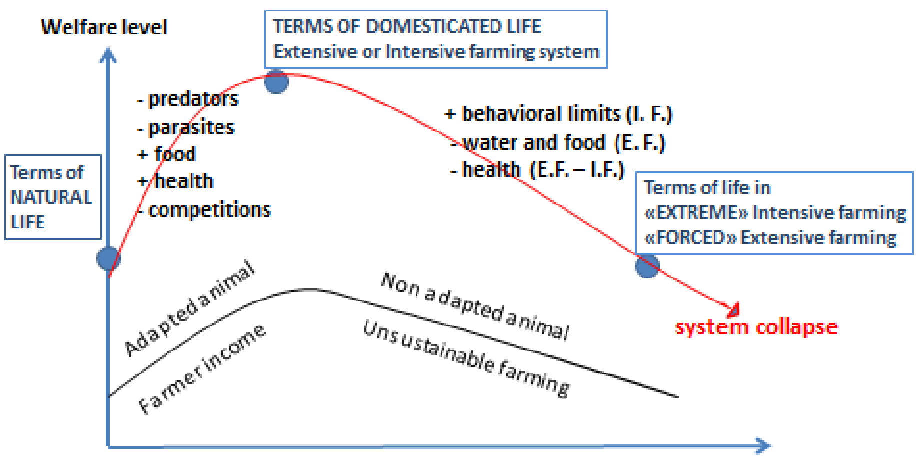

Figure 2. Animal welfare, animal adaptation and farming sustainability (Bertocchi and Fusi, 2014).

4. WELFARE AND ENVIRONMENT INTERACTIONS

Good standards of animal welfare cannot be achieved in conditions of poor health. Animal welfare is associated with behavioral and metabolic changes such as poor animal health and vitality, reduced feed intake, reduced digestibility of nutrients and increased energy requirements.

Improvements in animal health can reduce the loss of animals in the herd due to injury and disease, which in turn can increase the opportunity to extend the average productive life of the herd. Increasing herd life expectancy in dairy cattle has been proposed as a way to increase animal productivity and reduce greenhouse gas emissions per kg of product (Bell et al., 2011).

Improved animal health through prevention and control of disease and parasites are generally recognized as essential elements for animal welfare (Place, 2018). Welfare is determined by looking at the health conditions of animals and their ability to exhibit natural behavior. Although methods other than health are used to determine animal welfare, no specific strategy has yet been tested to reduce greenhouse gas emissions. Fundamental changes can be made in animal husbandry to achieve significant improvements in animal welfare and productivity. For example, stress due to poor husbandry conditions can reduce milk and meat production (Hemsworth and Coleman, 2011). Temperature-induced stress produces an increase in respiratory rate, rectal temperature and mobilization of body fat reserve for thermoregulation in lactating ewes, indicating reduced animal welfare (Arvidsson Segerkvist et al., 2021). In laying hens, social stress due to an excessive increase in the number of hens in the cage can lead to decreases in viability and productivity (Coon et al., 2006).

Some strategies aimed at increasing animal productivity may negatively affect animal welfare. Some strategies can positively affect animal productivity and economic performance and reduce greenhouse gas emissions (Akça and Yetişgin, 2023).

There are a wide range of studies citing examples of the interaction between animal welfare and environmental sustainability. Some of these studies were reviewed by Place (2018), with a particular focus on the United States of America (USA). The researcher reports that at the heart of the relationship between welfare and sustainability is the reduction of environmental stressors to which farm animals are exposed. Chief among these factors is global climate change, which, to some extent caused by humans, will lead to an increase in temperatures, which will become a major stress factor in animal production (Place, 2018). Apart from increases in average temperatures, these factors, combined with the occurrence of heat waves, droughts in some regions or, on the contrary, very heavy rainfall in others, can negatively affect the efficiency of animal production through heat stress or by reducing the quality of feeds available for animal consumption (Thornton et al., 2014). Heat stress is a phenomenon that already has negative effects on animal production, but it has an additional impact on farming activities in uncontrolled environments. For example, in the United States alone, the financial losses in beef and dairy cattle operations due to mortality increases, growth setbacks and yield declines resulting from heat stress due to climate change are estimated at USD 370-897 million (Place, 2018). Although performance declines in animals under heat stress conditions are generally attributed to reduced feed intake by heat-stressed animals, recent studies suggest that, in addition to decreases in feed intake, coordinated changes in metabolism, including decreased adipose tissue metabolism and increased skeletal and muscle catabolism, play a role in this outcome (Baumgard and Rhoads, 2013). Researchers have reported that studies in livestock exposed to heat stress have shown increased protein catabolism in muscle and increased urea nitrogen concentrations in milk and blood (Baumgard and Rhoads, 2013). These increases are directly linked to increased nitrogen excretion and ammonia emissions, affecting nitrogen emissions per unit of production, in addition to other negative effects of heat stress (Place, 2018).

