TOWARDS A PRECISION ANIMAL NUTRITION

EDITOR: Assist. Prof. Dr. Aynur BİLMEZ ÖZÇINAR

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PREFACE

Principles of basic animal nutrition and feeding subjects chemical composition, nutritive value, intake, digestion, absorption, utilization, gastrointestinal functionality of feeds in animal nutrition and health. In the last decades, precision animal nutrition is the new trend which combines and balance highly diversified feed constitutes such as probiotics, prebiotics, synbiotics, smino acids, protein hydrolysates, lipids, enzymes, vitamins, trace elements, clay minerals, dietary fibers, nonstarch polysaccharides, essential oils, herbs, spices and their extracts, saponins, condensed tannins, phytogenic feed additives, butyrate and many others. Apart from nutrition, some new approaches are tied to animal nutrition in relation to mycotoxins, antibiotics, oxidant/antioxidant balance, genetically modified feeds, deficiency and excess of minerals, nano mineral elements and many others. Sector is in a fast progress. Here some different approaches are presented in this book.

Assist. Prof. Dr. Aynur BİLMEZ ÖZÇINAR

CHAPTER 1

USE OF THYME IN THE NUTRITION OF BROILER CHICKENS

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1. INTRODUCTION

The world population, which was 3.5 billion in 1960, doubled in 2010. It is expected to reach approximately 9-10 billion in the next 30 years. While 33% of the global population were living in cities during the 1960s, this ratio is expected to reach 50% by 2010. It is predicted that 67% of the global population will be living in cities by 2050. Increasing urbanization with population growth is a prominent situation, especially in developing countries. Developing countries face several problems. When considered the arable land acreages and water are the main limiting factors in agriculture, which cannot be increased, it is predicted that food security will be a major problem. However, with the increasing desertification in different parts of the world, water is becoming a more valuable and scarce resource. Global climate change due to human activities, including animal production, decrease the amount and frequency of snow and rain precipitation, which has negative impacts on agriculture and animal husbandry (Crovetto, 2019).

Consumption of meat and other animal products has increased significantly worldwide as economically-increasing countries such as China, India, and Brazil are transitioning from a plant-based to a meat-based diet. According to global statistics, consumption of meat and other animal foods is totally income indexed. As the world population continues to increase, there will be a trend towards urbanization as countries become richer and income levels get rise. According to the Food and Agriculture Organization, the demand to meat and other livestock products is increasing radically and food production must

increase by about 70% from its current level by 2050 to feed the expected world population of 9-10 billion (FAO 2009). The poultry industry stands out to meet the increasing demand. Poultry meat is cheap compared to other protein sources, and is an animal origined protein source which is necessary for a healthy and balanced human diet.

When figures in recent years are analysed, it can be observed that poultry meat consumption is increasing both in developed and developing countries. Poultry meat consumption is also increasing in Turkey. When consumption amounts are examined, per capita consumption was approximately 1-1,5 kg; 10,2 kg; 15,4 kg; 19,2 kg and 21,9 kg in 1980s, 2001, 2005, 2010 and 2016, respectively. According to forecasts, this figure is expected to be 30 kg in 2025. The poultry sector has adopted intensive livestock husbandary systems to feed people with high-quality, safe foods, but faced several problems such as industrial-scale stress, sudden deaths and feed losses (Aydın, 2019). Synthetic substances have been used extensively to solve these problems. Due to the negative effects of the used synthetic materials on human health and the environment, antibiotic usage in animal production is prohibited primarily in the European Union (EU) countries. In this period, the producers faced serious public pressure. Awareness of consumers has highlighted the desire for a cleaner environment. This situation has led to the research and development on new unpolluting technologies adopted to animal production for the benefit of human health. Consumers have taken the risk of paying high prices by giving priority to more naturally produced foods from plant

and animal origin to consume (Saraç, 2009). As a result of the current situation, the search for alternative additives to replace synthetic substances has started. There has been an increased interest in products which do not harm human health, do not leave residues, and are abundant. Medicinal and aromatic plants, which have been used for centuries for different purposes (spice, medicine, fragrance, etc.), was emerged for this aim. Different studies examining the different effects (antimicrobial, antioxidant, antifungal) of sage, rosemary, ginger and thyme (Fan and Chen, 2001; Parlat et al., 2005; Kulisic et al., 2006; Çetin et al., 2011; Witkowska et al. ., 2016; Gümüş et al., 2017; Sevim and Cufadar, 2017; Aljabeili et al., 2018) are currently available. Use of medicinal aromatic plants as spices and in the treatment of various diseases and obtaining some active substances of some drugs from these plants, facilitated the producer, consumer and researcher adoption to these products. Thyme, whose properties have are well known for a long period of time, is one of the aromatic plants that is emphasized.

2. PRODUCTION AND IMPORTANCE OF THYME PLANT

There are various explanations about the origin of the name Thymus, which is the Latin name of the thyme plant. Some authors hypothesize that the Latin name for Thymus source from the Greek word thyo (perfume). Another form of its etymology is that it includes the Greek word thymos (courage, strength). Originally 'thymus' described a group of aromatic plants with similar properties used as stimulants of vital functions. (Stahl-Biskup and Sáez, 2002).

Thyme was a symbol of nobility, courage and wealth in ancient times. Soldiers of the Roman army bathed with thyme to increase their courage and fighting motivation (Kerem, 2021). In the 1st century AD, oils obtained from the thyme plant were used as mouthwash for oral health and as an antiseptic in the treatment of wounds (Bozdemir, 2019).

In Turkey, it is the third largest family with 45 genera and and 550 species, and there are five genera named Thymus, Origanum, Satureja, Tymbra and Coridothymus. The essential oil components of the thyme plant are mainly carvacrol, thymol, or both. While the number of species in the genus Thymus is 220, Turkey has 39 species. While the number of species belonging to the genus Origanum is 43, there are 23 species in Turkey. There are 13 species of total 30 species of Satureja genus in Turkey; 2 species of total 12 species of Thymbra genus and only one species of Coridothymus genus in Turkey. In Turkey, approximately 44.2% of the species are from the *Lamiaceae* genus, 65.2% of the species from the *Origanum* genus, 52.6% of the species from the *Thymus* genus and 28% of the species from the Satureja genus are endemic. This indicates that Turkey is the gene center of the mentioned genera (Bozdemir, 2019).

Thyme cultivation in Turkey is increasing in recent years and almost all of the exported thyme is produced agricultural fields. Thyme plant has an important place in Turkey's export products (Figure 1). Turkey's thyme production is 20,000 tons/year. Turkey ranks first in amount of thyme production and export in the world. Almost 70% of the world's thyme consumption are supplied by Turkey. The USA, Germany, Italy,

Canada, Poland, Netherlands, Belgium, Republic of South Africa, France, Japan and Australia are the countries importing Turkish thyme (Sokat, 2021).

Thyme production in Turkey is concentrated in the Aegean Region, where 95% of the 20,000 tons/year thyme production is from this region. Denizli (88%) and Manisa (4.6%) provinces are leaders in thyme production. In some regions, thyme is collected from nature and marketed at certain periods of the year. İzmir thyme (*O. onites*) and Çanakkale thyme (*O. vulgare*) species are cultivated under field conditions. The economic life of perennial plant thyme is 7 years. Depending on the cultivation conditions, its economic life is up to 10 years. Thyme, which is resistant to drought and cold stress, is not very selective in terms of soil requirement. Sandy-loamy, water-repellent, slightly inclined soils are suitable for thyme cultivation. While İzmir thyme mostly adapts to field conditions, Çanakkale thyme stands out in terms of adaptation to flat and high water-holding soil conditions. Thyme plant can be propagated by seeds and cuttings. Thyme seeds are planted in specially prepared pillows for planting in October, November and December, to produce seedlings. Although differ from region to region, thyme seedlings are planted in open fields starting from frost free time in the spring, commonly starting from the end of March to the mid-May, by using a thyme planting machine. Harvesting of thyme starts at the beginning of blooming or at the full bloom stage. Harvesting is applied from 10 cm above the soil level with a saw blade or special harvesting machine adopted to this plant (Sokat, 2021).

Thyme contains terpineol, linalool, carvacrol, cymol, thymol, p-cimen and borneol in different proportions (Table 1). Thymol and carvacrol are the active components that add thyme its unique smell. Thymol and carvacrol are the main components of thyme essential oil. Carvacrol is mostly present in the essential oil of *Thymbra*, *Origanum* and *Satureja* species, and thymol is present in higher proportions in the essential oil of *Thymus* species. Due to its crystallizable feature, thymol is widely used in the pharmaceutical industry and is also a strong antimicrobial. It is also used for food flavoring in various countries. Carvacrol, which has no crystallization feature, has limited use in the pharmaceutical industry. Carvacrol, which can have antibacterial and antifungal (especially against Aspergillus fungi that produce aflatoxin) effects, extends the shelf life of foods (Bozdemir, 2019).

Figure 1. Thyme production amounts by years (tons) (Boztaş et al., 2021)

Table 1. Essential oil components (%) of *Origanum onites* L. at different harvest times (Can et al., 2021)

Components	**Pre-blooming**	**Start of blooming**	**Full bloom**	**End of blooming**
α-Pinene	0.56	0.52	0.42	0.64
α-Thujene	0.95	0.82	0.85	1.22
Camphene	0.00	0.00	0.00	0.35
β-Myrcene	1.67	1.31	1.37	1.71
α-Terpinene	1.27	1.07	1.06	1.11
γ-Terpinene	5.39	4.58	4.48	4.94
p-Cymene	3.12	5.10	4.31	3.68
1-Octen-3-ol	0.00	0.24	0.00	0.00
trans-Sabinene-hydrate	0.46	0.49	0.42	0.50
Linalool	0.56	0.00	0.00	4.14
Linalyl acetate	0.25	0.00	0.00	0.00
Terpinene-4-ol	0.71	0.58	0.63	0.76
β-Caryophyllene	0.74	0.53	0.56	0.67
Borneol	0.53	0.54	0.56	1.37
β- Bisabolene	0.74	0.26	0.43	0.88
Carvone	0.00	0.55	0.00	0.00

Carvacryl acetate	0.34	0.00	0.00	0.00
Caryophyllene oxide	0.00	0.25	0.25	0.00
Thymol	0.32	0.36	0.33	0.37
tau-Cadinol	0.36	0.00	0.00	0.30
Carvacrol	82.03	82.80	84.35	77.36

3. USE OF THYME IN NUTRITION OF BROILER CHICKENS

3.1. Effects of Thyme on Performance in Broilers

As thyme plant is rich in essential oils, it has attracted attention of producers in the poultry industry and researchers working on alternative feed additives. Many studies were conducted on the subject. Factors such as growth climatic conditions and fertilization applications change the essential oil content of the thyme plant. Since these factors affect the content of thyme used for feeding broiler chickens, they may also effect the results. Generally in studies on broiler chickens, essential oil, extract or thyme water was added to broiler feeds. Different research results were reported, depend on the application types and addition levels to the meals.

In their study, Bölükbaşı and Erhan (2006) stated that adding 100 and 200 mg/kg of thyme oil to broiler mixed feeds was not affective on the performance parameters. Saraç (2009) stated that, addition of 100, 200 and 300 mg/kg thyme essential oil to broiler rations was significantly effective on performance. Göçmen (2014) stated that adding thyme at

4 different levels (1.66, 3.33, 4.99 and 6.66 g/kg) into broiler rations was not affective on the live weight and feed conversion ratio, but there was a significant difference between the groups in terms of feed consumption and the highest feed consumption. Halle et al., (2004) informed that, thyme oregano essential oil in broiler rations at 2, 4, 10 and 20 g/kg thyme or 0.1, 0.2, 0.5 and 1.0 g/kg levels increased the feed conversion rate. Feizi et al. (2013) reported that the addition of 200 cc/L to broiler waters increased the live weight and feed conversion rate, decreased the mortality rate. Zhu et al. (2014) informed that the addition of 0.05, 0.10, 0.15, 0.20, 0.25, 0.30 and 0.35 mg/kg thyme essential oil to broiler mixed feeds was not affective on feed consumption, but increased the body weight and feed conversion ratio with level of 0.10 mg/kg, compared to the control group. Placa et al., (2019) reported that addition of 0.05% and 0.1% thyme essential oil to broiler mixed feeds was not affective the performance parameters. Hassan and Awad (2017) added 2, 5, 8 g/kg thyme powder to broiler rations which increased body weight gain 5 g/kg and feed consumption, but was not affective on feed conversion rate. Fallah and Mirzaei (2016) reported that the addition of 5 g/kg thyme powder to broiler feeds was not affective on the performance values. Saleh et al., (2014) found no effect on live weight, live weight gain, feed conversion rate with addition of 200 mg/kg level of thyme essential oil. El-Ghousein and Beitawi (2009) reported that the addition of crumbled thyme at the rate of 2.0% increased the performance parameters in their study in which they added 0.5%, 1.0%, 1.5% and 2.0% crumbled thyme to broiler rations. Amouzmehr et al. (2012) found that the addition of 0.3% and 0.6% thyme extract to

broiler mixed feeds was not affective on performance parameters. Mansoub and Myandoab (2011) reported that the addition of thyme powder at the rate of 0.75%, 1.0%, 1.5% and 2.0% to broiler mixed feeds was significantly effective on performance.

3.2. Effects of Thyme on Carcass Quality in Broilers

Carcass quality is one of the most important criteria affecting marketable meat quality in broilers. Various studies were conducted by different researchers on the effect of thyme on carcass quality. Bölükbaşı and Erhan (2006) stated that adding thyme oil at 100 and 200 mg/kg levels to broiler mixed feeds reduced the amount of saturated fatty acids and polyunsaturated fatty acids and increased the amount of monounsaturated fatty acids. Saraç, (2009) added 100, 200 and 300 mg/kg thyme essential oil and was not determined a significant effect on carcass parameters. Göçmen (2014) stated that, addition of four different thyme powder (1.66, 3.33, 4.99 and 6.66 g/kg) to broiler rations was not differed carcass, liver, heart, gizzard, pancreas and abdominal fat weights significantly. Halle et al., (2004) added 2, 4, 10 and 20 g/kg thyme or 0.1, 0.2, 0.5 and 1.0 g/kg thyme essential oil to broiler rations and found no affect on carcass parameters, Hassan and Awad., (2017) added 2, 5 and 8 g/kg thyme powder to broiler rations and found no affect on carcass parameters, Amouzmehr et al. (2012) added 0.3% and 0.6% thyme extract to broiler mixed feeds and found no affect on carcass parameters. Pournazari et al., (2017) stated that adding thyme oil at a level of 1g/kg to mixed feed reduced the ratio of thigh and wing, but was not affective on other carcass parameters;

Mansoub and Myandoab (2011) stated that addition of 0.75%, 1.0%, 1.5% and 2.0% thyme powder to the mixed feed significantly affected the carcass characteristics; Toghyani et al. (2010) added 5 and 10 g/kg thyme powder to mixed feed and found no affect on carcass parameters; Amouei et al. (2021) found that adding 0.75 g/kg of thyme essential oil to the mixed feed was not effective on carcass parameters; Pourmahmoud et al., (2012) added 0.2%, 0.4% and 0.6% thyme extract to mixed feed and was not affective on carcass parameters; Kassie, (2009) added thyme extract to mixed feed at 200 mg/kg level and found that it increased liver, heart, gizzard weights, but reduced abdominal fat.

3.3. The Effects of Thyme on Serum Parameters in Broilers

There are research results reporting that essential oil, extract, powder and water obtained from the thyme plant have different effects on serum parameters. Used levels, added form and active ingredient components of thyme may have been effective in the differences in these results. Saraç (2009) stated that addition of 100, 200 and 300 mg/kg thyme essential oil to broiler rations was not significantly effective on serum biochemistry and serum antioxidants. Göçmen, (2014) added 4 different thyme powders (1.66) to broiler rations (1.66, 3.33, 4.99 and 6.66 gr/kg), but found no significant difference between the groups in terms of serum parameters such as alkaline phosphatase, total protein, cholesterol, LDL and HDL cholesterol, calcium and phosphorus. Instead, there was a significant difference in terms of albumin, triglyceride and VLDL cholesterol but no affect was reported on carcass

parameters. Bilgin and Kocabağlı (2013) reported that addition of 150 and 300 mg/kg thyme essential oil to broiler rations was not affective on plasma total cholesterol, HDL cholesterol and triglyceride levels. Hassan and Awad (2017) added 2, 5, 8 g/kg thyme powder to broiler rations without any affect on globulin, albumin, total protein, triglyceride values at 5 g/kg level, but it decreased cholesterol and LDL cholesterol and increased HDL cholesterol values. Fallah and Mirzaei, (2016) added 5 g/kg thyme powder to broiler feeds without any effect on glucose, total protein, uric acid and triglyceride values, but total cholesterol, HDL and LDL cholesterol values were decreased. Saleh et al., (2014) informed that 200 mg/kg thyme essential oil addition increased total protein, globulin, AST levels. El-Ghousein and Beitawi, (2009) added crumbled thyme to broiler (0.5%, 1.0%, 1.5% and 2.0% in rations) and observed reduced serum triglyceride and cholesterol levels; increased glucose, total protein and globulin levels. Amouzmehr et al., (2012) found that addition of 0.3% and 0.6% thyme extract to broiler mixed feeds was not affective on blood lipids levels; Pournazari et al., (2017) reported that adding 1 g/kg of thyme oil to broiler mixed feeds was not affective on serum parameters. Mansoub and Myandoab (2011) reported that addition of 0.75%, 1.0%, 1.5% and 2.0% thyme powder to compound feeds significantly affected serum biochemistry parameters; Toghyani et al., (2010) added 5 and 10 g/kg thyme powder to broiler compound feeds which increased HDL cholesterol, one of the serum parameters at 10g/kg level, was not affective on other parameters. Kassie, (2009) stated that adding thyme extract at 200 mg/kg level to broiler mixed feeds reduced serum cholesterol level but

increased serum total protein; Al-Mashhadani et al., (2011) reported that addition of 300 mg/kg thyme essential oil to broiler rations reduced serum glucose and cholesterol level;, Pourmahmoud et al., (2012) stated that addition of 0.2%, 0.4% and 0.6% thyme extract to broiler mixed feeds increased serum cholesterol by 0.4% and decreased serum triglyceride. The differences between the results reported by the researchers may be due to the amount of active ingredients contained in thyme essential oil, the levels added to the mixed feed and the applied forms (oil, powder, extract, etc.).

CONCLUSIONS

It is concluded that thyme essential oil can be used as an alternative feed additive in broiler feeds due to its antimicrobial, antifungal and antioxidant effects depending on the contained components. In many studies, it was stated that thyme essential oil has a positive effect on performance, carcass quality and serum parameters in broilers. However, there is the need for more scientific research on its usage in broiler nutrition, since the results of the studies on this subject are inconsistent and the action mechanism and correct application levels are not clear.

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CHAPTER 2

AVIAN DIGESTIVE SYSTEM ANATOMY

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INTRODUCTION

The nutrients and energy required for the survival of the living thing, growth, and repair of worn-out cells and tissues are obtained as a result of the digestion of the foods that are taken. Ingested foodstuffs progress by undergoing changes in the digestive tract with mechanical, enzymatic, chemical and bacterial effects. The secretions of the pancreas, liver, stomach, and small intestines also play an important role as secretion factors in the change of nutrients in the digestive tract. In order for nutrients to be used by cells and organs, they must be broken down to such an extent that they can be mixed with blood and lymph as a result of mechanical and chemical digestion. The main goal of the digestive system organs (rostrum, lingua, pharynx, glandulae salivales, esophagus, ingluvies, gaster, intestinal, hepar, vesica fellea, pancreas) is to break down the ingested nutrients into building blocks and make them absorbable from the intestines. The best absorption of digested nutrients from the intestines depends on the size of the inner surface of the intestine. The larger the inner surface of the intestine, the better the absorption. The absorption surface is increased by glove-like mucous membranes called villi that line the inner surface of the intestine.

We can briefly summarize the digestive system organs and functions in poultry as follows; the initial part of the digestive system is the beak (rostrum), which corresponds to the lips in mammals. The beak is responsible for catching food, breaking it down, and straightening the feathers. In poultry, the tongue (lingua) functions to capture nutrients

rather than mixing them in developed species. The saliva secreted by the salivary glands is responsible for creating lubrication in the mouth. It is responsible moistening and softening the feed. The esophagus is the tubular organ that allows food to pass through the pharynx and reach the crop (ingluvies). The crop stores and softens the nutrients and sends them slowly to the proventriculus. The glandular stomach (proventriculus) initiates chemical digestion with the digestive enzymes it produces. Mechanical digestion takes place thanks to the stones in the muscular stomach (ventriculus). The intestines (intestinum) is the part of the digestive tract that starts from the muscular stomach and ends in the coprodeum of the cloaca.

1. Systema Digestorium

In avian, unlike other animals, at first sight we notice; lip, cheek, teeth, soft palate, and the absence of a mammal-like pharynx (Çalışlar 1986, Dursun 2007). The cavum nasi participates with the oral cavity through the choana cleft in the palate. The border of the cavum oris and cavum pharyngis is distinguished only by the upper palate and inferiorly by the tongue papilla. Cavum pharyngis; It is the counterpart of the pars oralis pharyngis in mammals and is completely covered by cutaneous mucosa. The lower and upper jaws form the basis of the rostrum (beak). There are notches on the lower beak instead of teeth. The esophagus makes bags called ingluvies (crops) in front of the aperture thoracis cranialis. Since there are no teeth, this task is performed by the ventriculus muscularis (muscular stomach) (Dursun 2007).

In birds, the digestive tract consists of rostrum, lingua-glossa, pharynx, mouth sacs, ingluvies, esophagus, proventriculus, isthmus gastris, ventriculus, intestinum tenue (Duodenum, jejunum, ileum), intestinum crassum (cecum, rectum) and cloaca (Nickel et al. 1977, Dursun 2007, Bahadır and Yıldız 2014).