Another example is phosphorus excreted in feces, especially in poultry. Although phosphorus (P) is an essential nutrient needed by both plants and animals, its utilization in the animal body can be limited depending on the form in which it is found in feed. Accordingly, if it is not metabolized and excreted in feces, it is a potential pollutant. Some chemical forms of phosphorus adhere to soil particles that can be transported by soil and enter water bodies (Schmidt and Jacobson, 1994). In monogastric farm animals such as pigs and poultry, the most important factor affecting the digestibility of phosphorus in feed is the source of phosphorus. Phosphorus used in poultry diets can come in three forms: inorganic phosphorus obtained from phosphate rocks, inorganic phosphorus obtained from animal feed raw materials or organic phosphorus obtained from plant feed raw materials. In general, phosphorus from inorganic sources can be utilized by animals with simple stomachs if it is present in feeds, whereas the usefulness of phosphorus bound in phytate form for these animals is about 30%. In practice, the feeding approaches used to increase the availability of this phytate form phosphorus from plant sources, which has low availability, to simple gastric animals are; 1) formulating diets to meet phosphorus requirements more precisely, thereby reducing fecal excretion of phosphorus, 2) adding exogenous phytase enzyme to the feed of these animals to improve the availability of phytate form phosphorus to simple gastric animals, and 3) reducing the phytate phosphorus content of cereal grains by genetic modifications (Knowlton et al., 2004). In this context, there are numerous studies on modifying diets to increase the availability of phosphorus from sources such as corn and soybean meal (Qian et al., 1997; Cromwell et al., 1998; Boling et al., 2000; Kasim and Edwards, 2000; Li et al., 2000; Edwards 2002). Feed trials such as vitamin D supplementation, various organic acid supplementation, phytase supplementation and the use of maize varieties with low phosphorus bound in phytate form are available and the effect of such feed components on P digestibility and excretion is summarized in Table 3.

Table 3. Effects of different feed additives on phytate phosphorus evaluation and fecal phosphorus content in poultry

Animal	Total P (g/kg)	P_{Av} (g/kg)	Fitase (U/kg)	Vit. D_3 (µg/kg)	1-OHD_3 (µg/kg)	25-OHD_3 (µg/kg)	$1.25(OH)_2D_3$ (µg/kg)	Fecal P (g/kg)	Fitate P remain (%)	Source
Broiler 2-5 week	4.6	2.1	0;250; 500; 2500	-	-	-	-	2.08; 2.03; 1.9;1.84	-	Zhang et al., (2000)
8-20 day	4.2	1.4	-	-	0;20	-	-	8.9; 5.9	-	Biehl and Baker, (1997)
0-16 day	5.2	2.2	-	27.5; 112;2 20	-	-	-	-	51;58; 57	Edwards, (2002)
0-16 day	5.2	2.2	-	-	-	-	0;10	-	55.3;72.7	Edwards, (2002)
0-16 day	4.7	2.1	-	-	5	5	5	-	53.3;76.2; 71.2;74.4	Edwards, (2002)
0-21 day	5.1	2.7	0;300; 600;900	-	-	-	-	-	54.1;56.4; 58.3; 59.9	Qian et al., (1997)
0-21 day	5.1	2.7	-	66;660; 6600	-	-	-	-	56; 58.4; 58.2	Qian et al., (1997)
Layer	3.3	1.55	600	-	-	-	0;5	-	62.9;76.6	Carlos and Edwards, (1998)

5. ANIMAL WELFARE AND LIVESTOCK SUSTAINABILITY IN THE WORLD AND TURKEY

The Universal Declaration on Animal Welfare has set out the social benefits of animal welfare. Among these social benefits, animal welfare has been stated as an indispensable element in the process of sustainability goals and combating climate change. Changing animal husbandry practices by improving animal welfare will lead to sustainable production (WSPA, 2017).