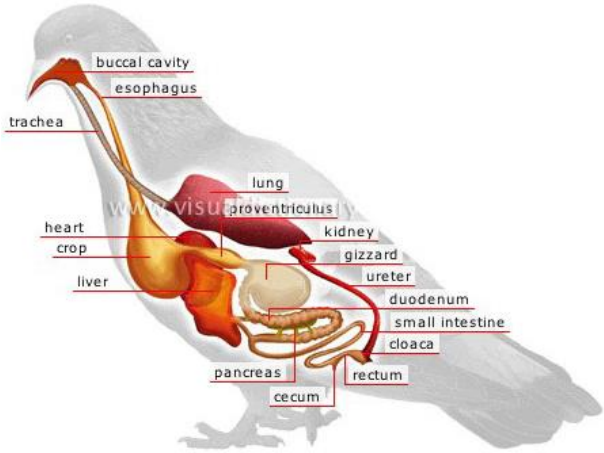

Figure 1. Anatomy of Digestive System Organs in Avians (Anonym 2016a).

1.1. Rostrum (Beak)

The beak originates from the epidermis in birds. It is used in tasks such as holding, catching, transporting, breaking down the food, straightening the feathers, and making a nest (Nickel et al. 1977).

The base of the upper beak is os inciivum, and the base of the lower beak is the mandible. The part of the beak that covers these bones like a sheath is called Rhamphotheca (Nickel et al. 1977, Dursun 2007). On the edge of the flamingo beak; It has a projection that acts as a filter for it to feed on small invertebrates, smaller flamingos, blue-green algae and protozoa (Stevens and Hume 1995). The tip of the beak that resists impacts is the hardest and strongest part. The layer from the corium of

the outer skin gives the beak its color with a red-yellow brownish tint. It is hard in the species fed with hard food and quite soft in those fed with soft food (Dursun 2007).

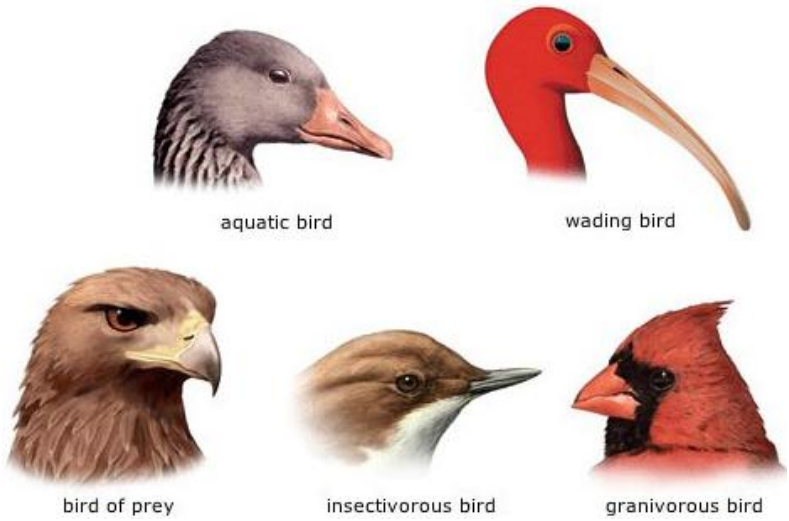

Figure 2. Characteristic Beak Shapes According to the Diet of Avian Species (Anonym 2016b).

1.2. Lingua-Glossa (Tongue)

In avian and pigeons it is narrow and pointed at the front (Nickel et al. 1977), in storks it is triangular expanding towards the radix (Tütüncü et al. 2012), in swimming birds it is broad and less pointed, in birds such as woodpeckers and colibri it is lance-shaped, in penguins isosceles triangle, sieve-shaped in vulture (Tütüncü et al. 2012), narrow and short in sparrow (Klasing 1999), small, triangular or U-shaped in ostrich (Tivane et al. 2011), and triangular in partridge (Rossi et al. 2005). Language in poultry; It has 3 parts: apex linguae, dorsum linguae and radix linguae. The anterior protrusion of the hyoid bone, the os entoglossum, enters the radix lingua and forms the basis of the tongue

(Dursun 2007). In poultry tongue, there is no internal musculature (Nickel et al. 1977). Since there is very little muscle tissue in the tongue structure, the muscles of the tongue bone provide the tongue movement. Only in very few birds, such as parrots, the tongue contains muscle (Stevens and Hume 1995). Apex linguae is the free tip of the tongue. The space under it is called cavum sublinguale apicale, and the space remaining in the lateral parts is called cavum sublinguale laterale. The tongue is attached to the floor of the mouth by the frenulum linguae, which occupies most of its length and extends to its tip (Dursun 2007). Dorsum linguae is the upper surface of the tongue against the palatum durum. The part behind the apex is called the corpus linguae. The part that connects the corpus linguae to the larynx is called the radix linguae (Dursun 2007). While the sulcus lingualis, which is located median on the dorsal surface of the tongue, is well developed in some orders (Anseriformes, Falconiformes), it is absent in some orders (Galliformes, Passeriformes, Strigiformes, Sphenisciformes) (Erdoğan and Iwasaki 2013). Roosters and waterfowl have sulcus lingualis. This groove is in perfect harmony with the median ridge on the palate, especially in geese and ducks (Dursun 2007). While some orders do not have papillae linguales (Anseriformes, Passeriformes, Struthioniformes), some have many carpet-like projections (Galliformes), some fish scale-like projections (Falconiformes), and sometimes rod-shaped projections (Strigiformes) (Erdoğan and Iwasaki 2013). While it has been reported that only papilla filiformis is found among papillae in poultry (Dursun 2007), it has also been reported that papilla filiformis and papilla conica are found together

(Sphenisciformes order) in some sources (Erdoğan and Iwasaki 2013). While no papillae were found in the apex and corpus of the dorsal part of the tongue in the stork, papilla filiformis were found in the radix linguae with their directions extending apically (Tütüncü et al. 2012). Tongues of ducks, geese and swans; It has lamellae along the beak, adapted both to filter small organisms from the water and to trap grass and seeds. The anterior portion of the domestic duck's tongue has a scoop-like projection and a double row of papilla-like projections on the lateral edge of the tongue (McLeland 1990). In geese and ducks, they are found on both the base and sides of the tongue in the form of a broad-based cone, also called the horny papilla. These conical papillae act as a filter by entering between the lamellae of the beak like a finger (Dursun 2007). It has been reported that the epithelium on the ventrolateral part of the tongue is thicker than the epithelium in other regions in chickens. While it was stated that the keratinization of the tongue was more intense in the dorsal part of the tongue (Nickel et al. 1977), it was observed that in storks, unlike other birds, keratinization was observed in the entire apex linguae and only in the dorsal part of the radix linguae (Tütüncü et al. 2012). The tongue is either strong or completely atrophied. It is vestigial in fish-eaters such as the pelican, while in woodpeckers it functions as a powerful catching organ. The sense of taste is not well developed in chickens. While birds do not usually have taste buds, they are found in the order Galliformes. Anseriformes also lacks taste buds, but Herbst corpusculum is common (Erdoğan and Iwasaki 2013). Chickens have taste buds, but goose and duck tongues do not. On the other hand, Grandry type nerve endings

that can perform this task were found in the lamina propria of the tongue. There are absolutely no taste buds at the tip of the tongue in poultry (Nickel et al. 1977).

Figure 3. Goose Tongue and Dentes (Anonym 2016c).

1.2.1.Palatum durum

In shape, it is compatible with the upper beak. It runs horizontally until the os palatinum joins the sphenoid bone. The os palatinum forms the floor of the nasal cavity and the bony roof of the palatum durum (Nickel et al. 1977). In avians, most of the palate is cleft. There is a second, median and wider cleft behind the roof of the mouth cleft (choana). This second slit is the infundibular slit, which is the common hole of both cavum tympani. In the walls of this slit is lymphatic tissue. In budgerigars, the choanal slit and the infundibular cleft open and close together. The choana cleft is long in chickens and pigeons, and short in geese and ducks. The reason why birds raise their heads while drinking water is to prevent water from going into the nasal cavity from the choanal cavity (Dursun 2007). The head is lowered to drink water. The

water is allowed to flow into the mouth, and then the mouth is closed and the head is lifted up. Thus, water and liquids flow through the esophagus under the influence of gravity. Since pigeons have a soft palate, they can easily swallow food and liquids with their heads down. (McLeland 1990, Yaman 1999). While it has been reported that the velum palatinum is absent in poultry (Nickel et al. 1977, Dursun 2007), it has been reported that pigeons have velum palatinum (McLeland 1990, Yaman 1999). In geese and ducks, the longitudinal ridge starting from the anterior end to the choanal cleft on the medial side of the palatal mucosa is called rugae palatinae mediana, and the groove around it is called sulcus palatinus medianus. Duck has 3-4 papillae on the median line on average, while goose has 15-16 papillae (Nickel et al. 1977, Dursun 2007).

1.3. Pharynx

The infundibular cleft (ostium pharyngeum tubae inspectors) located in the roof of the pharynx connects the pharyngeal cavity with the middle ear. Next to them gl. pterygoidea with gl. tubariae have flowing holes. The transversal row of papillae behind the slit gives the upper initial border of the esophagus (Dursun 2007). The rostral part of the oropharynx is bounded dorsally by the maxillary rhamphotheca and ventrally by the mandibular rhamphotheca (Tivane et al. 2011). The wide slit in the middle of the base of the pharynx is the entrance to the larynx cranialis. In the middle of this are two rows of transversal papillae that form the lower initial border of the esophagus (Dursun 2007).

1.4. Glandulae Salivales (Salivary Glands)

The salivary glands (gll.) are well developed in insect- and grain-fed birds, but not developed that feed on foods such as fish. It is absent in birds such as cormorants. The salivary glands in chickens from domestic poultry are well developed; gll. maxillares, gll. palatinae and gll. sphenopterygoideae is found on the roof of the oropharynx. The salivary glands in the cheek, gll. linguales and gll. mandibulares are located at the base of the oropharynx. In woodpeckers, the secretion of gll. mandibulares and gll. linguales is important in catching insects with its fluid and sticky properties. The secretion of gll. mandibulares in swallows is in the form of free glycoprotein and is used for nest building. (Dursun 2007). The salivary glands in poultry are as follows according to their location (Özer 2010); gll. maxillares, gll. palatinae, gll. pterygoideae, gll. tubariae, gll. mandibulares, gl. anguli oris and gll. linguales.

1.4.1.Gll. maxillares: It spreads from the choanal cleft to the part between the os inciivum. The draining duct opens to the apical region of the palate, bilaterally just below the rugae palatina mediana (Nickel et al. 1977).

1.4.2.Gll. palatinae: There are two groups, lateral and medial. The gll. palatinae laterales is located under the outer side of the rugae palatinae laterales, while the gll. palatinae mediales is located around the choanal cleft (Nickel et al. 1977).

1.4.3.Gll. pterygoideae (gll. sphenopterygoideae): They are located under the pharynx mucosa and around the infindibulum (Nickel ve ark. 1977).

1.4.4.Gll. tubariae: They are located around the tubae auditivae and open here (Dursun 2007).

1.4.5.Gll. mandibulares: There are two groups as gll. mandibulares anteriores and posteriores. It is located on the floor of the mouth between the tongue and the beak. The part of the tongue that settles in the cavum sublinguale apicale in the anterior part of the apex is called gll. mandibulares anteriores, and the part that settles in the cavum sublinguale laterale is called gll. mandibulares posteriores (gll. sublinguales). (Nickel et al. 1977).

1.4.6.Gl. anguli oris: It is located under the mucous membrane at the angle of the mouth (Dursun 2007).

1.4.7.Gll. linguales: There are two groups as gll. lingualis anteriores and posteriores. The anterior group is located on the lateral surfaces of the tongue, the posterior group is located on the radix linguae (Nickel et al. 1977). All birds have lymphoreticular tissue in the mucosa around the tubae auditivae. Gll. palatinae, gll. linguales, gll. mandibulares anteriores polystomatic glands; gl. maxillaris and gl. anguli oris are monostomatic glands (Özer 2010).

1.5. Esophagus

It has a relatively expandable structure. The initial part is located dorsal to the trachea. Then it turns right and watches on the right side of the neck. It shows a large enlargement (ingluves) at the chest entrance. Ingluvies are located to the right of the midline. It acts as a warehouse and is not well developed in grain-eating birds (Çalışlar 1986). The average length of the esophagus in the homing pigeon is longer in males than in females. It is divided into two parts, the pars cervicalis, which is long, and the pars thoracica, which is shorter. In the study performed in both sexes in homing pigeons, it was observed that the lumen diameter of the pars cervicalis was larger than the lumen diameter of the pars thoracalis (Kadhim and Mohamed 2015). Pars thoracica is shorter than pars cervicalis (Dursun 2007). Pars cervicalis is extensible, especially in waterfowl (Nickel et al. 1977). The pars cervicalis of the esophagus runs dorsal to the trachea in the upper part of the neck. Then, it passes to the right side of the trachea, unlike domestic mammals, from the level of the 5th cervical vertebrae in chickens in the middle of the neck (Dursun 2007). It is the part of the pars thoracica esophagus that continues in the thoracic cavity after the crop. It extends backwards on the base of the heart and dorsal to the trachea, and terminates by opening into the ventriculus glandularis (Dursun 2007). It is associated with a. carotis dexter et sinister and v. jugularis dexter et sinister, which accompanies the trachea's caudal. Pars thoracica is surrounded by cervical air sac, clavicular air sac, and cranial thoracic air sacs, respectively (Nickel et al. 1977). Thanks to the longitudinal folds on the

inner surface of the esophagus, its ability to expand is very high, especially in species such as hawks, owls and cormorants (Dursun 2007).

In species where feeding is rapid, the esophagus has the narrowest volume and the least folds. When it comes to the chest entrance, a ventral enlargement forms a structure called ingluvies (crop). In some male species, esophagus expands called saccus esophagealis before making ingluvies (Dursun 2007).

1.6. Ingluvies (Crop, Craw)

It is the enlargement of the esophagus at the entrance to the chest cavity. It is located in front of the furcula in the cranial part of the pectoral and clavicular muscles (Nickel et al. 1977). Its main task is to store food in the first stage and to ensure that it passes slowly into the stomach. Also, in fish and seed eaters, it is an organ in which the food is softened and prepared and given to the young by vomit for the feeding of young offspring. Small pieces of stone are also swallowed in seed eaters to aid in the breakdown of food, so they are larger than carnivores (Dursun 2007). In birds, the crop is usually unilateral and located on the right. But in pigeons it is located symmetrically on both sides. In the goose and duck (Nickel et al. 1977), some granivorous species (such as the finch) (Klasing 1999), and the Adelie penguin (Olsen et al. 2002), a true crop is absent but simply spindle-shaped by the enlargement of the oesophagus (Nickel et al. 1977). Crops are not present in insect-eating birds (Yaman 1999) and gulls (Gezer İnce 2010). Crops in pigeons are

generally well developed. Bird's milk (crop milk) is formed by shedding of adipose tissue cells in the well-developed lamina epithelialis layer of the crop mucosa (Nickel et al. 1977), which is highly vascularized in the crop in male and female pigeons (Dursun 2007). This secretion is secreted at the time of feeding the young (Çalışlar 1986). In another source, it has been reported that in the first two weeks after hatching in pigeons and doves, crop milk is produced and the offspring are fed (Anonim 1). The production of bird's milk is controlled by the pituitary gland hormone prolactin. Differentiation in the crop epithelium begins on the 6th day of incubation, and secretion on the 16th day of incubation. It continues until about 2 weeks after hatching. Although bird's milk is rich in protein like mammalian milk, it is poor in calcium and carbohydrates. Pigeons are fed with bird's milk for the first few days when they hatch. In flamingos, it is seen in red color because it is rich in erythrocytes (Dursun 2007).

1.7. Gaster (Stomach)

In poultry, the stomach is divided into two parts: the proventriculus (pars glandularis, ventriculus glandularis, glandular stomach) and the ventriculus (pars muscularis, ventriculus muscularis, muscular stomach) (Berkin and Alçığır 2007). These two parts are different from each other both in terms of anatomical structure and function (Dursun 2007).

Figure 4. Avian Digestive System Organs (Demiraslan and Dayan 2021).

1.7.1. Proventriculus (Pars Glandularis, Ventriculus Glandularis, Glandular Stomach)

It is located on the median line, spindle-shaped (Nickel et al. 1977). It is like a continuation of esophagus. There is no outer limit between them. Histologically, the inner surface of the esophagus is covered by the cutaneous mucosa and the proventriculus glandular mucosa, while the transitional region is glandless (Dursun 2007). It is the counterpart of the fundus of mammalian stomachs. It is positioned between the two lobes of the liver and slightly to the left (Berkin and Alçığır 2007). Its ventral side is in contact with the dorsal side of the liver. It is located on the intervertebral plane of the fifth thoracal and third lumbosacral in males, and the fourth and seventh thoracic in females. Caudodorsal has a spleen. It is in contact with saccus abdominis sinister and saccus thoracicus caudalis (Dursun 2007). In carnivorous birds, the glandular

stomach is large, while the muscular stomach is in the form of a sac with an indistinct muscle layer (Berkin and Alçığır 2007). It is quite small in chickens and pigeons, but in some birds that eat aquatic products such as storks and gulls, it can be large in volüme (Yaman 1999). In the hoatzin, the crop has replaced the proventriculus and is the first site of stony digestion (Grajal et al. 1989).

The mucosa of the glandular stomach has longitudinal ridges and macroscopic papillae (Özer 2010). As in humans, digestive enzymes are added to foods here and digestion begins here (Jacob 2013). Proventricular epithelium consists of two main gland types: tubular glands that secrete mucus and gastric glands that secrete HCL and pepsinogen (Klasing 1999). In some carnivorous and heron birds, the digestive enzymes secreted by the proventriculus even dissolve the bones (Dursun 2007).

1.7.2. Isthmus Gastris

It is the articulation of the proventriculus as it passes into the ventriculus. Its mucosa is called zona intermedia gastris and is glandless (Rossi et al. 2005). In parrots that feed on flowers or eat fruit, this region has a larger lumen than the glandular and muscular stomach and serves as a warehouse (Dursun 2007).

1.7.3. Ventriculus (Pars Muscularis, Ventriculus Muscularis, Gizzard)

It is in the form of a biconvex lens, flattened from the sides, and is hard and red in color (Nickel et al. 1977, Rossi et al. 2005). The ventriculus is located in the caudoventral of the abdominal cavity, on the median line. It located at the level of the 3rd-14th lumbosacral vertebrae in male, 7th-12th thoracic vertebrae in females (Dursun 2007). The wall structure is quite thick as it is mainly composed of smooth muscles (Özer 2010). It is connected to the proventriculus by a short isthmus from the craniodorsal. The dorsal part of the ventriculus abuts the left lobe and partly the right lobe of the liver. Cranial and right side it is adjacent to the spleen, caudal and right side intestinal loops (Nickel et al. 1977). The duodenum, jejunum, and pars distalis of the cecum are located in the ventral part of the ventriculus, and the jejunum is located in the dorsal part. Saccus abdominis sinister enters between the ventriculus and the rectum and left cecum. (Dursun 2007). In the hen and bustard, the ventriculus terminates with two conical ends associated with the saccus cranialis and saccus caudalis (Sisson and Grossman 1986).

The serous leaf called the mesenterium dorsale jumps from the proventriculus to the ventriculus. After wrapping the ventriculus, it combines with the ligamentum falciforme of the liver and connects the ventriculus to the sternum and intestines (Dursun 2007). It is larger and more muscular in granivores than frugivores and nectarivores. The size of the muscular stomach can vary according to diet and season. For

example, frugivores species showed a larger, muscular and sandstone-filled stomach in winter (when feeding mostly on seeds), while in summer (feeding mostly on soft fruit) lighter, softer and less pebbles were seen (Klasing 1999). In a study conducted in Japanese quail, it was reported that the size of the muscular stomach may increase twice due to the increased fiber ratio in the diet (Starck and Kloss 1995). In another study, the effect of genotype on the digestive system of 3 native Nigerian chickens was investigated. There was no significant difference other than esophagus weights and ventriculus widths (Mahmud et al. 2015).

Smooth muscles in ventriculus; m.lateralis dorsalis, m. lateralis ventralis, m. intermedius cranialis and m. intermedius caudalis. Mm. laterales are stronger than mm. intermedii. The mm. laterales form the corpus of the muscular stomach. (Nickel et al. 1977, Dursun 2007). The high concentration of myoglobin gives these muscles their distinctive red color (Klasing 1999).

The mucous membrane of the muscular stomach resembles the cutaneous mucosa (Dursun 2007). The mucosal surface generally contains longitudinal wraps. Lamina epithelialis consists of a single layer of columnar epithelial cells. This epithelium invaginates into the lamina propria to form the gll. ventriculares (mucosal glands). The cells of the surface epithelium and the secretions of the mucosal glands form a hard layer of keratin-like coils that covers the mucosal surface (Özer 2010). This layer periodically dissolves and vomits. Especially in grain-eating birds, the keratinoid layer forms a grinding surface. Stone and

sand particles are found in the muscular stomach cavity. These particles help grind food. The muscular stomach is the first place in the digestive system where proteolytic digestion takes place (Dursun 2007). Penguins, loons, pelicans, cuckoos, herons, and raptors have a third stomach compartment called the pyloris (Dursun 2007).

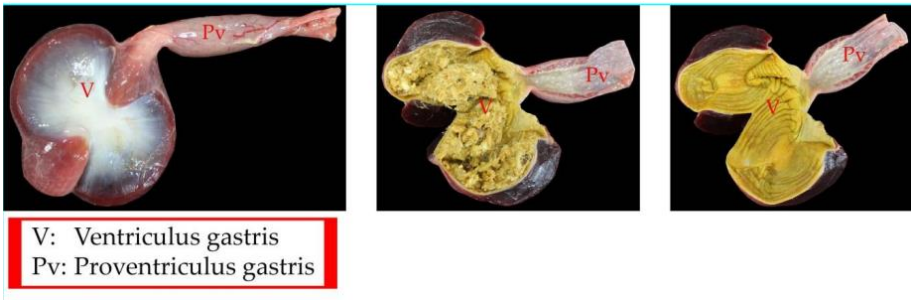

Figure 5. Inner and Outer Surface of Ventriculus (Muscular Stomach, Gizzard) (Demiraslan and Dayan 2021).

1.8. Intestinum (Guts)

It is the part of the digestive tract that exits the ventriculus and ends by opening into the coprodeum of the cloaca. As in mammals, it is divided into two parts, the intestinum tenue (small intestines) and the intestinum crassum (large intestines). Intestinum tenue is divided into three parts as duodenum, jejunum and ileum (Nickel et al. 1977, Bahadır and Yıldız 2014). Intestinum crassum is divided into cecum and rectum (Baumel et al. 1993). The intestines are located in the cavum peritonei intestinale (peritoneal sac), on the right side of the abdominal cavity (Dursun 2007).