Simply increasing livestock numbers in line with increasing demand is not a sustainable option, given the potential environmental impacts of livestock production (FAWC, 2014). Moreover, even if the wastage rates of 21% and 16% in meat and milk are successfully reduced, it is projected that demand will not be met in 2050 (FAO, 2012). For these reasons, animal welfare is among the key elements of the process in line with sustainability goals. Understanding the place of animal production in sustainability is becoming increasingly necessary due to the global food demand, which is expected to increase dramatically (Sert and Uzmay, 2017).

After the 1950s, with the development of the so-called "Green Revolution", modern agricultural methods became widespread and intensive production systems were introduced in livestock farms, exposing animals to mistreatment. The negative impact of these new production systems on the sustainability of life has been scientifically proven. The problems that have emerged as a result of the green revolution must be ended as they harm the present and future sustainability of human life (Susanto, 2015). The green revolution has not only caused environmental damage but also social and economic damage. The social change necessary to eliminate these negative effects has been the main goal of organic agriculture. Animal welfare, which came to the agenda as a reaction to the poor housing conditions and inhumane treatment that became widespread with the "Green Revolution", is among the basic elements of organic agriculture. Environmentally friendly agriculture, food safety and animal welfare are integral elements of the process in sustainable development goals (Sert and Uzmay, 2017).

The livestock sector is currently the world's largest user of natural resources: 80% of agricultural land is used for grazing or animal feed production, and 8% of global water use is used specifically for irrigation of forage crops (Steinfeld et al., 2006).

With the global population expected to exceed 9 billion by 2050, and in light of increasing life expectancy and urbanization, accelerating migration and limited environmental resources, these population trends will have far-reaching impacts for generations. By 2050, at least 3 billion people are expected to enter the middle class. The Food and Agriculture Organization of the United Nations (FAO) estimates that this will lead to a 60% increase in demand for high quality protein such as milk and meat (FAO, 2012). For all these reasons, livestock production is extremely important within the scope of sustainability.

In line with the developments in the world, discussions on animal welfare have gained momentum in Turkey. The issue of animal welfare has become one of the current issues in Turkey due to many reasons such as changing consumer demands, economic concerns of producers, especially the desire of producers to make more profit, criticism of today's intensive production systems that threaten sustainability, etc. Animal welfare, which is an important element of the food chain and ecological production systems, has gained great importance within the scope of good agricultural practices. In the 2018-2022 Strategic Plan of the MoFAL, the main objectives are to reach the targeted production levels by reducing economic losses due to diseases and pests, protect animal welfare, increase the income of producers and facilitate domestic and foreign trade through animal health practices based on reliable food supply (Sert and Uzmay, 2017).

According to the annual reports of the Ministry of Food, Agriculture and Livestock, the livestock sector in Turkey has come a long way since the 2000s. The most important legal regulation in this process in Turkey was the Animal Protection Law No. 5199 in 2004 (Sert and Uzmay, 2017). However, this law does not only cover farm animals but also laboratory animals, pet animals and wild animals.

These legislative efforts in Turkey have been primarily aimed at determining the conditions of transportation and slaughter. Important developments after 2004 were the adoption of the "Regulation on the Welfare and Protection of Animals during Transport" dated 24.12.2011 and numbered 28152, the "Regulation on General Provisions on the Welfare of Farm Animals" dated 22.11.2014 and numbered 29183, and the "Regulation on Minimum

Standards for the Protection of Calves" dated 22.11.2014 and numbered 29183. However, the difficulties in the implementation process of these regulations and the lack of supervision caused the targeted success of the regulations not to be achieved (Sert and Uzmay, 2017).

Turkey has taken measures to improve animal welfare in the European Union harmonization acquis; however, it has still not reached the European Union standards in terms of hygiene and design of shelters. Failure to reach the desired level in terms of quality and hygiene has been a limiting factor in animal export potential (Sert and Uzmay, 2017).