1.8.1. Intestinum Tenue (Small Gut)

The length of the small intestine varies considerably between species, depending on the eating habits. It is longer in herbivorous birds and shorter in carnivorous birds (Yaman 1999).

1.8.1.1. Duodenum

It emerges from the craniodorsal on the right side of the ventriculus. It makes a 'U' shaped fold in all poultry. Duodenum makes two branches as pars descendens and pars ascendens. Pars descendens is the left ventral branch of the duodenum. It lies caudoventrally between the right aspect of the ventriculus and the right lobe of the liver. It curves to the left behind the ventriculus and passes into the pars ascendens. The pars ascendens is the right dorsal branch of the duodenum. It extends cranioventral dorsal to the pars descendens, passes through the dorsal aspect of the liver, and comes anterior to the muscular stomach. In dorsal, it connects to the jejunum by making the flexura duodenojejunalis at the level of the arteria mesenterica cranialis in the ventral aspect of the right kidney (Berkin and Alçığır 2007, Dursun 2007). The two branches are connected to each other by the ligamentum pancreaticoduodenale. Pancreas is located between these two branches. The ducts of the bile and pancreas open to the pars ascendens. Pars ascendens is connected to the hepar by ligamentum hepatoduodenale (Bahadır and Yıldız 2014).

1.8.1.2. Jejunum

It is the widest and longest part of the small intestine. It is located on the right caudal of the body cavity. It is adjacent to the stomach, spleen, right lobe of the hepar, and the ovary in the female during the spawning period. The jejunum, which makes short folds in different lengths around the mesenterica cranialis in chickens(10 pieces), makes long folds (6-8 pieces) in the same length, parallel to the body axis and each other in geese and ducks. Approximately in the middle of the length of the intestine is the small protrusion, diverticulum vitellinum (Meckel's diverticulum), which is the remnant of the saccus vitellinus (Berkin and Alçığır 2007, Bahadır and Yıldız 2014). Meckel's diverticulum marks the end of the jejunum and the beginning of the ileum (Jacob 2013). There is no diverticulum vitellinum in gulls (Gezer İnce 2010) and Black kite (Hamdi et al. 2013). This diverticulum is the remnant of the yolk duct and opens into the small intestine via a papilla (McLeland 1990).

1.8.1.3. Ileum

The ileum opens into the large intestine between the cecums and attached to the ligamentum ileocecales and cecums. The ligamentum ileocecale continues until the jejunum ends and the ileum begins. (Bahadır and Yıldız 2014).

1.8.2. Intestinum Crassum (Large Gut)

It consists of two cecum and a short rectum. The end of the rectum opens into the bulb-shaped coprodeum part of the cloaca (Bahadır and Yıldız 2014).

1.8.2.1. Cecum (Blind Gut)

There are two on the right and left, their free ends are at the level of the border of the jejunum and ileum. It passes to the rectum with the ostium ceci located at the bottom (Bahadır and Yıldız 2014). While it is found on the right and left sides in most bird species, it has been reported that in most herons and bitterns the cecum is found in a single sac, and in the red hawk, only one of the 8 materials is found on the left, except for the left side, the others are bilateral (Halıgür 2008). The cecum, which is quite long and double in chickens, is rudimentary in pigeons (Berkin and Alçığır 2007). Parrots do not have cecum. It is where water is absorbed (Klasing 1999, Bahadır and Yıldız 2014). Another important function is to ferment the contents of the large intestine by producing 8 B vitamins (thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, biotin, folic acid and vitamin B12) as well as several fatty acids (Jacob 2013). Tonsilla caecalis appears as a small nodular blister at the entrance of the cecum (Berkin and Alçığır 2007). There is widespread lymph tissue in its wall, the villi are quite high in this section. There are no villi in the pigeon cecum (Bahadır and Yıldız 2014).

1.8.2.1. Rectum

It is very short compared to other species. It is like the continuation of the jejunum and is the part after the junction of the two cecums. It extends backward along the ventral aspect of the columnna vertebralis. Although the villi are long in the anterior parts, they become shorter as they go to the caudal. It ends by opening into the coprodeum of the cloaca. (Bahadır and Yıldız 2014).

1.9. Hepar (Liver)

The volume, weight, consistency and color of the liver depend on the specific nutritional status of the birds, age and breed (Nickel et al. 1977). It is found in the body cavity, most of which is protected by the ribs, and within the cavum peritonei hepatis ventralis (Bahadır and Yıldız 2014). It consists of two lobes, lobus hepatis dexter and lobus hepatis sinister. Lobus hepatis dexter is larger than lobus hepatis sinister (as in domestic mammals). The right and left lobes are separated from each other by two notches, the superficial incisura interlobaris cranialis anteriorly and the deeper incisura interlobaris caudalis posteriorly. (Dursun 2007). In chicken, turkey and guinea fowl, the left lobe is divided into two regions, lobus sinister lateralis and lobus sinister medialis, by a notch called incisura interlobularis. (Berkin and Alçığır 2007). In general, the liver is large in those which eat insects and fish, and small in those which eat meat and grains (Dursun 2007). Avian liver is similar to mammalian liver in terms of basic structural features and

functions. Differently, since birds do not have lymph nodes, there are lymph follicles in liver tissue as in other organs (Özer 2010).

1.10. Vesica Fellea (Gall Bladder)

It is located in the fossa vesicae fellea on the dorsal aspect of the right lobe of the liver. Pigeons, guinea fowl, budgerigars, parrots and ostriches do not have a gallbladder (Klasing 1999, Dursun 2007, Özer 2010, Bahadır and Yıldız 2014). There are three extrahepatic bile ducts. Of these, ductus hepatocysticus opens into the gallbladder, ductus hepatoentericus communis opens directly into the duodenum. Ductus cysticoentericus connects the gallbladder to the gut (Bahadır and Yıldız 2014). In the pigeon, ductus hepaticus dexter and sinister unite and do not form ductus hepatoentericus communis, these two channels open to the duodenum separately (Dursun 2007). The most interesting feature of the digestive system in the ostrich is the continuous production of bile; observed in macroscopic and histological studies of the liver and biliary system (Stornelli et al. 2006).

1.11. Pancreas

It is a pale yellow or pinkish gland located in the form of a strip between the fold of the duodenum (Whittow 1998, Dursun 2007). In some species, such as the budgerigar, the pancreas is located outside the duodenal fold. In chickens and pigeons, the pancreas completely filled the fold of the duodenum, but not in waterfowl (Bahadır and Yıldız 2014). Pancreas are relatively small in carnivores and granivores but large in piscivores and insectivores. It is usually divided into three lobes

as dorsal, ventral, and splenic (Whittow 1998). In some sources, it is divided into 4 lobes as dorsal, ventral, third lobe and spleen lobe (Özer 2007). In the ostrich, it is divided into the long dorsal lobe and the short ventral lobe (Stornelli et al. 2006). The pancreas has three secretory ducts in chickens and pigeons and two in waterfowl. They open near the opening of the bile ducts in the pars ascendens branch of the duodenum (Bahadır and Yıldız 2014). In the budgerigar, each of the three pancreatic lobes is drained by a separate channel (Klasing 1999).

1.12. Splen (Lien)

It is reddish brown in color. It is round in chickens, triangular in waterfowl, elongated oval in pigeons (Dursun 2007, Bahadır and Yıldız 2014), long like a cigarette in canaries (Berkin and Alçığır 2007). It is located on the right side of the isthmus gastris. Sometimes a few small appendages called splen accessorius may be found. It is a part of the reticuloendothelial system and acts as erythropoetic during the embryonal period and lymphopoetic after birth (Dursun 2007, Bahadır and Yıldız 2014).

1.13. Cloaca

The last part of the digestive, urinary and genital systems in poultry is called the cloaca (Hodges 1974, Nickel et al. 1977, Klasing 1999). It is divided into three parts by two annular and contractile wraps (Hodges 1974, Nickel et al. 1977, Bahadır and Yıldız 2014). In the ostrich and duck, there is a ring of muscle called plica rectocoprodealis between the rectum and the coprodeum (Dursun 2007). The first and anterior is the

bulb-shaped coprodeum. Stool from the rectum is poured here. The next part, the urodeum, is smaller, where the ureters and uterus and ductus deferens open. The third most posterior part is the proctodeum. All secretions and feces combine here and are expelled from the anüs (Bahadır and Yıldız 2014). It was determined that the coprodeum was separated from the urodeum by plica coprourodealis from the rectum with plica rectocoprodealis in the domestic duck (Arı et al. 2011). A hard sac, bursa cloacalis (bursa fabricii), is seen on the ceiling of the proctodeum, it contains abundant lymph follicles. Their numbers decrease as sexual maturity approaches. Removal of this organ makes it easier for the creature to catch infectious diseases (Bahadır and Yıldız 2014). On the ventral wall of the proctodeum, there is the mating organ (phallus protrudens), which is the equivalent of the penis in mammals in ostrich, duck and goose, and the rudimentary penis (phallus nonprotrudens) in the form of a mucous ridge in roosters and pigeons. In day-old chicks, there is a small ridge at the place of the phallus, and this ridge is used for sex determination. It is cone shaped in females and round in shape in males (Nickel et al. 1977, Dursun 2007). The urodeum is separated from the coprodeum by the plica coprourodealis. Oviducts in females and ductus deferens in males are opened in this region by ureters. The urodeum mucosa is glandless, in the real sense, villi are not encountered in the mucosa. The urodeum absorbs the excess water contained therein to solidify the stool (Dursun 2007).

1.13.1. Ventus

It is the name given to the opening of the cloaca, the counterpart of the anus in mammals. However, although the anus is only the opening of the digestive canal, the ventus is the common opening of both the digestive and urogenital canals (Bahadır and Yıldız 2014).

In the statistical analysis of poultry digestive system parameters, there was a positive correlation between the length of the small intestine and the entire length of the digestive tract; It has been stated that there is a negative relationship between the length of the esophagus and the length of the small intestine, and between the entire length of the digestive tract and the length of the small intestine (Dziala-Szczepańczyk and Wesolowska 2008).

CONCLUSION

Avian medicine has become an important field that veterinarians turn to, in parallel with the preference of avian as food, their breeding as ornamental animals and the increasing interest in wild birds. As a result, traditional and current studies on digestive system organs in avians were blended and brought together. I believe that this presented study will be beneficial to veterinarians and scientists who will work on domestic and wild birds.

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CHAPTER 3

NUTRITIONAL POISONING IN WATER BUFFALOES

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1. INTRODUCTION

Meeting the nutritional needs of the world's population, which is expected to exceed 8 billion in 2025, is seen as an important problem. Especially common in tropical and subtropical countries with hot and humid climates, water buffalo has an important role as a food source for humans.

Agriculture and livestock activities and the products obtained from them are important for human welfare and health. Livestock today has become an industry in developed countries and an integral part of the economy. This shows that agriculture, and therefore animal husbandry, is a strategic sector that needs to be developed at the national level (Özkan at al., 2017).

Water buffalo, which is a farm animal with an important economic efficiency in the world as milk, meat and draft animal, is raised in Southeast Asia, South America, North Africa, all Mediterranean countries except France, Balkan countries and some Central European countries and Australia. (Atasever and Erdem, 2008).

In many countries, including Turkey, buffalo breeding is in a significant increasing trend. Water buffalo breeding is most common in India (56%), Pakistan (18%) and China (12%), respectively. In Italy, buffalo breeding is carried out intensively (Anonymous1, 2021). Buffalo and cattle are two separate species that are very similar to each other in terms of morphological and physiological characteristics. However, buffalo is known for not choosing to feed, for being able to benefit from

roughage better than other ruminants, and for the high fat content of its milk (Şekerden, 2001). In Turkey, water buffalo breeding is carried out for milk and meat production. However, buffalo breeding enterprises are mostly traditional family type, and the rest are medium-sized enterprises in Turkish conditions. (Anonymous2, 2022).

Buffalo breeding in Turkey; In the Black Sea Region, in Samsun and Sinop on the coastline, and in Tokat, Çorum and Amasya in the interior; in Sivas and Yozgat in the Central Anatolia Region; in Afyon in the Aegean Region; in Istanbul in the Marmara Region; In Muş in the Eastern Anatolia Region; It is concentrated in Diyarbakır, in the Southeast Anatolian Regio.

Carcass meat and milk yields of buffaloes are less than cattle. However, they have high feed efficiency and are resistant to difficult climatic conditions and diseases. It has advantages such as being able to produce at lower costs and selling the products at a higher price. In addition, due to the unique structure of meat and milk obtained from buffaloes (low fat and cholesterol in meat, high fat in milk), it gives a different consistency and flavor to products such as sausage, cheese, yogurt and cream. In addition, buffalo meat and milk in Turkey have the potential to be produced organically and to be a geographically indicated product (Özkan at al., 2017).

1.1. POISONING

Animals often recognize and avoid toxic substances. However, for various reasons, changes in the smell, taste and color of poisons and

hunger facilitate poisoning. Toxic substances can also be ingested by animals in cases where organoleptic properties are accidentally or deliberately masked by other substances by humans. Poisoning cases encountered in the field in animals can be in four different ways. These; accidental poisoning, deliberate poisoning, bait and overdose drug poisoning. The most common of these is accidental poisoning. For example, poisoning with pesticides, pesticides, artificial fertilizers, poisonous plants that are directly eaten or mixed with roughage, industrial residues, mycotoxins, botulism, cleaning agents used at home and in the workplace can be counted. Especially due to the widespread use of silage and the rapid operation of machines, the entrapped death of reptiles and birds in silage and roughage bales increases the risk of botulism poisoning day by day (Oğuz, 2017).

2. POISONING CAUSED BY TAKING POISONIC PLANTS

Normally, these plants are not consumed by animals. However, it can be consumed in cases of overgrazing and drought. Toxic effects occur mostly during the flowering period. Toxic plants in the grazing area and in which periods they are toxic should be known, animals should not be grazed during these periods. The pastures should not be overgrazed, and animals should not be taken to the pasture when the pastures are insufficient.

2.1. SORGHUM POISONING

After drought and extreme cold, animals sometimes eat young sorghum grains. In such cases, plants often have hydrocyanic acid (prussic acid).

Cattle that eat these plants are often poisoned with cyanide. Asphyxia occurs because the use of oxygen at the tissue level is greatly impaired. For detoxification purposes, for example, sodium thiosulfate ($Na_2S_20_3$) combines with cyanide to form thiocyanate (SCN), which is practically non-toxic as well as having no cyanide property. Methemoglobin can be formed by administering sodium nitrite and other compounds to the poisoned animal. Then, methylene blue is given to help reduce methemoglobin to hemoglobin (Reece, 2012).

2.2. OAK POISONING

It is a plant poisoning and usually occurs as a result of feeding animals in the oak groves when the oaks give their first shoots. It is the tannin or tannic acid in its structure that causes poisoning. Sometimes diarrhea, sometimes severe constipation is seen. In addition, fatigue, stagnation, loss of appetite, increase in the amount of urine, changes in the color and density of urine are observed (Pendik Veterinary Control Institute, 2016).

2.3. OXALIC ACID POISONING

Oxalic acid salts are present at low levels in many plants, but the oxalate content of some plants (for example, *Oxalis and Halogeton*) may exceed 10% of the dry weight of the plant. Acute toxicity and death may occur in animals grazing on pastures where these plants are common. Animals that are slowly acclimated to a high oxalate diet actually tolerate high levels of oxalate well. This adaptation is related to increased oxalate degradation by *Oxalobacter formigenes*. The

necessity of this bacterium for oxalate as an energy source explains why the number of this bacterium increases with the increase in oxalate level in the diet (Reece, 2012).

2.4. SWEET CLOVER DISEASE

Stone clover can be grown in arid and barren lands where alfalfa and clover do not grow. It is a durable plant. It grows fast, inhibits the growth of weeds. It is poor in leaves, quickly lignifies. For this reason, it should be mowed when it is about 30 cm tall before flowering. It can be given to cattle up to 15-20 kg per day (Coşkun et al., 2000).

The coumarin in the plant is converted to dicumarol if the plant becomes moldy and causes internal bleeding by preventing blood clotting in animals that eat it, especially in calves. This condition is called clover disease. Vitamin K is applied for treatment (Coşkun et al., 2000) (Reece, 2012).

2.5. POISONING RESULTING FROM TAKING OVER AMOUNT OF ORGANIC COMPOUNDS TO THE PLANT

2.5.1. POISONING WITH PLANTS CONTAINING ORGANIC NITROGEN COMPOUND

Organic nitrogenous compounds such as 3-nitropropionic acid (NPA) and 3-nitropropanol (NPOH) are glycosides found in various Astragalus species (eg crowned vetch and forest milk vetch). The glycoside of NPOH is also known as mizrotoxin. Glycosides are rapidly hydrolyzed by rumen bacteria. NPOH is absorbed faster than NPA and is converted to NPA (toxic metabolite) in the liver. As a result of

microbial metabolism of NPOH and NPA in the rumen, they are reduced to amines (3-aminopropanol and 3-alanine), which are the counterparts of the aliphatic nitro group. This activity shows why ruminants are more tolerant of these compounds than other animals. These nitrogenous compounds are electron acceptors; *Denitrobacterium detoxificans*, which also uses formate and hydrogen as energy sources, plays an important role in the detoxification of these compounds (Reece, 2012).

2.5.2. NITRATE-NITRIDE POISONING

Drought stress and over-fertilization of cereal crops can result in the production of toxic nitrate feedstuffs. Most rumen bacterial species, and at least some protozoan species, reduce nitrate to nitrite and then nitrite to ammonia. The reduction of nitrate and nitrite is dependent on the presence of hydrogen-donating substrates, such as the addition of rapidly fermentable carbohydrates. Nitrate intake at high levels in the diet causes nitrite to accumulate in the rumen. When nitrite is absorbed, it combines with hemoglobin to form methemoglobin. When the methemoglobin level is 40-60%, oxygen transport is impaired and clinical symptoms appear. As a result of the slow increase in dietary nitrate, an increase in microorganism species that rapidly reduce nitrate and nitrite occurs in the rumen. Animals that have been accustomed to such a microbial population can easily tolerate the lethal level for unaccustomed animals (Reece, 2012).

3. POISONING CAUSED BY TOXIC SUBSTANCES INVOLVED WITH FEED

3.1. AMMONIA POISONING

Ammonia toxicity is most often caused by ingestion of large amounts of urea. Occasionally, toxicity occurs when animals graze fresh, high-protein meadows or abruptly switch to high-protein concentrates. Ruminal urease rapidly deaminates urea into ammonia. Ammonia can be used for microbial protein synthesis when sufficient intra-rumen VFA is available. (Reece, 2012).

The breakdown of urea by urease and the absorption of ammonia from the rumen wall depend on rumen pH. When the pH value is between 6.5-7, both events occur quickly. In contrast, urease activity and ammonia absorption are limited below pH 6. In order for ammonia poisoning to occur, the pH value in the rumen fluid should be above 6 and the ammonia concentration should be 1000 mg/lt, which is the upper limit. signs of poisoning; Respiratory disorders, decrease in feed consumption, increase in saliva secretion, deterioration in motoric functions of the rumen, muscle tremors and cramps (Ergün and Tuncer 2001). In such cases, the first thing to do is to make the animal drink a large amount of cold water. Thus, the ammonia concentration is diluted and the absorption is slowed down by the effect of cold. Drinking acetic acid sources such as vinegar with water further reduces ammonia absorption. Intravenous acetic acid can be administered if signs of toxicity are severe. The points to be considered for the use of urea in a way that is not harmful to animals are as follows: Feeds with urea are

given by getting used to (7-10 days). Urea feeds are given at least two meals and in equal amounts. Roughage is given before the urea feed is given. The ration should be rich in easily soluble carbohydrates. The ration is supplemented with Co, S, P. It is very important that urea mixes homogeneously with the feed. Urea is added to the concentrated diet at the most 3% and 1-1.5% to the total ration. Only 1/3 of the animal's total nitrogen needs can be met by urea (Coşkun et al., 2000).

3.2. MYCOTOXIC POISONING

Molds and fungi are toxic substances in feed, the most important of which are aflatoxins and ochratoxins. High humidity (> 15%) in feeds, poor storage conditions and high temperature are the reasons. In acute poisoning, loss of appetite, difficulty in breathing, runny nose, anemia, bloody diarrhea, convulsions or sudden death occurs. In subacute events, the severity of acute symptoms decreased. In addition to these, jaundice, hematoma, impaired blood coagulation mechanism, bleeding intestinal inflammation draw attention. Abortion, decrease in milk or even cessation of milk in chronic events, blindness that occurs suddenly in long-term mycotoxin intake, turning around, teeth grinding, severe straining movements are remarkable findings (Pendik Veterinary Control Institute, 2016).

3.3. BOTULISMUS

Botulismus is a potentially paralytic and fatal disease caused by Clostridium botulinum. This bacteria finds the best chance to grow in alkaline and neutral conditions, rotten vegetables and carcasses.

Scavenging behaviors occur in animals that are deficient in phosphorus, which can lead to botulismus outbreaks. Types C and D breed especially in feeds contaminated with rodent, cat, bird and reptile dead and their faeces, and cause epidemics in cattle that eat poultry faeces and waste. In this case, Clostridium botulinum type C and D toxins were found in the rumen and intestinal contents of animals. The presence of chickens roaming freely in the environment attracted attention. It was thought that the feeds were contaminated with chicken droppings and therefore the source of the phenomenon could be chicken droppings contaminated with feeds. The absence of disease in heifers, calves and dry animals kept in closed barns, where chickens cannot enter, supports this view (Çiçek et al…, 2013).

3.4. STRYCHNINE POISONING

It is a poisonous alkaloid substance produced from the seeds of the Kargabuken (Strychnos nux-vomica) tree, which grows in India, and destroys organic cells by disrupting them. It is used as a stimulant in 1-2 mg doses in medicine and veterinary medicine. Strychnine, which passes into the blood, is first included in the erythrocytes, reducing their ability to take oxygen. The back becomes stiff, twitching appears in the muscles. Nervous restlessness, excessive tension surrounding the whole body is seen. At the beginning of poisoning, the flutters are 2-3 minutes apart. After a while, the animal lays down in an exhausted state, asphyxia takes shape and death occurs (Pendik veterinary control institute, 2016).