6. CONCLUSION

Animal scientists generally strive to find scientific and methodical solutions to make animal production more efficient and effective, to improve welfare, and to ensure that the methods used are environmentally sustainable. How the possible solutions found/to be found during this endeavor will be received and/or understood by the public is not a very common concern (Place, 2018). Often, the economic sustainability of animal welfare tends to take precedence over the environmental sustainability of animal welfare. However, this relationship between production efficiency and animal welfare is not always positive, and even when it is positive, it is clear that environmental impacts should not be ignored and that environmental sustainability should not be completely neglected. It has become one of today's necessities that social sustainability concerns should also be taken into account when studying animal welfare, and that production and research should be planned and implemented in three dimensions to cover these environmental, economic and social sustainability areas. As public understanding and interest in animal production increases with the increasing demand for animal protein, new research approaches are needed to address the environmental, economic and social dimensions of the issue.

REFERENCES

Akça, B., Yetişgin, S.O. (2023). Hayvansal Üretim Sistemlerinde Sera Gazı Emisyonlarının Etkisini Hafifletmeye Yönelik Öneriler. Turkish Journal of Agriculture - Food Science and Technology, 11(5): 987-993, https://doi.org/10.24925/turjaf.v11i5.987-993.6022.

Andeweg, K., Reisinger, A. (2013). Reducing greenhouse gas emissions from livestock: Best practice and emerging options. Global Research Alliance on Agricultural Greenhouse Gases. New Zealand Agricultural Greenhouse Gas Research Centre.

Arvidsson Segerkvist, K., Hansson, H., Sonesson, U., Gunnarsson, S. (2021). A Systematic Mapping of Current Literature on Sustainability at Farm-Level in Beef and Lamb Meat Production. Sustainability. 13(5):2488. https://doi.org/10.3390/su13052488.

Baumgard, L.H., Rhoads, R.P. (2013). Effects of heat stress on postabsorptive metabolism and energetics. Annu Rev Anim Biosci. 1:311–337.

Bell, M.J., Wall, E., Simm, G., Russell, G. (2011). Effects of genetic line and feeding system on methane emission from dairy systems. Animal Feed Science and Technology 166, 699–707.

Bertocchi, L., Fusi, F. (2014). Guidelines For The Assessment Of Welfare And Biosecurıty In Dairy Cattle In Loose Housing Systems. 1st Edition, Publisher: Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna "Bruno Ubertini"; Brescia, Italy. ISBN: 978-88-9097-041-2

Biehl, R.R., Baker, D.H. (1997). Microbial phytase improves amino acid utilization in young chicks fed diets based on soybean meal but not diets based on peanut meal. Poultry Science, Vol:76(2), 355-360. https://doi.org/10.1093/ps/76.2.355.

Boling, S. D., D. M. Webel, I. Mavromichalis, C. M. Parsons, and D. H. Baker. (2000). The effect of citric acid on phytate-phosphorus utilization in young chicks and pigs. J. Anim. Sci. 78:682–689

Broom, D.M., Galindo, F.A., Murgueitio, E. (2013). Sustainable, efficient livestock production with high biodiversity and good welfare for animals. Proceedings of the Royal Society B: Biological Sciences 280, 1771.

Coon, C.N., De Beer, M., Manangi, M., Lu, J., Reyes, M., Bramwell K. and Sun, J. M. (2006). Broiler Breeder Nutrition: The Amino Acid and Crude Protein Requirements of Broiler Breeder Hens for Maintenance, Production and Fertility. Proceedings of Arkansas Nutrition Conference, Rogers, Arkansas.

Cromwell, G. L., J. L. Pierce, H. L. Stillborn, D. W. Rice, D. S. Ertl, and V. Raboy. (1998). Bioavailability of phosphorus in low-phytic acid corn for chicks. Poult Sci. 77(Suppl. 1):117.

Darnhofer, I., Fairweather, J., Moller, H. (2010). Assessing a farm's sustainability: insights from resilience thinking. International Journal of Agricultural Sustainability, 8 (3):186–198.

Edwards, Jr., H. M. (2002). Studies on the efficacy of cholecalciferol and derivatives for stimulating phytate utilization in broilers. Poult. Sci. 81:1026–1031.

Farm Animal Welfare Committe (FAWC), (2011). Economics and Farm Animal Welfare, London, United Kingdom. From http://www.defra.gov.uk/fawc/

Food and Agriculture Organization (FAO), (2012). World agriculture towards 2030/2050: The 2012 Revision. ESA Working Paper No. 12-03, Rome.