3.5. TYMPANI

It is a phenomenon characterized by excessive gas accumulation in the rumen. Rumen content normally consists of 3 layers. There is a liquid layer in the lower part, a more solid structure in the middle, and a gas layer in the upper part. Abdominal pressure increases and free gas accumulation in the rumen is observed in sudden feed changes, excessive concentrated feed consumption, insufficient roughage intake, very finely ground feeds, consumption of fresh legume grasses. Normally formed gases are expelled by belching. Tympani occurs when gas is prevented from moving away from the rumen for any reason.

Consumption of excessive amounts of tender, sap-rich legumes such as alfalfa and clover causes frothy, acute tympanis. The saponin substance (contains surface activity) forms tympani with foams containing many small gas bubbles. This situation is at the highest level especially between pH 4.4-5.5. In most of the swellings, the rumen pH value is determined as 5.2-6.0. High saliva secretion prevents foam formation.

Gas formation puts pressure on the rumen diaphragm. With the pressure on the lungs, breathing becomes difficult. In acute cases, death is observed. In severe cases, bilateral swelling on the left-upper side of the abdominal region. In suckling calves, rapid, incorrect delivery of milk or excessive consumption of milk causes the cardia mouth to be blocked. Consumption of excessive amounts of long fiber, energy-deprived roughage in the 3rd week of life in calves can cause chronic gas accumulation. In calves over eight weeks of age, roughage consumption with a piece size of less than 6 mm often leads to gas

formation. Grazing should be limited on legume-rich pastures. Young clover and clover rich in sap should be given with dry roughage (0.2 - 1.5 kg/KM). The amount of clover and clover should be limited to 1 kg KM/100 kg LW for each meal (Anonymous2, 2022).

3.6. PETROLEUM PRODUCTS POISONING

Many distillation products of active petroleum, various petroleum ethers, carosene, gasoline naphtha varieties, kerosene, diesel fuel, fuel oil, solid and liquid paraffin varieties. In poisoned animals, symptoms such as severe foaming in the respiratory tract, depression, weakening of condition, weakness, severe tremors, general instability and head shaking are observed (Pendik Veterinary Control Institute, 2016).

3.7. SOYBEAN MEAL POISONING

The poisoning is not due to soybean meal. Trichloroethylene is used as a toxic solvent in some places while obtaining soybean oil. Large poisonings occur as a result of this solvent remaining in the pulp. Generally, anemia, weakness, and poor condition are seen (Pendik veterinary control institute, 2016).

3.8. ORGANIC CHLORINE PESTICIDE POISONING

Active substances DDD, DDE, DDT, HCB, HCH, Endosulfan, Chlordane, Aldrin, Dieldrin, Endrin, Heptachlor, Toxophane, Bromopropylate, Tetradifon, Acetochlor, Diclofop-methyl, Fenoxoprop-P-ethyl etc. Aggression that starts with abnormal warning and fear in animals , tremors, balance disorders, teeth grinding, salivation, diarrhea, dehydration, extreme weakness, jaw locking,

arching of the trunk, epileptic cramps, convulsions, dilation of the pupils, difficulty in breathing, increase in body temperature are observed (Pendik Veterinary Control Institute, 2016).

3.9. ORGANIC PHOSPHORUS PESTICIDE POISONING

Active substances Parathion, Malathion, Folithion, Gusathion, Enthion, Diazinon, Dipterex, Dichlorvos, Trichlorfon, Chlorpyrifos, Coumaphos, Naled, Dimethoate. Excessive sweating, tearing, constriction of the pupil, nasal discharge, increased secretion of bronchial mucosa, shortness of breath, salivation, cyanosis, muscle twitching, cramps and paralysis, urinary and stool incontinence, tremors in the eyelids and tongue occur. Death occurs as a result of blunting of reflexes and paralysis of the respiratory and circulatory center. (Pendik veterinary control institute, 2016).

3.10. CARBAMAT GROUP PESTICIDE POISONING

Active ingredients Methomyl, Carbaryl, Carbofuran, Primicarb, Methiocarb. It is the same as in organophosphorus compounds.

3.11. CYANIDE POISONING

Consumption of plants containing cyanhydric acid in their structure and calcium cyanamide in various compounds (rat poison, fertilizer) cause poisoning. Death occurs in a few seconds in cyanide poisoning. The animal is often found dead (Pendik veterinary control institute, 2016).

4. POISONING CAUSED BY MINERAL SUBSTANCES INVOLVED WITH FEED

4.1. SULFUR POISONING

Sulfates are less toxic. Water containing excess sulfur (5000 mg/kg) also reduces feed and water consumption. Diets containing 0.5% sulfur in the form of sulfate salts or drinking high levels of sulfated water have been reported to cause a syndrome resembling polyencephalomalacia in beef cattle. The strong reducing environment of the rumen reduces dietary sulfate and thiosulfate to sulfite. Hydrogen sulfide is a potent neurotoxin. Excess dietary sulfur inhibits the absorption of other elements, especially copper and selenium. Acute sulfur poisoning causes neurological symptoms such as blindness, coma, muscle twitching and recumbency. Severe enteritis, peritoneal effusion and petechial hemorrhages (especially in the kidneys) are the main postmortem findings. The breath often smells of hydrogen sulfide, the toxic form of sulfur. (Reece, 2012 Pg: 578).

4.2. ARSENIC POISONING

Arsenic compounds are used in the manufacture of various products such as pesticides and pesticides, rat poison, some cancer drugs, paint, wallpaper, and ceramics. When inorganic arsenic compounds are taken orally, they have a corrosive effect on the mucous membranes. After absorption, it increases oxidative stress, disrupts cell signal transmission and suppresses some enzymes. In acute events, severe pain, staggering, weakness, exhaustion, increased salivation, vomiting,

thirst, sometimes bloody exile, as well as mucous fragments in the stool, blood in the urine, occasional convulsions, increased pulse rate and weakening, paralysis of the legs, body temperature normal or below normal decrease and death occurs in the first 1-3 days (Pendik veterinary control institute, 2016).

4.3. COPPER POISONING

Copper, in its salts (such as copper sulfate, copper chloride and copper oxide), is used in agriculture and veterinary medicine. After oral intake, it is absorbed in the body through the small intestines, enters the circulation. In acute poisoning, nausea, vomiting, increased salivation, severe abdominal pain, exile, weakness, anorexia, cold feet and legs, paralysis, collapse and death occur in 1-4 days following the onset of clinical symptoms. The stool is dark green and contains mucus. Long-term grazing of cattle in areas sprayed with "Bordeaux slurry" and similar copper preparations used as fungicide in vineyards and gardens causes chronic copper poisoning (Pendik Veterinary Control Institute, 2016). Milk replacer feeds to be given to buffalo puppies should not contain more than 5 mg/kg Cu. High mortality rate was observed in buffalo pups fed with milk replacer feeds containing 20 ppm/kg Cu and 92 ppm/kg Fe in DM. This high mortality rate in buffalo offspring is due to unbalanced ratios between the two micronutrients. It has been reported that death events stopped when buffalo pups were fed with milk replacer feeds containing 30 ppm/kg Cu and 240 ppm/kg Fe in DM (Gonzalez, 2011).

4.4. MERCURY POISONING

Mercury is the only metal that is liquid at room temperature and can evaporate easily. Unreacted metallic mercury (elementary mercury), inorganic and organic mercury compounds are used in paper, leather, paint industry and measuring instruments such as electrical devices, batteries, thermometers, antiseptics, and amalgam production in dentistry. Mercury can be absorbed by ingestion, inhalation and through the skin. The first sign of acute poisoning with inorganic mercury salts is coagulation, irritation and corrosion of the tissues with which it is in contact. A severe gastrointestinal inflammation and exile are seen. In some cases, death occurs due to circulatory collapse. If death does not occur within 1-2 days, symptoms of stomatitis and nephritis follow. In chronic mercury poisoning, discoloration of the posterior surface of the lens is common in the eyes. In addition to these classical symptoms, weakness, feeling of extreme tiredness, weight loss, loss of appetite, gastrointestinal disorder attract attention. Rarely, a blue-black mercury line is seen on the gums (Pendik veterinary control institute, 2016).

4.5. LEAD POISONING

Lead and its compounds are mainly used in paint, accumulator, ceramic, porcelain and rubber industries; in the production of metal alloys (such as printing string, solder, bronze), lead pipes; The gasoline additive is used in making insecticide (lead, arsenate). Lead poisoning can develop chronically and sometimes acutely in those with a history of soil ingestion, from the drinking water supply system using lead paints, ceramic pots glazed with these paints, or lead pipes. Lead is a typical

cumulative poison. In the body, 90-98% of the lead load is found in the bones. Acute, subacute and chronic poisonings are seen with lead. It is usually of the acute type and clinical signs usually do not occur 2-3 days after administration of the lethal dose, but it results in death within 12-24 hours after symptoms appear. Abdominal pain, constant belching, increased salivation, lacrimation followed by constipation, stool dark and foul-smelling, frequent and painful urination. Concerning the CNS, especially convulsions, tremors, muscle spasms, grinding of teeth, attacking the surrounding objects draw attention (Pendik Veterinary Control Institute, 2016).

4.6. CADMIUM POISONING

In coatings against corrosion of various metals (such as iron, steel, copper, zinc), in cable coatings in the form of alloy with lead; in paint and glass production; in the manufacture of nickel-cadmium batteries; in insecticide production; It has important uses as a stabilizer in plastics. Cadmium accumulating in soil and water passes to aquatic organisms and reaches animals and humans through the food chain. Cadmium is absorbed from the gastrointestinal tract to a lesser extent. Its absorption from the small intestine increases in calcium, iron and protein deficiency. Cadmium, a cumulative poison, is mainly collected in the liver and kidney. It also accumulates in erythrocytes and bone tissue in the blood. Absorption of cadmium in acute doses from the gastrointestinal tract causes gastroenteritis, vomiting, nausea, salivation, diarrhea, abdominal cramps occur. Death occurs as a result of shock and dehydration (Pendik veterinary control institute, 2016).

4.7. THALIUM POISONING

Thallium compounds are used in industry as luminescent paint, window glass, some alloys, optical lenses, jewellery, low-temperature thermometers, and catalysts. Thallium sulfate is used as a rodenticide. It is easily absorbed from the skin and gastrointestinal tract. Thallium is a cumulative poison. It accumulates mainly in the kidney. Smaller amounts are collected in bone, spleen, liver and brain.

The main symptoms are metallic taste in the mouth, nausea, vomiting, anorexia, dry mouth, pain in the gums, nose bleeding, conjunctivitis, abdominal pain, diarrhea. Severe stomatitis, paralysis of one or more muscles may occur in a few minutes, and alopecia occurs within a week (Pendik veterinary control institute, 2016).

4.8. ZINC POISONING

It is not toxic in elemental form. Poisoning occurs as a result of the pollution of the grasslands around the industrial branches and rice furnaces, where zinc sprouts are extracted and salts are prepared, with zinc oxide and the consumption of these grasslands by animals. In addition, the wrong drugs given for the treatment also cause poisoning. After oral intake with food, zinc is poorly absorbed from the digestive tract, but the rate of absorption depends on the body's needs. Symptoms seen in poisoning with zinc phosphide are not special. Certain anorexia persists until death. Abdominal pain, tympani in ruminants, sometimes watery stools and post-coma death occur (Pendik veterinary control institute, 2016).

4.9.HYPERCALCEMIA

Chronic wasting disease (Enteque Seco) In some parts of the world, plants such as Solanum malacoxylan, Cestrum diurnam and Trisetum flavescens cause life-threatening hypercalcemia when eaten by grazing animals. These plants contain high amounts of the glycoside form of 1,25-(OH)2 vitamin D, which becomes biologically active in the small intestines (Reece, 2012).

5. POISONING CAUSED BY OVER CONSUMPTION OF NUTRITIONAL MATERIALS

5.1. WATER POISONING

It occurs with the disruption of osmotic balance in sudden excessive water consumption. It can be observed in calves in the 2nd month. Diarrhea, paralysis, muscle tremors, incoordination and edema occur in these animals. The main reason is irregular water supply and unlimited water consumption as a result of long thirst. It has been observed that thirsty calves (approximately 70 kg Ca) consume up to 30 liters (half the CA) of water. However, the kidneys cannot adapt to this situation. Free water consumption of sick animals should be prevented and physiological salt water (2-3 lt, 5% solution in mild cases, intravenous 300 ml 10% solution in severe cases) should be given (Ergün and Tuncer 2001).

5.2. LACTIC ACIDOSIS

It occurs as a result of giving excessive amounts of easily fermentable carbohydrate feeds to ruminants without getting used to it. Lactic acid

microorganisms multiply in the rumen and rumen pH: 5.4-5.2 decreases and lactic acid increases. Rumen content pH value should normally be between 5.8-6.2 /6.4-6.8. It is usually seen when the ration containing a large amount of grain is given to the animal in the first period of lactation without getting used to it (Anonymous2, 2022).

Ruminal pH is normally buffered by the bicarbonate ions of saliva. Reducing the percentage of roughage in the ration causes a decrease in chewing and rumination, which stimulates saliva secretion, and increases acid formation in the rumen. The most commonly used agents against acidosis are sodium bicarbonate and MgO. These agents can be included in the diet at a rate of 0.5-2.5%. The animal's response to these agents depends on the rough/concentrate ratio of the ration, feed intake and the amount of buffer in the ration (Kaplan et al., 2010).

In subclinical ruminal acidosis cases, air bubbles are observed with unbroken feed grains in the stool. If feces are placed on a sieve and water is poured over it, unbroken grains can be seen more clearly on the sieve. When the undigested food that passes into the large intestine is used by microorganisms, the excess acid that comes out damages the intestinal mucosa. The mucosa is excreted with feces. In mild cases, temporary decrease in appetite, decrease in rumen movements, decrease in milk yield, changes in stool color and consistency can be observed. Severe diarrhea, mostly gray-brown foamy stools, and soiling of the anal area and tail are clinical manifestations of acidosis.

In moderate cases, the animal's feed and water consumption stops. Sudden decreases in milk yield are seen. Animals may experience

symptoms such as a constant desire to lie down, groaning, and teeth grinding. It also causes diseases such as laminitis, rumenitis, liver abscess, polyencephalomalacia and foot rot. In severe cases, death is observed in animals that fall into a coma in a short time. In order to prevent acidosis, 28-35% NDF should be present in the dry matter of the ration. The disease can be prevented by mixing the feeds well, making the ration change gradually and switching to concentrated food slowly (Anonymous2, 2022).

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CHAPTER 4

DISEASES IN SOME MINERALS AND VITAMIN DEFICIENCIES IN WATER BUFFALOES

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1. INTRODUCTION

Buffalo is a very strong animal that is resistant to environmental conditions and diseases, has a high ability to benefit from roughage. Buffalo bred for meat, milk and work; It is grown continentally and regionally in South America, North Africa, Balkan countries, Southeast Asia, Australia, the Mediterranean and some Central European countries. 96.4% of the world's water buffalo is present in the Asian continent and generally presents a traditional breeding structure.

India (55%), Pakistan (17%) and China (13%) hold 85% of the world's water buffaloes. On the European continent, especially Italy is one of the model countries where water buffalo breeding is carried out with modern techniques, and an important trend is foreseen in organic water buffalo breeding (Yılmaz and Kara, 2019).

Turkey is a country rich in diversity of animal and plant genetic resources. Anatolian Buffalo, which has a special importance among domestic animal genetic resources, has become the focus of attention in the private sector that wants to invest in animal husbandry in recent years, as a result of the increasing demand for products such as milk, cream, yoghurt, pastrami, sausage and leather. There are 74 different races of the buffalo species (Bubalus bubalis), which is divided into two as swamp and river (river) buffaloes. In the world, they are classified as Bubalus group, Asian buffalo (Bubalina) and African buffalo (Synserina). The buffaloes existing in Turkey originate from the Mediterranean buffalo, a subgroup of the river buffalo, and are called

the Anatolian buffalo. Anatolian buffaloes are generally black in color, with horn type bow-shaped and curved backwards. Lactation yields are reported as 850-1000 kg during 100-350 days of lactation for buffaloes in the hands of the breeder (Kaplan at al., 2015).

Today, when the demand for organic products is increasing, buffalo, which is a ruminant animal species suitable for extensive and intensive farming, can effectively transform it into animal products by consuming low quality, cheap roughage sources with high cellulose content. It is very economical to grow in marsh and reed areas, in regions where cheap roughage is available.

Buffaloes are generally concentrated in countries where land, forage crops and pasture areas are limited. Because of their better evaluation of forages, they have a wide choice of plants compared to cattle. Although buffalo is a ruminant that is generally neglected all over the world, it is widely cultivated in Southeast Asian countries, South American countries, North Africa, all Mediterranean countries except France, Balkan countries and some Central European countries and Australia. Today, it is seen that studies on the feeding of buffaloes are insufficient and buffalo rations are generally prepared according to the norms prepared for cattle. Although they show similar characteristics to cattle, special rations should be prepared for the feeding of buffaloes, especially due to the differences (number and proportions of microorganisms) in the rumen environment of buffaloes. Determining the feeds and feeding practices used in the feeding of buffaloes under current conditions and revealing the nutrient content of the daily rations

given to the animals constitute the first step to be taken in this way. Buffalo meat also contains less fat and cholesterol than beef, but contains more protein and mineral substances. Buffalo milk has higher values in terms of fat content, especially compared to the milk of other animals. Since using silage in 69% of the total ration will cause low milk fat content, breeders should be warned to limit the use of silage in order not to reduce milk fat. In addition, rations should be prepared considering that the protein content of buffalo milk changes with different feeding practices (Yavrucu and Kılıç 2021).

1. DISORDERS DUE TO MINERAL DEFAULTS

1.1. MACRO MINERALS DEFICIENCIES

1.1.1. GRASS TETANY, LACTATION TETANIA (HYPOMAGNESAEMIA)

Magnesium also enters the structure of the skeletal system, such as Ca and P, and also takes part in the transmission of neuromuscular impulses and the activation of many enzymes. 60% of the Mg in the body takes place in the skeletal system and this reserve is used in case of insufficiency. However, hypomagnesemia occurs within 2-18 days following the transition to an inadequate diet. In practice, Mg deficiency occurs in two ways.

The first is the insufficiency situation that occurs after the use of the existing Mg reserve in the bones of calves fed only with milk for a long time. Death occurs as a result of loss of appetite, hypersensitivity, calcification in soft tissues, tetany, convulsions and convulsions.

The second is the state of insufficiency, which we call grass tetany or hypomagnesemic tetany.It is seen in dairy cows. With age, the susceptibility of animals increases due to decreased Mg mobilization. Excessive consumption of young grass grown in soils using nitrogen or potassium fertilizers is one of the most important causes of grass tetany. There is a great similarity between prairie tetany and hypomagnesemic tetany. But in grass tetany, the symptoms appear very suddenly.Because magnesium availability is so variable, it is difficult to give exact figures on the amount needed.For example, while usability is 70% in suckling calves, it is 30-50% in older calves.In a study on this subject, it was determined that the availability of Mg in hay and meadow grasses in aged dairy cows was between 11.6% and 37.3%.Generally speaking, the availability of Mg in grain feeds is higher than in roughage. Contrary to other minerals, the availability of Mg in roughage increases as the plant grows. The Mg requirement of suckling calves per kg body weight is 12-16 mg, and 0.07% Mg in the total ration is sufficient. The survival rate of dairy cattle can be used. Mg requirement is about 2-2.5 g per day, and 120-150 mg per kg of milk is added to this. The presence of 0.20% Mg in the total ration is sufficient. This rate can be increased to 0.25-30% in young grass-consuming animals and animals with high milk yield. Mg is mostly found in the premixes used for dairy cows. (Coşkun at al., 2001). It can be added to concentrated feeds up to 0.8% in order to benefit from the buffering effect of MgO, which is used as a Mg source, and to increase the milk fat ratio (Kaplan et al., 2010). Magnesium is obtained from limestone and mineral premixes and is generally stored in the bone structure. Organic trace minerals are stored

in higher concentrations in tissues and organs such as blood, liver, bone and kidney. Mg is in the center of the chlorophyll molecule, which gives green plants their color, so green vegetables are a good source of Mg. Some legumes, seeds and grains are rich in Mg Magnesium oxide, magnesium carbonate, magnesium hydroxide, magnesium citrate, magnesium lactate, magnesium chloride and magnesium sulfate 60%, 45%, 42%, 16%, 12%, 12% and magnesium sulfate, respectively. It contains 10 Mg elements (Kaplan ve Avcı.., 2012).

High potassium concentration in the rumen fluid causes depolarization of the apical membrane of the rumen epithelium. As a result, the electrical potential of the transepithelial membrane, which is responsible for the transmission of magnesium from the rumen fluid to the blood, decreases. The most important factor affecting the transport of magnesium in the rumen epithelium is that high potassium in the diet reduces magnesium absorption. It has been determined that there is a 50% decrease in magnesium absorption in young animals that switch from a low-potassium diet (0.6%) to a high-potassium diet (4.9%) (Reece, 2012).

Grass tetany is a nutritional disorder characterized by severe muscle contractions, cramps, and partial paralysis. Weight loss, isolation from the herd, lying down, inability to graze adequately, and walking with rigid joints are considered as the first symptoms. These symptoms are followed by irritability, muscle contractions, abnormal gait to some extent, and decreased milk yield. Grass tetany is usually specific to dairy cows. However, it can also be observed in young animals.

Sufficient amount of usable Mg should be given to dairy cows to prevent grass tetany. An adult cow has a body reserve of approximately 250 g. However, if the Mg in the feed is very insufficient, the reserves are practically meaningless. On the other hand, blood plasma Mg level is 2-3 mg/100 ml, and when adequate mineral is not provided, this amount decreases and falls to 1 mg/100 ml. If this decrease continues, grass tetany occurs. Evaluation rate of Mg in feed varies between 5-35%. The rate of evaluation depends on the food and the animal and affects the amount of Mg needed. In case of disease, animals are injected with Mg (Ergün and Tuncer 2001).

High Ca, P, and possibly Al cause decreased magnesium absorption. Symptoms related to Mg deficiency are decreased appetite, sensitivity, abnormal muscle contractions, breathing difficulties and excessive salivation. If the animal is not treated, symptoms such as shaky gait, falling on the legs and alternately lying on both sides occur in the advanced stages. Magnesium is found in sufficient quantities in most roughage grains. Mg found in grains (30-40%) is digested more than that found in roughage (20%). It is reported that the amount of Mg in the ration should be between 0.25-0.30% in high-yielding cows and in case of grass tetany risk. (Ergün and Tuncer 2001).Mineral-deficient diets should be supplemented with MgO (25-50 g/day per animal), which is inexpensive and readily available to the animal (Kaplan et al., 2010).

Magnesium forms a complex with PTH (Parathormone) receptors. Since the structure of the parathyroid receptor will be disrupted during

hypomagnesemia, hypomagnesemia is usually accompanied by hypocalcemia. Magnesium deficiency, which causes grass tetany and milk fever, is related to the accumulation of high levels of trans-aconitic acid in some fast-growing grasses in spring. However, trans aconitate does not accumulate in the rumen because it is rapidly degraded by rumen microorganisms to form tricarballylate. After absorption of tricarballylate, it chelates with magnesium in the blood and causes tetany. Selenomonas ruminantium is one of the microorganisms that can produce tricarballylate. One way to avoid the risk of hypomagnesemia is to metabolize trans asonitate before it is converted to tricarballylate. A microorganism that can do this (Acidaminococcus fermentans) has been defined. Magnesium in cerebrospinal fluid is in equilibrium with that in plasma. If the plasma concentration decreases, the magnesium concentration in the cerebrospinal fluid also decreases and can lead to clonic convulsions. In many animal species, hypomagnesemia is associated with calcification of the soft tissues of the body. There is also a relationship between hypomagnesemia and atherosclerotic lesions (Reece, 2012).

Unlike monogastric animals, ruminants cannot absorb magnesium very well from the small intestines. Magnesium deficiency is encountered when grass grows at its maximum in spring or autumn and is mostly observed in grazing lactating ruminants. High-yielding cows are at greater risk. Since magnesium cannot be mobilized from body tissues to maintain normal plasma concentration, it must be continuously ingested and digested with feed. Hypomagnesemia develops as a result

of reduced feed consumption in cases such as a long-distance transport (transport tetany) and sudden exposure to harsh weather. In cattle, hypomagnea may develop as a result of insufficient energy consumption in the last period of pregnancy. This syndrome is also called winter tetany because when animals are left outside in the winter, they have to feed only on grain residues such as corn straw and straw. Severe hypocalcemia with hypomagnesemia may also develop in animals grazing on wheat crops (wheatgrass tetany) or other early growing grain forages. Hypomagnesemia may also occur in calves fed only milk or milk replacer (milk tetany) beyond the first two months of age. Magnesium deficiency is a common problem in ruminants. Therefore, the details presented below are important. Magnesium absorption from the rumen depends on the magnesium concentration in the rumen fluid and the integrity of the magnesium transport mechanism, which functions thanks to the sodium-dependent active transport system.

The concentration of soluble magnesium in the rumen fluid depends on the following factors;

1. The magnesium content of the diet. Low-magnesium roughages and the addition of insufficient magnesium to the feed cause the soluble magnesium content to be consistently low. In spring and autumn, when meadows grow fast, it becomes difficult for plant tissue to absorb magnesium. This also occurs when meadows are fertilized with potassium.

2. The pH of the rumen fluid. The solubility of magnesium decreases markedly when the rumen pH exceeds 6.5. Grazing animals tend to have a high rumen pH due to the stimulation of the salivary buffer system associated with grazing and the high potassium content of the grass. Heavily fertilized irrigated meadows often contain high levels of non-protein nitrogenous substances and easily fermentable carbohydrates. When rumen microorganisms exceed their capacity to convert non-protein nitrogenous substances into microbial protein, ammonia and ammonium ions accumulate in the rumen and cause the rumen pH to rise. The pH of the rumen fluid often falls below 6.5 in ruminants fed diets containing high grain or carbohydrate. This pH is generally suitable for the solubility of magnesium.

3. Forage to bind magnesium. Roughage contains 100-200 mmol of unsaturated palmitic, linoleic and linolenic acids per kilogram, which can often form insoluble magnesium salts. Herbs may also contain trans asonitic acid or citric acid. Tricarbalylate, the metabolite of trans-asonitic acid, forms a complex with magnesium and this complex is resistant to rumen degradation. However, its role in hypomagnesemic tetany is unclear (Reece, 2012).

1.1.2. CALCIUM AND PHOSPHORUS DEFICIENCIES

The calcium and phosphorus required in the ration depend on the daily milk yield, the calcium and phosphorus in the composition of the milk, and the sources of the minerals in the ration. There is no need to increase the Ca and P levels of the ration too much, as the feed consumption will

increase to meet the increasing energy and protein requirements. On the other hand, it is necessary to have a sufficient level of phosphorus in the ration in order to see the heat severely and therefore to increase the probability of conception and pregnancy (Baran, 2018).

1.1.2.1. CALCIUM INSUFFICIENCY (HYPOCALCEMIA)

It usually occurs at birth or within 6-48 hours after birth. Older (>5), highly productive and well-conditioned animals are more susceptible. The reason is the decrease in the amount of ionized Ca in the tissue fluids. Prenatal ration Ca level is important. It is possible to divide hypocalcemia into three phases. The first period is short, excitement, tetany, tremors in the head and feet, head shaking, tongue sticking out, teeth grinding are observed. Body temperature slightly increased. In the second period, the animal lies on its chest. Consciousness is half lost, seemingly absent. He lies in an (S) form with his head resting on his side. The hind legs are paralyzed. The marble dries up, the skin and legs become cold. Body temperature decreases (37-38 ^{0}C). In the third period, the animal lay down and went into a coma. His legs are outstretched and limp, it is impossible for him to stand up. Body temperature has decreased (36-37 ^{0}C). Untreated animals die within 2-24 hours. For treatment, parenteral Ca salts are given.

Anionic salts (ammonium chloride, ammonium sulfate, calcium sulfate, magnesium sulfate) are given. As a preventative, low Ca-containing feeds should be given 2-3 weeks before birth (Anonymous, 2022).

The acid-base status of the cow at birth is important in determining the risk of milk fever. Metabolic alkalosis weakens the physiological activity of PTH (release of calcium from bone and production of 1,25 dihydroxy vitamin D). Thus, there is a disruption in the successful supply of calcium needs in lactation. In metabolic alkalosis, conformational changes occur in the PTH receptor and therefore PTH cannot bind tightly to its receptors. Cows fed diets with relatively high potassium and sodium go into a state of partial metabolic alkalosis. Metabolic alkalosis causes inadequate functioning of the adaptation mechanism related to the successful meeting of calcium needs in lactation, and cows develop milk fever. These cows show a transient pseudohypoparathyroidism at birth. The parathyroid glands sense the onset of hypocalcemia and secrete enough PTH. In contrast, tissues respond only weakly to PTH, resulting in a deficiency in osteoclastic bone resorption and 1,25 dihydroxy vitamin D production in the kidney. Since metabolic alkalosis is an important factor in the etiology of milk fever, it is important in the prevention of milk fever. High levels of potassium and/or sodium in dry cow diets alkalize the cow's blood and increase susceptibility to milk fever. The addition of calcium to prenatal diets practically does not increase the incidence of milk fever. Today, it is known that the addition of anions to the prenatal diet can prevent milk fever. Chlorite and sulfate salts of ammonium, calcium, and magnesium have been successfully used as acidifying anion sources. Chlorite salts are more acidogenic than sulfate salts. Hydrochloric acid is also successfully used as an anion source in the prevention of milk fever and is the strongest available anion source. In prenatal cattle, the second

common cause of hypocalcemia and milk fever is hypomagnesemia. Low blood magnesium can reduce PTH secretion from the parathyroid glands and cause temporary hypoparathyroidism. In addition, it causes transient pseudohypoparathyroidism by changing the ability of tissues to respond to PTH by making shape changes in the PTH receptor (Reece, 2012).

When dietary calcium is insufficient to meet the animal's needs, calcium is removed from the bones to maintain normal extracellular calcium concentration. If dietary calcium is very insufficient for a long time, severe bone lesions develop in the animal. Dietary calcium deficiency in young animals results in failure of new bone mineralization and delays growth. Rickets usually results from vitamin D or phosphorus deficiency, but calcium deficiency also contributes to rickets. Dietary calcium deficiency in older animals forces the animal to extract calcium from the bone to maintain homeostasis of extracellular fluids. This causes osteoporosis and osteomalacia, which makes the bone prone to spontaneous fracture. Milk calcium concentration does not change even during severe dietary calcium deficiency. Almost all mammals (especially cows) in early lactation are in negative calcium balance. The animal takes calcium from the bones to maintain normal blood calcium concentration (lactational osteoporosis). Dairy cattle lose 800-1300 g calcium (13% of skeletal calcium) in the first period of lactation. This loss is replaced by providing adequate dietary calcium in the last period of lactation. Milk fever affects approximately 6% of dairy cows each year. The

homeostatic mechanisms that keep the normal blood calcium concentration (9-10 mg/dL) constant in these cows fail and the calcium concentration in the blood falls below 5 mg/dL as a result of the excretion of calcium together with the milk. This hypocalcemia weakens muscle and nerve function to such an extent that the cow is unable to stand up. Intravenous calcium treatments are used to adapt the intestinal and bone calcium homeostatic mechanisms of the affected cow and to keep the cow sufficiently alive (Reece, 2012).

1.1.2.2. PHOSPHORUS DEFICIENCY

Phosphorus requirement varies depending on live weight and yield level. Phosphorus requirement is also expressed as 0.3-0.4% of the total ration dry matter. Phosphorus deficiency symptoms are more common during growth and advanced lactation periods. An arched back, deformed ribs, and delayed growth are symptoms during the growth period. This situation is called “rickets”. P deficiency symptoms may not be very evident in adult animals. This is because the animal can use up its body reserves before a particular symptom appears. In animals with phosphorus deficiency, appetite generally decreases, and the desire to eat against materials such as wood, bone and feather is awakened. In addition, the estrus period may be disrupted, anoestrus may be seen, procreation becomes difficult, the P content of the blood decreases, the bones become increasingly brittle (Şekerden, 2001).

Table 1: Daily Ca and P requirement of buffalo.

Özellikler	Ca g	P g
Growing buffalo	20-27	13-18
Share of growth	23-26	17-19
Cow (non-pregnant)	18-21	15-17
Cow (in late pregnancy)	31-37	22-26
1 kg of milk (7% fat)	3.2	2.1

Most roughages and legume grains do not contain much P. Animals fed plants grown on soils that do not contain sufficient amounts of P show symptoms of P deficiency, especially when fed without protein supplementation. Although the amount of P in cereal grains is higher than Ca, it cannot be said that they are very rich in this respect. While it is important to take Ca and P in sufficient amounts, it is also important that the ration contains these two elements in appropriate proportions. Excess amounts of either or both of these minerals in the diet can have dire consequences. If the Ca/P ratio of the diet is appropriate, the need for vitamin D in the diet decreases. If the diet contains sufficient amount of vitamin D, it is appropriate to have a Ca/P ratio of 2/1 (Şekerden, 2001).

Not providing enough phosphorus in the diet leads to a decrease in the concentration of phosphorus in the plasma. As a result, the mineralization process cannot be supported and mineralization does not occur in the bone matrices. Bone phosphorus released during bone remodeling processes is used to maintain plasma phosphorus concentration, which should normally participate in new bone formation. Young animals in the growing period suffer from joint pain and show reluctance to move. The growth rate decreases. Animals have

narrow chests, the costochondral joints are enlarged and easily felt. Adult animals with osteomalacia also suffer from joint pain. Joint enlargements and lameness are also seen. Weakening of pelvic bone development in heifers fed diets containing insufficient phosphorus may cause difficult birth. If the amount of phosphorus in the diet is low, the phosphorus concentration in cattle fed with such diets is around 0.6-1.1 mmol/L (2.0-3.5 mg/dL), and chronic hypophosphatemia is present. As fetal growth accelerates in the last stages of pregnancy, plasma phosphorus level decreases and a significant amount of phosphorus is removed from the mother's circulation. These animals usually lie on the ground and cannot get up, although they seem quite awake, but eat the bait that is placed in front of them. Cows carrying twin calves are most affected. The plasma phosphorus concentration of such animals is usually less than 0.3 mmol/L (1.0 mg/dL). The disease usually also progresses with hypocalcemia, hypomagnesemia and in some cases hypoglycemia (Reece, 2012).

Large amounts of phosphorus are taken from the extracellular phosphorus pool due to the production of colostrum and milk at the beginning of lactation. Even in this way alone, there is often an acute reduction in plasma phosphorus levels. In addition, if hypocalcemia is also developed in the animal, large amounts of PTH are secreted in the urine and saliva, which increases the loss of phosphorus. Cortisol, which is secreted during labor, can also lower plasma phosphorus concentration. Plasma phosphorus concentration in dairy cows falls below normal at the time of birth. The plasma phosphorus concentration

in cows with milk fever is usually between 0.3-0.6 mmol/L (1.0-2.0 mg/dL). Plasma phosphorus concentrations usually rise rapidly after intravenous administration of calcium solutions to hypocalcemic cattle. The reason for this rapid improvement is 1) the decrease in PTH secretion, which increases the loss of phosphorus in the urine and saliva, 2) the increase in the plasma concentration of 1,25-dihydroxyvitamin D, which provides the absorption of phosphorus in the diet and the reabsorption of phosphorus in the salivary secretion, and 3) the resumption of gastrointestinal motility. In some animals that develop acute hypophosphatemia, the plasma phosphorus concentration does not return to normal. This is seen in cattle with downer cow disease. This syndrome begins when there is milk fever, but unlike cows with milk fever, plasma phosphorus remains low despite successful treatment of hypocalcemia. This hypophosphatemia in cattle appears to be an important factor in inability to lift the feet, but the reason for low plasma phosphorus is still unknown (Reece, 2012).

Rickets is a disorder in which the new osteoid and cartilaginous septa in the growth plate of growing animals fail to mineralize. Osteomalacia is softening of adult bones and is characterized by a lack of mineralization in reconstructed bone. This condition is most often associated with a lack of vitamin D or phosphorus in the diet. Both deficiencies lead to a decrease in blood phosphate concentration. Because more phosphorus is needed to support the mineralization of newly growing bone, blood phosphorus concentrations in young animals are higher than in adult animals. In adult animals deficient in

vitamin D or phosphorus, the blood phosphorus concentration is low and below the level needed to mineralize the newly formed bone matrix during the remodeling process. Pathological changes occur much more slowly than in rickets. Over a long period of time, the bones can become more flexible, causing pain in all joints. In principle, calcium deficiency differs from phosphorus deficiency in the following way: in phosphorus deficiency, normal bony tissue is formed but not mineralized, whereas in calcium deficiency, normal bony tissue is either not formed at all (osteoporosis) or is replaced by fibrous tissue. It is common to have mixed lesions such as osteomalacia, osteoporosis and fibrous osteodystrophy in the same bone in vitamin D deficiency (Reece, 2012).

1.1.3. POTASSIUM DEFICIENCY

The third most abundant element in the animal body is potassium. It takes part in the regulation of osmotic pressure, water balance, transmission of nerve impulses, transport of oxygen and carbon dioxide, and formation of various enzymatic reactions. When severe potassium deficiencies are encountered, decrease in feed consumption and milk yield, pica, dulling of hair, decrease in plasma and milk K levels and increase in hematocrit value are observed. In case of a more moderate deficiency in the ration, general symptoms such as decreased feed consumption and milk yield are observed. There is enough potassium in the roughage to meet the needs of the animals in excess. On the other hand, this amount is a little low in corn silage and the use of concentrated feed with such roughage causes insufficiency by reducing the amount of K in the total ration below the level required by

the animal. The K concentration in plants decreases significantly as the plant matures, and this is more pronounced in plants grown on moist soils. The K level is quite high in plants grown in fields where potassium fertilizers are applied and mowed at a very young age, and this may cause grass tetany by negatively affecting magnesium metabolism. The K requirement in dairy cows is accepted as 8%. It has been reported that the need increases up to 1.2%, especially in animals exposed to heat stress, as the loss increases with sweating. The amount of K in milk is about 0.1.5%. Since there is no excretion with milk in young breeding animals, the need is low and K is sufficient up to 0.6% (Coşkun at al.., 2001).

Potassium fulfills the tasks of maintaining acid-base balance and electrolyte balance in the body. It would be appropriate for the K level in the ration to be 0.7-0.8% of the total ration dry matter in calves and 1% in lactating cows. Green forages normally contain high levels of K. Therefore, significant K deficiency symptoms will not occur if the diet contains sufficient green roughage. In K deficiency; Symptoms such as general muscle weakness, dulling of feathers, and decreased K levels in milk and blood are observed, especially in the intestinal and cardiac muscles (Şekerden, 2001).

Potassium is essential for growth. The combination of amino acids to form proteins depends on the normal intracellular potassium concentration. In addition, potassium is required for normal insulin release. Therefore, the decrease in growth rate seen during potassium deficiency may be due in part to insulin deficiency. Most diets provide

more than enough potassium that the body needs for survival, growth, pregnancy and lactation. The kidneys excrete the excess potassium that is absorbed. High blood potassium concentration (hyperkalemia) stimulates the release of aldosterone from the adrenal glands. As a result of the mineralocorticoid activity of aldosterone, sodium ions and potassium ions are excreted. Hypokalemia also affects insulin secretion and impairs carbohydrate metabolism. Lack of potassium reduces renal blood flow and reduces the ability of the kidneys to concentrate urine. Many bacterial toxins stimulate the release of both potassium and chloride from the small intestinal epithelium. Total body potassium is rapidly depleted in the disease. It is also complicated by acidosis, which causes elevated blood potassium concentration. Treatment should first focus on normalizing blood pH, and then potassium should be provided. Oral potassium bicarbonate serves these two purposes. The animal is alkalotic because chlorine anions are collected in the abomasum displacement in cattle. This may cause hypokalemia (Reece, 2012).

1.1.4. SODIUM AND CHLORINE DEFICIENCIES

Plants contain small amounts of sodium. If salt is not added to the diet, the risk of sodium deficiency increases in herbivores. Animals with sodium deficiency have an intense craving for salt, and licking and chewing behaviors (pica) of various substances are observed. Long-term sodium deficiency causes a decrease in yield, as well as a rough and exhausted appearance in the animal. Severe deficiency causes tremor, inordination, weakness and cardiac arrhythmia, cows produce too little milk. Although many animals with sodium deficiency have a

strong urge to consume sodium, these animals do not take too much salt as they also perfectly control their sodium chloride consumption. They only consume enough salt to make up for the salt deficiency in the body. Salt starvation is quite severe in ruminants and other herbivores. Injecting sodium chloride to compensate for low sodium concentration does not immediately lead to a decrease in appetite for salt. However, the increase in sodium in the cerebrospinal fluid immediately suppresses the appetite for salt. While it is necessary to take very little salt with the ration, a little more is usually taken, but in such cases, there will be no significant changes in salt appetite and excess salt will be excreted in the urine (Reece, 2012).

The body loses sodium when the animal has diarrhea. Sodium loss in liquid diarrhea is higher than in diarrhea caused by malabsorption. In both cases, the total body sodium concentration may fall to such a level that it causes a drastic reduction in extracellular fluid volume. This leads to circulatory collapse and metabolic acidosis. Chlorine deficiency can cause metabolic alkalosis and hypovolemia. Less severe disability causes lethargy and poor performance. This rarely occurs if the animal is given salt. If salt is not taken for a long time, sodium deficiency usually occurs long before chlorine deficiency. During the displacement of the abomasum in ruminants, the chlorine secreted as hydrochloric acid is trapped in the lumen of the abomasum. Depending on the severity of the displacement and the presence of abomasal torsion, chlorine may not be available for reabsorption in the small intestine. This creates metabolic alkalosis in the animal and further

increases the depression in animals suffering from this disease. In the case of diarrhea, besides sodium, chlorine is lost from the body. The amount lost in secretory diarrhea is greater than in malabsorption diarrhea (toxins actually stimulate chloride secretions). In both cases, the total body chlorine concentration may drop to such a level that it causes a drastic reduction in extracellular fluid volume, leading to circulatory collapse (Reece, 2012).

1.1.5. SULFUR INSUFFICIENCY

About 0.15% of the body is sulfur (sulphur). Sulfur, chondroitin sulfate; and amino acids such as methionine, cysteine (cystine), homocysteine and taurine, and B group vitamins such as thiamine (Vitamin B1) and biotin (Vitamin H). Methionine, thiamine and biotin cannot be synthesized by mammalian tissues. These nutrients must be provided in the diet. When sufficient substances are also provided (nitrogen, energy and sulfur), rumen microbial synthesis of methionine, thiamine and biotin can meet the daily needs of ruminants except very high yielding cattle. For this reason, only ruminants have to meet the sulfur in the diet. Sulfur combined with microbial protein is absorbed from the small intestine as cysteine and methionine. Some dietary sulfur can be absorbed in the form of sulfates and sulfites. Sulfur in the form of sulfates is more effectively absorbed from the small intestines. The body essentially does not need sulfur (or sulfate). 'Sulfur deficiency' is actually a deficiency of sulfur-containing amino acids, thiamine or biotin. Ruminants need a certain amount of dietary sulfur for the

synthesis of cysteine, methionine, thiamine and biotin in microorganisms (Reece, 2012).

1.2. MICRO MINERALS DEFICIENCIES

1.2.1. IODINE DEFICIENCY

It is a component of the hormone thyroxine. The amount of I in milk is low. In case of iodine deficiency, the thyroid gland enlarges excessively. This condition is generally called “goiter” in calves. In severe I deficiency, calves may be born with very sparse hair, completely hairless or dead. Iodine deficiency is specific for certain regions and is not seen in all regions. If the amount of goiter-forming substances such as soybean meal is not too high in the diet, feeding with iodized salt significantly prevents I deficiency (Şekerden, 2001).