Hemsworth, P.H., Coleman, G.J. (2011). Human–livestock interactions. In The stockperson and the productivity and welfare of farmed animals (ed. PH Hemsworth and GJ Coleman), p 208. CABI, Wallingford, UK.

Kasim, A. B., and H. M. Edwards, Jr. (2000). Effect of sources of maize and maize particle sizes on the utilization of phytate phosphorus in broiler chicks. Anim. Feed Sci. Technol. 86:15-26.

Knapp, J.R., Cady, R.A. (2015). Estimated feed and water requirements to meet global 2050 demand for animal proteins. Journal of Dairy Science 98 (E-Supplement 2): 719.

Knowlton, K.F., Radcliffe, J.S., Novak, C.L., Emmerson, D.A. (2004). Animal management to reduce phosphorus losses to the environment. J. Anim. Sci. 82(E. Suppl.), E173–E195.

Koç, G., Uzmay, A. (2019). The effect of climate change on the cost of dairy farms in Turkey; Case study of Thrace Region. Mediterranean Journal of Economics, Agriculture and Environment, Vol. 18:3, 31-45.

Koyuncu, M. ve Nageye, F.İ. (2020). İklim Değişikliğinin Sürdürülebilir Hayvancılığa Etkileri, J. Anim. Prod., 61 (2): 157-167, https://doi.org/10.29185/hayuretim.673145.

Li, Y. C., D. R. Ledoux, T. L. Veum, V. Raboy, and D. S. Ertl. (2000). Effects of low phytic acid corn on phosphorus utilization, performance, and bone mineralization in broiler chicks. Poult. Sci. 79:1444-1450.

Nelson, G.C., Rosegrant, M.W., Koo, J., Robertson, R., Sulser, T., Zhu, T., Ringler, C., Msangi, S., Palazzo, A., Batka, M., Magalhaes, M., Valmonte-Santos, R., Ewing, M., Lee, D., (2009). Climate Change Impact on Agriculture and Costs of Adaptation. International Food Policy Research Institute.

Place, S.E. (2018). Animal Welfare and Environmental Issues. Chapter 4 of the book "Advances in Animal Agricultural Welfare-Science and Practice". Ed: Mench, J.A., Woodhead Publishing. United Kingdom. ISBN: 978-0-08-101246-8.

Qian, H., E. T. Kornegay, and D. M. Denbow. (1997). Utilization of phytate phosphorus and calcium as influenced by microbial phytase, cholecalciferol, and the calcium: total phosphorus ratio in broiler diets. Poult. Sci. 76:37-46.

Rotz, C.A., (2004). Management to reduce nitrogen losses in animal production. J. Anim. Sci. 82(l.), E119-E137

Schmidt, M. and L. Jacobson, (1994). Manure Management: Practices for the Minnesota Pork Industry. Minnesota Extension Service. Periodical, 298-65-11.

Sert, H., Uzmay, A. (2017). Dünya'da Hayvan Refahı Uygulamalarının Ekonomik ve Sürdürülebilirlik Açısından Değerlendirilmesi. Adnan Menderes University, Journal of Institute of Social Sciences, Vol.:4, No: 4 (pp. 263-276).

Shibata, M., Terada, F. (2010). Factors affecting methane production and mitigation in ruminants. Animal Science Journal 81, 2e10.

Steınfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. and De Haan, C. (2006). Livestock's long shadow - Environmental issues and options, FAO Agriculture Technical Paper, Rome.

Susanto, I.R. (2015). Sustainable organic farming for environmental health: a social development model, Internetional Journal of Scientific and Technology Research 4(5): 196-211.

Thornton, P.K., Ericksen, P.J., Herrero, M., Challinor, A.J. (2014). Climate variability and vulnerability to climate change: a review. Global Change Biol. 20, 3313-3328.

WSPA, (2007). World Society for the Protection of Animals. Universal Declaration on Animal Welfare.

Zhang, Z. B., E. T. Kornegay, J. S. Radcliffe, D. M. Denbow, H. P. Viet, Larsen, C. T. (2000). Comparison of genetically engineered microbial and plant phytase for young broilers. Poult. Sci. 79:709-717.

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