Iodine deficiency slows down the oxidation rate of all cells by reducing the production of thyroid hormones. Fetal death can occur in any period of pregnancy in iodine deficiency. Mothers usually look normal. When the diet contains too little or insufficient iodine, the mother's thyroid gland becomes highly efficient at removing iodine from the blood and reusing iodine by the thyroid hormone. However, this reduces the amount of iodine coming to the fetal thyroid gland and hypothyroidism occurs in the fetus. Goiter is when the thyroid stimulating hormone secreted in excess from the pituitary makes the thyroid gland hyperplastic. In the case of mild iodine deficiency, the hyperplastic thyroid gland can compensate for the decreased iodine availability. Adult animals deficient in iodine are unproductive and generally sterile.

Goitrogens are compounds that cause hypothyroidism by inhibiting the synthesis or secretion of thyroid hormones. These are cyanogenic goitrogens and impair the uptake of iodine by the thyroid gland. Cyanogenic glycosides can be found in many feeds such as raw soybeans, sugar beets, maize, sweet potatoes, sweet clover and millet and are metabolized to thiocyanate and isothiocyanate when ingested. These compounds alter the transport of iodide to the cell membrane of the thyroid follicle, reducing iodide uptake. This effect is easily prevented by the additive of iodine. Iodine, which must be added to the diet to eliminate the effects of goitrogens, increases the iodine content in milk. Excessive increase in the amount of iodine in milk may cause fetal thyrotoxicosis in some people (Reece, 2012).

1.2.2. COPPER AND IRON INSUFFICIENCY

Iron deficiency causes hypochromic-microcytic anemia as a result of failure to produce hemoglobin. In addition, as a result of the restriction of iron in the diet, the muscle myoglobin level decreases, causing the white color of veal meat. Anemic animals are sluggish and feed consumption and body weight gain are poor. In iron deficiency, there is an increase in the rate of morbidity and mortality in connection with the suppression of the immune system. An increase in disease rate may be observed before iron deficiency affects hematocrit. Iron deficiency is not common in adult animals because during this period the animals' needs are reduced and there are also iron sources in the environment. In herbivores, the iron requirement of adult animals is usually met or

exceeded as a result of the contamination of the roughage with soil (and the ingestion of the soil in the meadow by the animal) (Reece, 2012).

Cu and Fe are necessary for the formation of blood hemoglobin. If these two minerals are deficient in the ration, anemia related to nutrition occurs in the animal. In general, these elements are present in significant amounts in dairy cattle rations. However, anemia is seen in animals fed with fodder plants grown on soils deficient in Fe and Cu. Anemia is also seen in animals fed with large amounts of milk and cereal grains (Şekerden, 2001). In copper deficiency; weight loss, decrease in milk yield, severe diarrhea, coarsening of the hairs and loss of color, swelling of the bone ends, frequent fractures of the femur, humerus and ribs, and stiffness in the joints. Delay in estrus and fertility parameters, difficult births, increase in retention cases, deaths as a result of fall disease and heart failure caused by congenital rickets can be seen. A fairly typical symptom for Cu deficiency is a loss of pigment and a grayish discoloration in the black hairs around the eyes. Cu sulfate, Cu carbonate and Cu oxide are the most widely used feed additives (Coşkun at al., 2001).

One effect of copper deficiency that is not easily observed is the loss of immune function. The susceptibility to infections increases as a result of decreased ability of neutrophils to kill microorganisms. Dietary copper required to maintain optimal immune function may be greater than that required to prevent the classic manifestations of copper deficiency. Plants grown in swamps or muddy soils may contain high amounts of molybdenum. In cattle and sheep that eat these plants,

copper deficiency and unpigmented circles around the eyes and chronic diarrhea (ruminant gas bubble diarrhea) may develop (Reece, 2012).

1.2.3. COBALT DEFICIENCY

Animals fed with forage grown on soils containing insufficient levels of Co have decreased appetite, weight loss and fatigue. Young animals, on the other hand, reach sexual maturity late, as they cannot grow normally. Co is necessary for rumen bacteria to synthesize vitamin B12. To eliminate the cobalt deficiency, it is sufficient to add a Co salt to the ration (Şekerden, 2001).

Some of the cobalt in the diet can be absorbed in the cation form. However, the cation form does not have a defined function and when absorbed, it cannot return to the rumen for microorganisms to use it. Most are excreted in the urine and a smaller amount in the bile. Chlorite, nitrate, carbonate and sulfate compounds of cobalt are the most suitable sources of cobalt for ruminants. Cobalt oxide is less soluble and therefore less useful. Although partially lost during rumination, cobalt oxide pellets and glass pellets that are deposited in reticulorumen and melt in a controlled manner, releasing cobalt successfully provide cobalt during the grazing period of ruminants. Canary grass (Phalaris, kiwi grass) stagger is a neural syndrome caused by alkaloids in certain canary grasses and can be prevented by supplementation with cobalt. Cobalt either inactivates this neurotoxin or prevents its absorption (Reece, 2012).

1.2.4. MANGANESE DEFICIENCY

manganese; Since it enters the structure of hydrolases, kinases, decarboxylases and transferases, its deficiency causes disruption in metabolism. It manifests itself as slowing or stopping of growth, anomalies in the skeletal system, adversely affecting fertility and calf anomalies. It is found in high concentration in the organism, especially in glands such as pancreas, kidney and pituitary. The Mn in the feeds is enough to meet the needs of the animal. Forages contain more Mn than grain feeds (Coşkun at al., 2001). Daily requirement is 7-10 ppm in calf ration dry matter and 20 ppm in adult ration dry matter (Şekerden, 2001).

Manganese deficiency can cause growth retardation, skeletal abnormalities (shortened and deformed), reproductive failures or suppression, and neonatal anomalies (for example, ataxia due to insufficient development of the inner ear). Skeletal changes are associated with loss of galactotransferase and glycosyltransferase enzymes. These enzymes are necessary for the production of cartilage and bone essential substances (mucopolysaccharides and glycoproteins). In one study, neonatal deformities were observed in all calves of cattle fed 16-17 ppm dietary manganese for 12 months. Observed deformities are weak feet and calves, enlarged joints, bent feet, general weakness, and decreased bone strength. Heifers and cattle fed low-manganese diets show later estrus and are more prone to 'hidden oestrus'. Therefore, the pregnancy rate is low (Reece, 2012).

1.2.5. ZINC DEFICIENCY

Nucleic acid is involved in the structure of many enzymes involved in protein and carbohydrate metabolism. In its deficiency, regression in growth performance, restlessness, swollen feet with open wounds, hair loss, a more serious general dermatitis around the feet, neck, head and nostrils and other parakeratoic lesions are observed in calves. In dairy animals, however, such severe lesions are not observed, parakeratosis is observed as a result of delayed healing of wounds and related traumas (Coşkun at al., 2001). Daily need; 8-10 ppm in calf ration dry matter and 40 ppm in adult ration dry matter (Şekerden, 2001). A sudden decrease in feed consumption and growth rate is observed in animals with zinc deficiency. Animals with longer periods of regurgitation show slow growth of the testicles, weakening of the nail horn, and parakeratosis (excessive keratin deposition) in the skin on the legs, head (especially the nostrils), and neck. Atrophy in the thymus and lymphoid depletion in the spleen and lymph nodes are evident in necroscopic examination (Reece, 2012).

1.2.6. SELENIUM DEFICIENCY

White muscle disease is a nutritional muscular dystrophy that causes necrotic changes in the striated muscles of the body. It is very common in calves. The disease got its name from the white lines observed in many muscles, especially in the thigh and shoulder. Lesions are bilateral and symmetrical. Selenium deficiency causes infertility and growth retardation in most species. There are also some species-specific

effects. Some of these effects can be reduced by adding vitamin E. Selenium requirement of many animals is between 0.1 and 0.3 mg/kg. Selenium deficiency is associated with mastitis as well as increasing the risk of placental failure. Selenium deficiency is thought to reduce the immune response in cattle, but its mechanisms are unfortunately unknown (Reece, 2012).

It enters the structure of the glutathione peroxidase enzyme and has antioxidant properties. Especially in plants grown in acidic soils, although the soil is sufficient in selenium, the plant does not contain selenium and deficiency symptoms are frequently observed in animals grazing on such pastures. The most important symptom of SE deficiency is White Muscle Disease or Nutritional Muscular Dystrophy. It is a disease characterized by chalky lines, degenerations and necrosis in the heart and skeletal muscle. Heart failure, paralysis of the hind legs, dystrophy of the tongue are observed. In case of deconditioning, which is usually accompanied by diarrhea and can be seen in animals of all ages, the suspicion of Se deficiency should be considered. Se deficiency also negatively affects fertility. Especially if it is given together with vitamin E, its incidence decreases (Coşkun at al., 2001).

1.2.7. CHROMIUM FAILURE

Since glucose tolerance factor is inactive in chromium deficiency, it causes hyperglycemia. Studies also indicate that chromium is an important immune function regulator. (Reece, 2012).

2. VITAMIN NEED

2.1. INSUFFICIENCY OF FAT-SOLVENT VITAMINS

2.1.1. VITAMIN A DEFICIENCY

Vitamin A deficiency is characterized by keratinization of epithelial tissue. In its deficiency, degeneration of the mucous membranes is observed. Symptoms such as increased susceptibility to infections, cold and pneumonia, and diarrhea, loss of appetite, and emaciation are also observed. Later, significant changes occur in the eye such as excessive tears, keratitis, softening of the cornea, and blindness. Typical symptoms for vitamin A, such as reduced dark adaptation and night blindness, are easily detected by suddenly placing the animal in a dark environment. In the further stage of insufficiency, staggering gait, convulsions, edema in the papillae, and decrease in cerebrospinal fluid pressure are observed. The first sign of vitamin A deficiency in pregnant animals is the shortening of the gestation period. An increase is observed in the incidence of retention and stillbirths or the birth of non-coordinated, blind calves. In the case of using low quality roughage, it becomes necessary to give additional β carotene or vitamin A to young animals that do not receive enough colostrum and milk (Coşkun at al., 2001).

Keratomalacia (corneal metaplasia) and xerophthalmia (dryness and thickening of the conjunctiva) are classic eye lesions. As a result of excessive keratinization of the skin and papular eruption of the skin, the epidermis dries up. Squamous metaplasia occurs in the bronchorespiratoric duct, resulting in loss of mucous secretion and

increased keratinization in the duct, leading to decreased elasticity of the lungs. Respiratory infections are common. In males, spermatogenesis is impaired, while in females, abortion and resorption of the fetus often occur. Abnormal baby births are seen. There is a decrease in the number of goblet cells and the mucous secretion of the gastrointestinal tract. Metaplasia of the pancreatic duct affects digestion. Bone remodeling does not occur and bone development is weakened. This type of bone development narrows the cerebrospinal fluid flow and thus causes an increase in cerebrospinal fluid pressure (Reece, 2012).

2.1.2. VITAMIN D DEFICIENCY

Since vitamin D deficiency is related to Ca and P metabolism, symptoms that can be seen in the deficiency of these two mineral substances are observed in its deficiency. In its insufficiency, thickening of the bones, swelling in the knee and shoulder joints, hunching on the back, and fracture of the vertebrae result in paralysis. In severe cases, an increase in the amount of synovial fluid of the joints occurs. As the deficiency progresses, difficulties such as hypersensitivity, tetany, difficulty in breathing, anorexia, delay in growth, shuffling of the hind legs are encountered (Coşkun at al., 2001). Vitamin D content is low in green fodder and silage. Thanks to sunlight, ergosterol, the provitamin of vitamin D, is converted to vitamin D. The amount of vitamin D in hay that has not been sun-dried is generally low as in corn silage. Quality sun-dried dried herbs are the best source of vitamin D. Animals that benefit from sunlight adequately do not show

the symptoms of Vitamin D deficiency. Daily vitamin D requirement per 100 kg live weight is 1000 I.U. for adult animals and 660 I.U. for calves. These amounts of vitamin D will be sufficient to prevent rickets if there is sufficient amount of Ca and P in the diet (Şekerden, 2001).

Vitamin D deficiency leads to disruption of calcium and phosphorus homeostasis, resulting in lower plasma phosphorus (and less commonly plasma calcium) levels. In such a case, rickets in young animals and osteomalacia in adults are observed. Both are bone diseases associated with a lack of mineralization in the organic bone matrix. In rickets in young animals, the joints are swollen and painful, and the costochondrial joints of the ribs are easily palpable. In adults, lameness and pelvic fracture are the most common consequences of vitamin D deficiency. Some factors in the diet (potassium and sodium) make the blood alkaline and prevent the kidney tissue (including bone) from recognizing the PTH hormone. Therefore, the decrease in the production of 1,25-(OH)2 vitamin D leads to severe hypocalcemia by disrupting the calcium balance in the prenatal cow (Reece, 2012).

2.1.3. VITAMIN E DEFICIENCY

Vitamin E is important for fertility. Vitamin E deficiency is not uncommon in dairy cattle and buffaloes. Cereal grains and pulp contain large amounts of vitamin E. Daily vitamin E needs of calves are below 40 mg (Şekerden, 2001). It is a vitamin that is a biological antioxidant and protects the phospholipid membranes of cells from the destruction of peroxides. Muscular Dystrophy, also known as White Muscle

Disease, is encountered in vitamin E deficiency. It is a typical appearance that the hind legs are kept crossed during walking with weakening of the leg muscles. Since the tongue muscles are also affected, the animal has difficulty during sucking. In later stages, it becomes difficult for the animal to keep its head upright and to stand. It is sufficient to use 50 mg of O-tocopherol to prevent deficiency symptoms in calves given skimmed milk or fed fats rich in unsaturated fatty acids together with milk replacer feeds (Coşkun at al., 2001).

It was determined that the incidence of new clinical mastitis was reduced in 37% of dairy cattle farms with a daily supplement of 1 g of vitamin E. The highest protection against mastitis is provided when vitamin E and selenium are added to the ration together. In deficiency of vitamin E in the diet, udder edema and retention in dairy cows also occur. Another benefit of vitamin E is that the milk of cows supplemented with vitamin E is less exposed to oxidation, increasing the commercial value of milk. The fact that vitamin E is an antioxidant and its stabilizing effect on cells with this feature is defined as the beneficial effect of vitamin E. In many species, anemia (hemolysis of red blood cells), growth retardation and low reproduction are the most prominent symptoms of vitamin E deficiency (Reece, 2012).

2.1.4. VITAMIN K DEFICIENCY

Vitamin K deficiency reduces the prothrombin content of the blood. Coagulation time is prolonged and hemorrhages are seen in various parts of the body spontaneously or after bruising. The only true

symptom seen is subcutaneous hemorrhage. Vitamin K antagonists can inhibit the activity of vitamin K and cause vitamin K deficiency. Dicoumarol and similar compounds bind epoxide reductase and prevent the formation of active vitamin K, quickly reducing the activity of vitamin K in the body (Reece, 2012).

2.2. WATER-SOLVENT VITAMIN INSUFFICIENCY

2.2.1. VITAMIN C (ASCORBIC ACID) DEFICIENCY

The deficiency of vitamin C in the rations of various animals causes a disease called scurvy. However, this disease is not seen in cattle and buffaloes. Because the need for these two types of vitamin C is met by vitamin C synthesized in the tissues. The amount of vitamin C taken with feed has little effect on the level of vitamin C in milk (Şekerden, 2001). The performance of animals reared under heat stress cannot reach the desired levels. Heat stress reduces growth rate, feed consumption. Additional ascorbic acid added to the feed alleviates the effect of heat stress and improves the performance of the animal. (Avci, at al.., 2004).

2.2.2. BIOTIN (VITAMIN H, VITAMIN B7) DEFICIENCY

Biotin deficiency is rarely seen in animals fed maize and soybean diets. Animals with biotin deficiency exhibit alopecia (hair loss), poor hair coverage, dandruff dermatitis, and acromotrichia (lack of hair colour). Weak nail development and reduced nail hardness are symptoms of biotin deficiency in cattle. A high amount of fat in the diet, especially

if the fat is rancid, can oxidize biotin and cause biotin deficiency (Reece, 2012).

2.2.3. CHOLINE FAILURE

Choline deficiency causes fat accumulation in the liver due to the insufficiency of phospholipids necessary for the transport of fats from the liver to the tissues. Choline can be synthesized from phosphatidyl serine in the body if methionine, which acts as a methyl donor, is provided in sufficient quantity. Corn soy diets provide adequate choline, and high protein feeds are also a good source of choline (Reece, 2012).

2.2.4. CYANOCOBALAMINE (VITAMIN B12) DEFICIENCY

In ruminants, vitamin B12 deficiency occurs when dietary cobalt is insufficient for microbial synthesis of vitamin B12 in the rumen. Ruminants appear to be more susceptible to vitamin B12 deficiency than non-ruminants because ruminants are more dependent on gluconeogenesis to meet their glucose needs. The stage where methylmalonyl CoA is converted to succinyl CoA in propionate metabolism is the main site of vitamin B12 deficiency. The presence of methylmalonic acid in the urine is an indication of such an insufficiency. As a result of vitamin B12 deficiency, methionine synthesis of rumen microorganisms may also be inhibited. In the absence of cobalt in the diet, the production of vitamin B12 in the rumen decreases rapidly (within days). A diet deficient in vitamin B12 and

cobalt stored in the liver of adult ruminants can usually be sufficient for a few months. Young animals are more susceptible to cobalt deficiency as they have lower liver reserves of vitamin B12. Growth retardation, inefficiency and weight loss are the initial symptoms of cobalt deficiency. More severe manifestations are fatty degeneration of the liver, pale mucous membranes (anemic), and decreased resistance to infection as a result of weakened neutrophil function. While cattle have enough vitamin B12 stores for several months, this is not the case in rumen microorganisms. A few days after feeding with a diet deficient in cobalt, the succinate concentration in the rumen increases due to either the inability of rumen microorganisms to convert succinate to propionate or an increase in rumen bacterial population from propionate production to succinate production (Reece, 2012).

2.2.5. FOLACINE (FOLIC ACID DERIVATIVE) INSUFFICIENCY

Rumen microorganisms meet all the folic acid needed by ruminants. Folic acid deficiency causes regression in growth, poor hair cover and poor hair growth. Macrocytic hypochromic anemia is common (Reece, 2012).

2.2.6. NIACINE (VITAMIN B3, NICOTINIC ACID) INSUFFICIENCY

The addition of niacin to dairy cattle diets during calving reduces the incidence of ketosis and fatty liver. Niacin is antilipolytic and it has been reported that it prevents fatty liver and ultimately ketosis due to

this feature. The increase in metabolic activity due to increased milk yield and the decrease in feed consumption during calving may lead to insufficient niacin synthesis in the rumen. Since niacin is involved in most of the metabolic events, a rapid regression is observed in tissue regeneration and growth in case of deficiency. Decreased body weight gain and dry dandruff skin are common. Necrosis and ulceration developing primarily in the digestive system is followed by diarrhea secondarily. Diets high in tryptophan with high-quality protein reduce the need for niacin. Rumen microorganisms synthesize niacin that ruminants need (Reece, 2012).

2.2.7. THAIMIN (VITAMIN B1) DEFICIENCY

Thiamin synthesized by rumen microorganisms generally meets all the needs of ruminants. However, sudden changes in the diet, especially corn silage and concentrate feeds, may inhibit microbial thiamine synthesis or result in the proliferation of thiaminase-producing microorganisms. Diets containing high sulfide and sulfate may also inhibit thiamine activity in the rumen. Low tissue thiamine levels result in energy starvation in tissues, leading to necrosis of glial cells and cortical neurons in the brain (polioencephalomalacia, cerebrocortical necrosis in cattle). The brain softens (malacia) and the tissues appear autofluorescent under UV light in the postmortem differential diagnosis test. Sick animals are depressed, have medial strabismus (strabismus) and are usually blind (cortical blindness). In most cases, hypersensitivity (hyperaesthesia), supine position and subsequent death

are inevitable. Intravenous administration of thiamine may save some animals (Reece, 2012).

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CHAPTER 5

THE EFFECT OF TEMPERATURE STRESS ON REPRODUCTIVE PERFORMANCE OF WATER BUFFALOES

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1. Introduction

Defined as "water buffalo" in English and domesticated approximately 5,000 years ago, the buffalo is now resred in nearly 40 countries. Water buffalo is a farm animal that is resistant to diseases and the ability to adapt to different environmental conditions, which people have been using for centuries for various yields such as meat, milk and leather (Nanda and Nakato, 2003).

The buffalo is a mammalian species belonging to the bovine subfamily of the Bovidae family and has two classified species. These are African wild buffalo (Synceru) and domesticated Asian buffalo (Bubalus bubalis). There are 74 different breeds of buffaloes originating from domestic and wild forms. Asian buffaloes are divided into two subspecies as river buffalo (Bubalus bubalis bubalis) and swamp buffalo (Bubalus bubalis carabenesis). While swamp buffaloes are used as beast of burden, meat and milk yields are prominent in river buffaloes (Medhammar et al., 2012).

Buffalo is a farm animal that lives in areas with more water currents and loves shade and water. However, they are under a great deal of stress when exposed to direct sun rays or on days when the air temperature is high. Buffalo and products obtained from buffaloes are particularly affected by environmental as nutrition. However, in hot climate seasons, appetite decreases with the increase in ambient temperature, which causes slowdown in growth and disruption of reproduction (Marai et al., 2006).

The ambient temperature at which an animal's body is in balance, that is, does not gain or lose heat, is called the Thermo Neutral Zone. In extremely hot humid or hot dry weather, it becomes difficult for the buffalo to balance the heat by sweating and respiration, and thus heat stress occurs. Buffaloes are more vulnerable to heat stress at high ambient temperatures due to their fewer sweat glands and black hairs than cattle, resulting in loss of fertility (Upadhyay et al., 2008).

In buffaloes exposed to heat stress, feed intake and feed utilization decrease, and changes occur in protein, water, energy and mineral balances, enzymatic reactions, and hormonal secretions. This situation causes a decrease in reproductive performance in buffaloes (Das et al., 2013).

In this review, the effect of heat stress on the reproductive traits of buffaloes reared in hot climates was investigated.

2. Adaptive Characteristics to Heat

Farm animals respond in a number of ways to keep their body temperature at an optimum level. Autonomic responses include a number of physiological features such as vasodilation or narrowing of the vessels, tremors and sweating. Behavioral responses, on the other hand, are associated with situations such as animals needing shaded areas or puddles, moving to places with air currents (Sessler, 2016).

Temperature adaptation of buffaloes is a process related to the integrity of various systems such as respiratory, circulatory, excretory, nervous,

endocrine and enzymatic systems (Das et al., 2013). Animals need different temperature receptors located on the skin surface, the preoptic region of the hypothalamus, and other parts of the body to regulate body temperature (Caballero-Chacón et al., 2010). Skin thermoreceptors are polymodal. Skin thermoreceptors are polymodal. Because, they not only respond to thermal stimuli, but also to other types of stimuli, such as mechanical and chemical, with different measures (Schepers and Ringkamp, 2010).

In the structure of the skin surrounding the body, it has a sympathetic nervous system that includes multiple nervous systems that have vasoconstrictor, vasodilator functions and stimulate thermoreceptors (Smith ve Johnson, 2016). These different and complex structures in the skin enable the skin to become a central organ in order to balance the heat increase in the body. Because with the increase in temperature in the ambient temperature, it detects this temperature increase and transmits it to the central nervous system so that the vital, reproductive and production activities of the living thing are not endangered (Morrison, 2011; 2016). Nerve structures in the skin receive nerve impulses sent by the heat center in the central nervous system; It provides heat transfer to the body through sweating, respiration, convection, conduction and radiation (Kanosue et al., 2010).

The negative effects of heat stress on the reproductive and production performances of animals have been revealed in detail by studies. As the shelter ambient temperature rises above normal levels, increases in rectal temperature occur. This situation restricts the dry matter

consumption of animals and causes decreases in fertility and milk yields. In extremely hot periods when the optimum temperature values (5-25 °C) disappear, if the relative humidity is high, the thermoregulation ability of the living thing is negatively affected. Since heat production in the body is higher in high-yielding animals, they are much more affected by heat stress than low-yielding animals. Because high-yielding animals are more metabolically active and cause extra heat increase in these animals (Gorgulu, 2013).

Considering the ideal environmental conditions for growth, development and reproduction in buffaloes, air temperature should be 13-18 °C, relative humidity 55-65%, wind speed 5-8 km per hour and moderate sunlight (Payne, 1990). Due to its morphological, anatomical and behavioral characteristics, buffaloes are well suited to hot and humid climates and muddy lands. Buffaloes prefer to cool in the pit instead of the shade as their behavioral traits. On average, they spend 5-6 hours a day in puddles or muddy areas. While buffaloes cool in these areas, they do not exhibit rolling behavior in muddy areas (Ablas et al., 2007).

Buffaloes are more affected by temperature increase than cattle, depending on the temperature of their environment. Buffaloes are homoethermic animals like other farm animals. Their skin is thicker and contains fewer sweat glands (1:6) than cowhide (Borghese, 2005). In addition, their hairs have a sparse structure compared to cattle (Buffalo: 100-200 pieces/cm2, Cattle: 1000 pieces/cm2). Since the sweat glands are less and the skin thickness is greater, the loss of heat through

sweating and evaporation is limited. This negatively affects feed consumption, growth rate, milk yield and pregnancy rate in buffaloes (Thomas, 2004). Administrative arrangements such as canopy, water fogging, shower application, fan systems and water pools must be implemented so that buffaloes can resist against hot environmental conditions. These practices reduce the amount of heat the animal will receive from the environment and acilitate the removal of heat from the body (Gorgulu, 2013).

3. Effect of Heat Stress on Reproduction Performance

Heat stress causes reproductive problems such as decreased birth weight, immune system and semen quality, and damage to the developing embryo, resulting in a decrease in pregnancy and fertilization rates (Gantner et al., 2011).

High ambient temperature is one of the main factors responsible for reduced fertility in livestock. Heat stress reduces the appearance of estrus behavior symptoms, affects follicular development in the ovaries, and decreases fertility by causing embryonic losses (Mondal et al., 2017). In addition, due to the excessive increase in ambient temperature, the uterine blood flow rate in cows decreases and the uterine temperature rises. This situation suppresses embryo development, causes embryonic deaths and decreases the pregnancy rate (Rivera and Hansen, 2001). A positive relationship was found between heat stress in the preimplantation period and early fetal loss in dairy cattle. Heat stress can affect endometrial prostaglandin secretion,

leading to early luteolysis and embryo loss. However, most embryo loss in heat-stressed cows occurs before day 42 (López-Gatius et al., 2005).

The temperature humidity index (THI) is a common indicator of heat stress used in cattle and buffaloes for production performance in tropical and subtropical climate conditions. THI is a measurement calculated from relative humidity and air temperature and is calculated for a particular day. Since the sensitivity of heat increases as the percentage of relative humidity increases, the relationship between ambient temperature and relative humidity seems to be the most important. The THI value is the increase in relative humidity at any temperature and the harder it is for the animal to cool itself. However, a THI value of 70 or less indicates a comfortable, 75-78 stressed environment, and higher than 78 an extremely stressful environment temperature (Kadzere et al., 2002). Increased milk production in buffaloes leads to an increase in metabolic temperature. The presence of fewer sweat glands and less developed thermoregulation properties in buffaloes reduce thermal tolerance. Therefore, they cannot recover from excessive metabolic heat and are sensitive to heat stress (Marai and Haeeb, 2010). High temperature and humidity adversely affect feed intake and adversely affect reproductive efficiency by changing hormonal concentrations (Mostafa Habeeb, 2020).

In buffaloes, there is an increase in sexual cycles with the decrease in day length and temperature. The highest reproductive performance is observed in winter, and the lowest in summer. Postpartum estrus symptoms were minimal in April and May, when the air temperature

was highest, and maximum in September and October (Abayawansa et al., 2011). In the study conducted in Murrah buffaloes, the highest average pregnancy rate was in October with 78%, and the lowest in August with 59%. Since the overall pregnancy rate decreased with the mean THI exceeding the 75 threshold value, the threshold value for the conception rate was determined as 75 (Dash, 2013).

3.1. Effects of Heat Stress on Estrus and Fertility

The average estrous cycle length in buffaloes is 21 days. Various factors such as climate, temperature, photoperiod and nutrition affect the intensity and length of the estrous cycle. It also increases the incidence of silent estrus and anoestrus in farm animals (Singh et al., 2013). In hot climates, buffaloes show their highest sexual activity at 6:00 in the morning and 24:00 at midnight, and their lowest sexual activity at 12:00 noon. During periods when the ambient temperature increases excessively, buffaloes have physiological characteristics that can change their sexual behavior, especially at night (24.00 hours) (Madan, 1988). When the body temperature exceeds 40°C, ACTH and cortisol secretion increase and follicular damage occurs. Due to the increase in these hormones, estrus behaviors originating from estradiol are blocked. Low secretion of estradiol reduces fertilization by suppressing gamete transport, signs of oestrus, ovulation, fluctuation of gonadotropins (Wolfenson et al., 2000).

Heat stress affects pregnancy in three ways. The first is at the formation of pregnancy, the second is in the embryonic period, and the third is in the late period of pregnancy and in the postpartum period.

Hyperthermia occurs in buffaloes with heat stress, which leads to embryonic absorptions and abortions (Grunert et al., 2005). In female animals exposed to thermal stress, the blood circulation system is affected and the nutrition of the uterus and egg is compromised. If this stress occurs in the ovulation or early embryonic period, the deterioration in the formation of pregnancy will be more severe (Hansen, 2003).

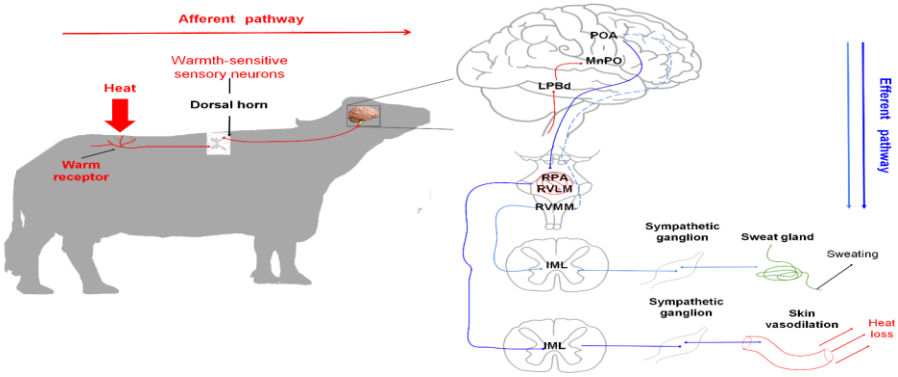

Figure 1. The river buffalo's neurophysiological mechanism of thermoregulation under conditions of heat. The afferent and efferent pathways are reported. The broken arrow indicates that the anatomical pathway connecting the POA to the RVMM is still unknown. POA, preoptic area; RPA, raphe pallidus area; RVLM, rostral ventrolateral medulla; RVMM, rostral ventromedial medulla; IML, intermediolateral column; MnPO, median preoptic nucleus; LPBd, lateral parabrachial nucleus, dorsal subregion (Mota-Rojas et al., 2020).

4. Practices to Reduce Effects of Heat Stress on Reproduction

4.1. Housing

Adequate shelters, canopies, water pools and sprinkler are required to protect buffaloes from temperature rises in tropical and sub-tropical areas. The presence of good ventilation systems in barns and milking

parlors causes them to be less affected by stress. Shelters should be built in a size appropriate to the age, sex and live weight of the animal. Systems that change shelter air, such as ventilators, sprinklers, and fan sprinklers, are the best management tools used to reduce heat stress. Shades are one of the cheapest ways to change an animal's environment in hot weather (Kimothi and Ghosh, 2005). It has been reported in studies that dry matter consumption increases in buffaloes exposed to heat stress with the use of fan and fogger systems. In addition, there is an increase in reproductive and production characteristics (Jegoda et al., 2015; Sandeep et al., 2015)

4.2. Drinking water

The most serious nutrient required by the animal is water. Animals need plenty of fresh and clean water for ruminal fermentation, passage of nutrients in the digestive tract, absorption of nutrients, normal tissue and blood volume. Cows should be provided with clean water in the barns and on the way back from the parlor to the barn. During heat stress, water consumption increases by 30% or more than normal times. Cold water consumption is a method used to reduce the heat load on livestock. The increase in the amount of drinking water in hot periods causes an increase in the water in the tissues. Thus, evaporative heat loss through sweating and respiration increases further and the high temperature in the body is reduced. The importance of drinking cold water in a hot climate is to help animals achieve a stable physiological state in terms of hemodilution that normally occurs in heat stressed animals. Drinking cold water causes cooling in the body and increases

appetite and feed consumption in animals. With an increase in feed consumption, there is an increase in protein, vitamin, mineral and blood substrates. Drinking cold water during hot periods is an ideal and easy technique to increase the reproductive and productive performance of animals (Habeeb at al., 2012).

4.3.Nutritional management

The fact that buffaloes consume roughage and convert to meat and dairy products compared to other farm animals is due to their unique adaptation and physiological characteristics. One of the most striking detrimental effects of the environment on the reproductive traits of buffalo raised in the tropics is seasonal feed shortages and nutritional imbalances. Condition score decreases due to malnutrition and increases in service sire count of the per pregnancy occur during the service period (Vale, 2004). In water buffaloes exposed to heat stress, there is a decrease in dry matter and crude protein intake and a negative energy balance is formed. Therefore, it is important to use high quality roughage and concentrate feeds and oils to increase nutrient density in animal rations. In addition, the supplementation of feed additives to the ration is beneficial to protect the rumen environment from dietary changes and to improve energy use (Zimbelman et al., 2010).

In farm animals, heat production increases in the process of consuming and fermenting feed. Giving the feed early in the morning and in the evening when the animal's appetite is high ensures both the consumption of the feed and its freshness. Also, giving 20% to 40% of the total feed in the morning and 60% to 80% of the remaining feed in

the evening will help alleviate heat stress. Antioxidant activity is high in medicinal plants. Medicinal plants can be used to increase immunity in animals by inhibiting non-enzymatic peroxidation and help them tolerate heat stress (Awadallah, 2002). It is beneficial to add vitamins A, C and E to the diets to reduce oxidative damage. The presence of yeast in the diet plays an important role in the digestibility of food by changing the production of volatile fatty acids in the rumen, reducing the rumen ammonia production and increasing the rumen microorganism population (Stella et al., 2007).

4.4.Genetic selection

The increase in temperature values due to global warming causes an increase in the problems of concern in farm animals. Changes in the shelter and feeding strategies relatively alleviate the effects of thermal stress on animals during warm periods. However, despite the negative effects of climatic changes, different strategies are needed to develop adaptation and resistance. Thermal tolerance differs between farm animals. If animals are able to maintain their fertility and milk yield when exposed to high temperatures and their survival chances are higher than others, it would be beneficial to select these animals. Cows with short hair, thicker hair diameter and lighter coat color are more adapted to hot environments than those with long hair and darker hair color (Bernabucci et al., 2010). The heat shock gene related to thermo tolerance is used in breeding studies. The most well-known of Hsps are Hsp100, Hsp90, Hsp70, Hsp60, Hsp40 and small Hsps. Hsp_s have a critical role in cell stress recovery and cytoprotection, and also protect

cells from subsequent attack (Stella et al., 2007). Increased HSP expressions protect cells against heat shock, hyperthermia, circulatory shock and cerebral ischemia. When the exposure to heat stress is prolonged, the endocrine system also affects the cellular stress response. Melatonin, prolactin, prostaglandin-α, and glucocorticoids have been reported to increase HSP expression, while leptin has been reported to suppress HSP expression (Collier et al., 2008). When the results of the research on East African Shorthorned Zebu, which are known to have high tolerance to hot climates, are compared with the studies conducted with other cattle breeds, which are known to have high tolerance to hot climates, it was determined that African Shorthorned Zebu were positively selected for the HSPB9, DNAJC7, DNAJC8, DNAJC14, DNAJC18, PPP1R10, PPP1R8, KRT and PMEL genes. It has been reported that most of these genes are in the family of heat shock proteins (HSP) that protect cells against heat, and some of them are related to coat color and hair structure, which are also factors that directly affect sensitivity and resistance to heat (Bahbahani et al., 2015). In a study conducted in Holstein, milk yield; Changes in milk fat and protein ratios were considered as factors affected by the stress response, and principal component analysis was performed. The region of BTRC, FGF8, MGEA5, KCNIP2 and HPS6 genes with the region of CCSER1 gene were found to be associated with milk yield. Regions of DGAT1, HSF1, ARHGAP39 and RPL8 genes with MAPK15 and ZNF34 genes were associated with milk fat ratio (Macciotta et al., 2017).

5. Conclusion

The predicted temperature increases in surface temperature due to global climate change will cause an increase in the risk of heat stress in countries in the temperate climate zone. For this reason, studies conducted to elucidate the physiological and biological mechanisms of responses to heat stress and thermotolerance are becoming increasingly important. Water buffalo is a farm animal bred for its valuable products and services in all countries of the world. The adaptability of buffaloes is high and they adapt easily to the region they are in. However, they are more prone to heat stress due to their natural phenotypic characteristics being different from cattle. For these reasons, thermal stress is a major concern for farmers in tropical regions. Because animals that are affected by heat stress decrease in growth, development, welfare, production and reproduction characteristics. There are a number of management changes that can be made to reduce the impact of heat stress. Shelter management with microclimate change devices such as foggers and fan sprinklers can help reduce heat stress. Nutrients that reduce heat stress, increase milk yield and reproductive performance can be added to the ration. Selection methods can be tried to breed animals that can adapt to the conditions of the region. The adaptation of native breeds to the regions where they are grown is more than other breeds. In addition to the adaptation of these breeds to environmental conditions, the improvement of their yield characteristics with effective selection methods may be among the measures to be taken against thermal stress.

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CHAPTER 6

MEAT AND MILK YIELD CHARACTERISTICS IN WATER BUFFALOES

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1. Introduction

The water buffalo is an animal that people have been using for centuries for various yields such as meat, milk and leather, has a high ability to adapt to different environmental conditions, is resistant to diseases and is contented. Water buffalo, which is a suitable species for extensive breeding, has the ability to convert low quality, high cellulose and cheap roughage into animal products (Soysal, 2009). More than 95% of the world's buffalo population resides in countries located in the Asian continent. The most prominent of these countries are India and Pakistan. India (55%), Pakistan (17%) and China (13%) have 85% of the world's water buffaloes. On the European continent, especially Italy is one of the model countries where water buffalo breeding is carried out with modern techniques, and organic water buffalo breeding is also given importance (Sarıözkan, 2011). In recent years, a special value has been given to water buffalo breeding, especially due to its valuable products such as sausage, pastrami made from buffalo meat, and cream, yoghurt, cheese, butter and similar products made from buffalo milk (Kaplan et al., 2015; Tekerli, 2016).

The ancestor of the domestic buffalo is called “bubalos arnee”. Buffalo are evaluated under two animal groups, namely Asian buffalo (Syncerus) and African wild buffalo (Bubalus). The Asian buffalo is divided into two classes, namely the Wild Asian Buffalo and Domestic Buffalo. Domesticated Buffaloes are classified as Swamp Buffalo (Bubalus carabanensis) and River Buffalo (Bubalus bubalis). The swamp buffaloes raised in China and Southeast Asia have low meat and

milk yields and are mostly used as draft animals. The origin of river water buffaloes, which are raised for meat and milk yields, is India (Şekerden, 2001; Özbeyaz, 2015). The river buffalo group includes many races such as Murrah, Nilli-Ravi, Kundi, Surti, Meksana, Jafarabadi and Mediterranean buffalo (Moioli and Borghese, 2008).

Buffaloes are excellent meat and dairy producers and have been used as draft animals for centuries. The importance of animal products in human nutrition is known by everyone. The daily protein requirement of a healthy adult is about 70 grams. At least 40-50% of the daily protein needs should be met from animal products. 51% (13.2 g) of animal protein production, which is 26 grams per person, should be met from milk and dairy products (Akman et al., 2010).

In this review, the general, meat and milk yield characteristics of water buffaloes, which have a wide distribution area in the world, were investigated.

2. General Characteristics of the Buffalo

Although water buffalo has not been given much value compared to other farm animals, it has become an animal that is emphasized in many countries in recent years due to its various characteristics and yields. Among the features that make the water buffalo stand out is its high ability to adapt to natural conditions and diseases. In addition, it has the ability to convert poor quality roughage and crop residues into protein-rich, low-cholesterol meat and quality milk (Desta, 2012). The fact that the ability to evaluate pastures better than cattle is related to the fact that

the tongue muscle, masseter muscle and digastric muscle cause effective chewing and rumination movements (Vega et al., 2010). Other features include large body size, slow movement, and greater bacterial and fungal activity (Napolitano et al., 2013).

Buffaloes, which have a longer lifespan than other cattle species, live up to 30 years. It develops later than cattle and its development continues until the age of six. The age of use in breeding is getting older. Reproductive activities in buffalo heifers start at the age of 13-14 months. Therefore, buffalo heifers can be inseminated at 22-24 months of age. Male buffaloes, on the other hand, can be used as bulls from the age of 20-21 months until the age of 5-6 years (Soysal, 2009).

Buffaloes can adapt to hot or humid-hot environmental conditions in the regions where they are grown. However, when they are exposed to temperature increase for a long time, physiological and biological changes and disruptions occur. Decreases in food intake, decreases in milk and fertility, and significant disorders occur in water metabolism, protein, energy and mineral balances, hormonal secretions, enzymatic reactions and blood metabolite levels (Marai ve Haeeb, 2010). The skin thickness in adult buffaloes is 6.0-7.6 mm, and it has a thicker structure than cattle skin. However, hair cover and subcutaneous sweat glands are 1/10 less than cow skin. Having fewer sweat glands negatively affects cooling through the skin, and therefore it is more sensitive to heat stress. It needs canopies, ponds, water pools and fans to provide thermoregulation. When heat is effective, buffaloes increase blood volume and skin surface while lying in mud or water to reduce high

skin temperature and facilitate heat dissipation. In addition, due to the low density of skin hair, they are more resistant to cold weather than cattle (De Rosa et al., 2005; De Rosa et al., 2009).

3. Meat Production

Buffaloes are bred for dual purposes for meat production as well as milk yield. While 2/3 of the total meat consumed in the Philippines is obtained from buffaloes, stuffing, which is the traditional dish of Azerbaijan, is made from buffalo meat. In Egypt, 3-4 months old malak meat is used in the production of sausage and salami (Soysal, 2009). Buffalo meat has a lower degree of marbling, leaner meat, more protein, more pigmentation and dry matter than beef. It contains 9% less cholesterol, 10% more minerals and 55% less calories and 10% more protein, and higher concentrations of K, Mn, Fe, Zn, Cu and P (Tamburrano et al., 2019). In addition, buffalo meat has PUFA levels of 24.3% with 22.3% and n-6 fatty acid levels of 23.7% with 21.5%, respectively, compared to beef (Infascelli et al., 2009).

Buffalo meat is gaining popularity in producing countries and its production is increasing rapidly. Meat quality is an important factor used in the marketing of the product. The price of buffalo meat is much lower than beef, pork, mutton, pork or poultry and therefore the cheapest source of protein available to the poorer segments of society (Ranjhan, 2013).

Meat quality is evaluated by physical, biochemical, histological and sensory analysis. Three important factors can affect the quality and

composition of the meat produced. These are: 1- the feed raw materials and ratio of the ration used to feed the animal, 2- the genetic structure (species, breed, sex) and 3- the age at which the animal was slaughtered. Buffalo meat is considered a highly nutritious and valuable food. It has high biological value protein, omega 3 and omega 6 fatty acids, and low levels of fat and cholesterol (Issanchou, 1996; Infascelli et al., 2009). The reason why buffalo meat has a darker color than beef is due to its higher myolobin content. Due to the homogeneous distribution of white fat molecules between the muscle fibers, it is a delicious meat that is consumed with admiration by the consumers (Tateo et al., 2007). Muscle fibers are thicker than beef, and their chemical composition and taste characteristics are similar to beef. The distribution of fat between muscle tissue and fibers is lower than in cattle (Rodrigues and Andrade, 2004).

Carcass and meat quality varies depending on age. When carcass and meat quality of male buffaloes slaughtered at a younger age (10 months old) are evaluated, it is reported that their meat is softer than older buffaloes. For this reason, the animal should be slaughtered at a younger age in order to have higher carcass and meat quality (Singh et al., 2018).

In the study conducted with Murrah, Jaffarabadi and Mediterranean breeds, carcass rates were found to be 53.9%, 54.39% and 54.32%, respectively. However, no differences were found between the meat regions with the highest commercial value (Jorge et al., 2005). When the live weights of four-year-old buffaloes are evaluated according to gender, it has been determined that males are heavier (515.34 vs. 496.44

kg) and carcass weight is higher (236.08 vs. 234.60 kg) than females (Akdag and Celik, 2006). Carcass weights for un castrated and castrated male buffaloes were reported as 222.75 and 210.45 kg, dorsal fat thickness 0.67 and 0.77 cm, and bone percentage 12.41% and 12.11 %, respectively (Atencio-Valladares et al., 2007). When the meat of the buffaloes slaughtered after the fattening studies were evaluated in the sensory panel tests, the panelists stated that the taste, color, juiciness and tenderness of the young buffalo meats were quite good (Marques et al., 2016; Pontes et al., 2018). When the fattening studies between buffalo and cattle were compared, there was no difference in body weights. However, researchers reported that buffalo carcass productivity is higher and the cost of producing each kg of quality meat is lower (Chashnidel et al., 2007).

4. Milk Yield, Composition and Affecting Factors

One of the most important products of buffaloes is milk. In terms of milk production, buffalo is the second most important species in the world after dairy cows and produces the highest quality milk among domestic animals. In many countries, the main purpose of raising buffalo herds is milk. With the production of buffalo milk, it is seen as an alternative to improve the social and economic aspects of the agricultural sector, transforming it into quality milk and dairy products and finding buyers at high prices in the market (da Silva JAR et al., 2021). Buffalo milk contains less water, more dry matter, minerals, oil and protein than cow's milk. It is understood that the dry matter composition in buffalo milk has the highest value compared to milk

obtained from other species. In addition to high dry matter, high fat and calorie content are considered as superior and distinctive features of buffalo milk (Soysal, 2009).

Lactation yield and milk yield are affected by many factors, including genetic and environmental factors. Genetic factors are race and individual genetic make up. Among the environmental factors, there are important factors such as care, nutrition, ration content and quality, animal health status, farm management and biosecurity. Nutrition is the most important factor for the increase and sustainability of milk yield. Since the dry period will affect the milk yield in the next lactation, buffaloes should be weaned 2 or 3 months before the next calving. The dry period allows the buffalo to rest and rebuild mammary tissue (Sørensen and Enevoldsen, 1991; Thomas, 2008).

In the study conducted in Italian buffaloes, the average milk yield, fat content and percentage, protein content and percentage were given as 2286.8 kg, 196 kg and 8.59%, 196 kg and 4.55%, respectively, during the 270-day lactation period (Rosati and Van Vleck, 2002). In Nilli-Ravi buffaloes, the average milk yield has been reported as 2020 liters during the 277-day lactation period (Khan and Akhtar, 1999). When different genetic groups of buffalo were compared, differences were found in milk yield. Milk yields for Murrah, Mediterranean, Mestizo and Jafarabadi females are 1651.4, 1592.2, 1578.3 and 1135.5 kg, respectively (Ramos et al., 2007). In studies conducted to determine the relationship between different phenotypic traits and milk yield, black buffaloes produced more milk (2195 ± 34 versus 1863 ± 30 kg) than

dark brown females. Differences in horn shapes and sizes did not have any effect on milk yield. As a result of studies on temperament, it has been reported that docile animals produce more milk (2120 ± 27 kg) than nervous (1829 ± 49 kg) or aggressive animals (1743 ± 147 kg) (Bharadwaj et al., 2007).

The composition of milk from buffaloes and the concentration of certain components in milk are of great interest to dairy processors and consumers, as they influence the pricing policy of milk on the market. Genetic and environmental factors affecting milk components should be well known in order to develop breeding programs to change the composition of milk. Many factors such as calving season, dry period, body condition score, body weight, pregnancy, heat stress, diseases, milking temperament, calf gender, age, race and lactation period have effects on milk composition. Milk contains essential nutrients that are necessary for the growth, development and healthy life of the calf as well as humans. Economically important milk components include fat, protein, non-fat solids, lactose and ash. In addition, there are components in the composition of milk, such as water, vitamins, minerals, amino acids, fatty acids and lipids, which play a role in important physiological and biochemical activities in the body. Studies have revealed that buffaloes have the A2 allele and therefore consumers can safely consume buffalo milk without any hesitation (Misra SS et al., 2008; Misra SS et al., 2009). Compared to cow's milk, buffalo milk is richer in almost all major milk nutrients. A recent study showed that people allergic to cow's milk can tolerate buffalo milk.

One of the most striking features of buffalo milk is its completely white color due to the presence of vitamin A and the absence of carotenoid pigments. Therefore, the butter and milk produced from this milk are completely white. Another important feature of this milk is that although it contains much less lactose than cow's milk, it has a sweeter taste (da Silva JAR et al., 2021).

In the studies, the fat rate in buffalo milk was found to be higher than in cow's milk. The average fat content in buffalo milk is around 7% to 8%. Buffalo milk fat has a higher content of saturated fatty acids and lower amounts of unsaturated fatty acids than cow's milk, and a higher melting point. Buffalo milk has higher palmitic, butyric and stearic acid content and lower amounts of caproic, caprylic and capric acid content (Thomas, 2008). Buffalo milk contains 275 mg of cholesterol, while cow's milk contains 330 mg of cholesterol. Buffalo milk has a higher dry matter content than bovine milk, which plays a role in higher cheese yield (Zicarelli, 2004).

While cow's milk contains 3.6% protein, the protein content in buffalo milk varies between 4.2% and 4.5% (Thomas, 2008). The casein concentration in buffalo milk is higher than in cow's milk with a higher casein index (casein content/protein content x 100). Buffalo milk has a higher buffering capacity than cow milk. Buffalo milk has more calcium, magnesium, etc. The casein micelles in milk are due to the fact that it has less hydration and more mineralization than cow's milk (Ahmad et al., 2008).

When the studies are evaluated, many factors are effective on milk yield and its components. It has been reported that the number of lactations has a significant effect on fat, protein, casein and total solids ratios and 305-day milk yield. There is an increase in milk yield up to the 5th parity and then a decrease occurs. The highest rate of fat and total solids in milk was reported in the first lactation. In the third lactation, a positive increase was observed in protein and casein ratios and 305-day milk yield (Sundaram and Harharan, 2013). It is presented in another study that the effect of lactation periods on milk yield, fat and lactose content is also important, but there is no effect on protein. In addition, milk yield, fat, protein and lactose percentages in milk according to lactation periods were given as 4.3 to 9.5 kg, 7.19±0.04 to 8.63±0.07 %, 3.46±0.01 to 3.56% and 4.36 to 4.60%, respectively (Yadav et al., 2013). In swamp buffaloes, it was reported that lactation periods had a significant effect on the percentage of fat and total solids in milk, and their mean percentages of fat, lean solids and total solids were 8.47±0.67, 9.19±0.04 and 17.67±6.09, respectively (Zaman et al., 2007). Calcium content in buffalo milk varies according to the year and lactation periods. It has been reported that the lowest mineral content (Ca, P, K, and Cu) is in winter and in the last 1/3 of the lactation period (Patino et al., 2007).

The effect of pregnancy on milk yield can be seen from the 5th month. After the 8th week of pregnancy, a decrease in milk yield begins, while an increase in the fat ratio in milk is observed. The influence of the father on buffalo milk yield and composition is also important in

different buffalo breeds. The effects of season and years on milk yield and its components are important (Bhonsie et al., 2003). There is an increase in the amount of fat in milk, fat-free solids and total solids in summer months. The milk protein level was 3.4% and 3.55% in the summer, winter-autumn seasons, which are the calving periods, respectively. The highest protein rate is observed in humid-hot months (Yadav et al., 2013).

Body condition score (BCS) technique is a method used to minimize prenatal and postnatal diseases (hypocalcemia, hypomagnesemia and ketosis, etc.) and live weight losses in dairy animals. Because the general physical condition of the animal is the most important method used to determine whether the ration prepared by the breeders meets the needs of the animals (Klopčič et al., 2011). High-yielding dairy cows in the early lactation period often have a negative energy balance. Because the amount of energy required for the maintenance of body tissue functions and milk production is more than the amount of food that cows can consume (Narender Singh and Madhur, 2019). Sudden and rapid changes in dairy animals will adversely affect animal health and production. Management of BCS optimizes animal potential by improving herd health, reproductive performance, animal nutrition, milk production and overall farm profitability. It also helps to understand the disruptions in milk and reproductive efficiency of animals in the past and the errors in feding (Klopčič et al., 2011). When the body condition score approaches 3, there is an increase in the daily average amount of milk. It is reported by many researchers that

buffaloes with BCS 3.5-3.99 exhibit higher milk production characteristics (Anitha et al., 2011; Saludes et al., 2021). However, other researchers reported that in Murrah buffaloes that condition score 4 had higher lactation milk yield than 2.5-3. (Patel et al., 2018). In addition, buffaloes with BCS 4-5 have higher milk production compared to those with BCS 1-2 (Ishaq et al., 2011). Lactation periods have an effect on body condition score and daily milk yield. The early lactation stage of dairy buffaloes had a significant ($P<0.01$) negative correlation ($r = -0.27$) with BCS and a positive correlation ($r = 0.39$) with milk yield. Buffaloes in early and middle lactation give higher milk yield with low condition score, while buffaloes in late lactation give lower milk with higher condition score (Saludes et al., 2021).

Conclusion

Water buffalo is a dual purpose breed with excellent zootechnical properties, both for milk and meat. All over the world, water buffalo farming is mostly carried out using traditional methods. For this, it is necessary to move away from traditional methods and to bring the care, feeding, air conditioning and shelter conditions to an appropriate level as in dairy cow farming. In the last 30-40 years period, significant progress has been achieved in milk, meat and reproductive efficiency with the breeding and crossbreeding studies in dairy cattle. In addition, positive increases in production capacities have been observed with the development of herd management programs and in shelter conditions in dairy cattle breeding. Bringing these practices to the forefront in water buffalo breeding will be a starting point for increasing the yield

characteristics. In order for buffalo meat and milk to be better appreciated and appreciated by the consumer, important tasks fall on the written and visual media.

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CHAPTER 7

PHYTOGENIC FEED ADDITIVES

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1. INTRODUCTION

Phytogenic feed additivies are completely herbal in origin and are obtained by extraction from phytogenic (aromatic) plants. “Phytobiotics” or “phytogenic feed additives” is a term used for plant extracts obtained from aromatic and spicy plants, which have aromatic properties as well as functional properties when added to animal feeds. The most important feature of these plant species is their aromatic activity. For this reason, these plants are also called aromatic plants (Yeşilbağ, 2007). Aromatic plants produce various essences to reproduce, maintain their lives and protect themselves. The herbal extracts obtained; called aromatic oil, essential oil, essential oil, essential oil or vegetable essential oils (Jones, 2001). Apart from the aromatic effects of phytogenic plants, they have many effects such as antioxidant, fungicidal and antimicrobial (Durna Aydın et al., 2020). In addition, these plants have been used for centuries to protect foods against spoilage (Jones, 2001). Phytogenic feed additives obtained by extraction from aromatic plants or phytogenic feed additives directly affect feed consumption and palatability by changing the sensory characteristics of the feed, such as taste and smell. Therefore, herbal extracts help digestion. For example, extract products of aromatic plants such as garlic and mustard (allicin and allylisothiocyanate) have a positive effect on digestion. This positive effect is manifested by an increase in salivary secretion, gastric acid secretion and certain digestive enzymes (Jones, 2001).

2. HISTRORY OF PHYTOGENIC FEED ADDITIVES

The use of phytogenic feed additivies has been known since ancient times, in countries such as Ancient Egypt, Rome, China and Greece; It has been used for many years in the treatment of cancer, asthma, pain reliever, ulcer and as a digestive regulator. The most important of the papyri related to drugs and treatment dates back to BC. It is known that it is the Ebers Medical Papyrus, which is estimated to have been written around 1550. In the recipes, the names of bitter melon, mountain onion, juniper berry, henbane, crocus, mustard, castor oil, fig, gentian, flaxseed, coriander, elderberry, pomegranate peel, wormwood, gum, aloe, onion, cinnamon, turpentine and grape are mostly mentioned (Bayramoglu and Toksoy, 2008).

According to the World Health Organization (WHO) reports, 80% of the population living in developing countries generally rely on traditional herbal medicines for their basic health needs. At least 25% of the active ingredients of drugs produced pharmacologically in the modern sense are obtained from plants. In addition, the active ingredients of many synthetically produced drugs are similar in structure to chemicals isolated from plants for the first time. Demand for medicinal plants; It is increasing in both developed and developing countries due to its low cost, no side effects, less toxic effects and being naturally produced (Sekar and Kandavel, 2010).

Medicinal plants are the natural source of compounds that can be used against many diseases today (Vital et al., 2010). Many plants contain a wide variety of chemicals that have significant biological effects on

humans (Njume et al., 2009). Chemicals such as flavonoids, alkaloids, terpenoids, tannins, berberines, kinins and emetines synthesized by plants are widely used in the treatment of infectious diseases (Hussain, 2011). Substances that suppress the growth of many microorganisms have been isolated from the stems, leaves, seeds and roots of naturally grown plants (Ertürk and Demirbağ, 2003).

While more than 40% of the drugs listed in the early twentieth century (mostly unrefined) were of plant origin, this had dropped to less than 5% by the mid-1970s (Craker and Gardner, 2005). In the 1980s and 1990s, consumers became more informed about health, the increase in interest in favor of herbal medicines, especially in developed countries, and the orientation towards organic and natural foods brought medicinal and aromatic plants to the agenda again. This situation has led to the serious consideration of the laws and regulations regarding herbal medicines in developed countries (Baser, 1998).

Plants and herbal extracts, which have been used for medicinal purposes in many countries, especially in the prevention and treatment of human diseases, have recently been widely used in animal mixed feeds as new era natural yield-enhancing feed additives in many countries. For this purpose, research has focused on identifying the most beneficial plants and herbal extracts and determining their importance in animal production (Yeşilbağ, 2007).

3. MECHANISM OF EFFECT OF PHYTOGENIC FEED ADDITIVES

Commonly used phytogenic feed additivies, the usable parts of these phytogenic feed additivies, the active ingredient in their structure and their basic properties are given in Table 1 (Kamel, 2000). As it can be seen from Table 1, as the most important active substances with both appetite increasing and digestive stimulant and antimicrobial properties; there are carvacrol, thymol, cineol, anethole, cuminaldehyde, sinnamaldhyde, borneol. Many researchers also report that these active substances can show synergistic effects with various combinations (Kamel and Greathead 2007; Durna Aydın and Yıldız, 2020). Carvacrol, tymol and rosmarinic acid show their antimicrobial properties thanks to their functional hydroxyl groups and high redox potentials. In addition to its flavoring and appetizing properties, Carvacrol allows protons to pass into the extracellular fluid, causing the pathogen microorganisms to die by breaking their cytoplasmic membranes (Çetin and Yıldız, 2004).

Table 1. The Effective Part, Active Component and Basic Activities of Some Phytogenic Feed Additivies (Kamel, 2000).

Aromatic Plant	Plant Part	Active Ingredient	Basic Properties
Thyme	All	Thymol	Digestive stimulant, antiseptic, antioxidant
Anise	Fruit	Anethol	Digestive Stimulant
Pepper	Fruit	Capsaicin	Antidiabetic, anti-inflammatory
Mint	Leaf	Menthol	Flavoring, antiseptic, digestive stimulant
Garlic	Onion	Allicin	Digestive stimulant, antiseptic

Rosemary	Leaf	Cineol	Digestive stimulant, antioxidant, antiseptic
Clove	Clove	Eugenol	Digestive stimulant, antiseptic, flavoring
Cinnamon	Bark	Aldehit	Digestive stimulant, antiseptic, flavoring
Cumin	Seed	Cineol	Digestive stimulant and carminative
Parsley	Leaf	Apiol	Digestive stimulant, antiseptic, flavoring
Laurel	Leaf	Cineol	Digestive stimulant, antiseptic, flavoring
Coconut	Seed	Sabinene	Digestive stimulant and antidiarrheal

1/3 of nearly 300 plant families grown in nature contain essential oil. The characteristic smell and positive effects of aromatic plants are due to the essential oils in its structure. Essential oils are obtained by distillation or extraction method from the parts of plants from flower to root. They are volatile, oily and fragrant mixtures that drift with water at room temperature. For this reason, they are also called essential oil or essential oil. Essential oils have a very concentrated complex structure. The characteristic smell of many plants is due to the oil it contains (Ceylan, 1996). The essential oil content of plants varies between 0.01-10%. The amounts of essential oils in some aromatic plants are shown in Table 2 (Yeşilbağ, 2007).

Table 2. Essential Oil Amounts of Some Medicinal and Phytogenic Feed Additives

Aromatic Herbal	Essential Oil Amount,%	Aromatic Herbal	Essential Oil Amount,%
Thyme	0.5-3.0	Sage	1.0-3.0
Anise	1.5-6.0	Cumin	2.5-6.0
Laurel	0.5-2.0	Fennel	2.0-6.0
Mint	0.1-1.0	Dill	0.2-4.0
Garlic	0.1-0.3	Cinnamon	0.5-3.0
Rosemary	0.5-2.0		

Herbal extracts, especially those containing saponin, have antiprotozoal activity (Teferedegne et al., 1999). At the same time, herbal extracts fix nitrogen and contribute to the formation of a healthy environment by controlling ammonia (Gill, 2001). Herbal extracts support the formation of a clean and healthy environment by binding nitrogen and controlling ammonia. Since herbal extracts increase N uptake, they improve bacterial protein synthesis, slightly reduce short-chain fatty acids, cause less gas production in the rumen, and increase digestibility (Makkar et al., 1998).

Essential oils, which are low molecular weight secondary metabolites of plants, have aroma, odor and color properties. Its biological activities include antibacterial, antioxidative and fungicidal effects. It is included in animal feeds as phytogenic feed additives in intense concentrations. They strengthen the immune system (Nir and Şenköylü, 2000).

Many aromatic herbs; It is used in various fields due to the active chemical compounds found in its seeds, fruits, leaves or roots, and because of its different effects. In terms of animal nutrition science, these plants have appetizing and digestive stimulating properties as well

as their antiseptic effects. Although the effects vary according to the active ingredients, many essential oils; It has antimicrobial, carminative, coloretic, sedative, diuretic, antispasmodic effects and strengthens the immune system (Çelik, 2007).

4. CONCLUSION

Phytogenic feed additives have found use in the treatment of many diseases, preventive medicine and as an alternative to the use of antibiotics due to the increase in the existence of a conscious society, the increase in the belief in the benefit of nature and the relatively few advers effects. In the 21st century, it has become the focus of attention of the scientific world in many ways. Benefiting from phytogenic feed additives obtained from these plants will become an increasingly widespread trend in all societies, and animal nutrition will also take the necessary share from these developments. As a matter of fact, our country has a rich plant diversity, different climate structure, an important potential from natural and cultivated medicinal and aromatic plants. For this purpose, it is necessary to show the necessary importance and care in order to benefit from medicinal and aromatic plants effectively and to increase their economic return.

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CHAPTER 8

POULTRY NUTRITION IN ORGANIC ANIMAL PRODUCTION

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1. POULTRY CARE AND HOUSE CONDITIONS

Houses should be constructed from a sanitary building material, and house conditions should meet the biological and racial needs of the animals.

Insulation, heating, ventilation of buildings; It should be in a way to keep the air flow, dust level, temperature, relative humidity and gas concentration within the limits that will not harm the animals. Natural air and light should be able to enter the buildings very well.

The density of animals in buildings should be such that they are comfortable and in good condition, depending on the type, breed and age of the animals.

The optimum animal density should be such that the animals have enough room to stand comfortably and naturally, lie down easily, turn, clean themselves, and perform all natural movements such as stretching and flapping their wings (Yenice, 2002; Peker, 2021; Tekeli, 2004).

Birds must be raised on natural pastures and cannot be kept in cages. Due to animal comfort or hygiene conditions, waterfowl should be able to access streams, ponds or lakes when climatic conditions allow (Yenice, 2002; Tekeli, 2004; Şayan et al., 2010; Peker, 2021).

All poultry houses must meet the following minimum requirements;

1. At least one-third of it should be flat, not a grid structure, and should be covered with materials such as straw, sawdust, sand or short grass. Shelters should have clean and dry

lounging/resting areas. The litter, straw and straw used in the rest area should be organic. Chickens should not be raised in cages.

2. A large part of the floor reserved for the hens in the laying hens buildings should be suitable for the collection of feces.
3. There should be a perch in proportion to the size of the bird group and the bird.
4. There should be entry/exit holes according to the size of the bird and these holes should have a minimum total length of 4 m for each 100 m^2 of the bird house (Yenice, 2002; Peker, 2021; Öztürk et al., 2017).
5. There should be sufficient number of feeders and drinkers in the shelters; Animals should have easy access to food and water. The laying hen houses should also have enough perches and nests (18 cm per hen, 1 nest for 8 hens and 120 cm^2 of floor area per hen per nest) (Yenice, 2002; Öztürket al., 2017).
6. More than 4800 broilers, 3000 laying hens, 5200 African guinea fowls, 4000 female peking ducks, 3200 male peking ducks or other ducks, 2500 meat roosters, goose or turkey in each poultry house should not be hosted.
7. In broiler production, the total usable area of the poultry houses should not exceed 1600 m^2.
8. Laying hens should not be illuminated for more than 16 hours a day. It is essential to benefit from natural daylight in laying hens.

9. Birds should be taken to open-air shelters where climatic conditions allow, and this should be applied in at least one third of their lives where possible. These open-air shelters should be mostly covered with vegetation, have protective facilities (wire mesh, etc.) and allow animals to access sufficient water and feed troughs (Yenice, 2002).
10. During the period between each group of birds reared, buildings should be evacuated from animals for health reasons. During this time, buildings and installations should be cleaned and disinfected.

In addition, when the rearing of each poultry group is completed, the open-air shelters should be left empty for health reasons, allowing the vegetation to develop again. The control and/or certification body will determine the periods when the shelters should be left empty and will notify their decision. This requirement will not apply to small quantities of birds that are not housed and roam freely during the day (Anonim, 2018; Yenice, 2002).

2. FEED SUPPLY AND ANIMAL NUTRITION IN ORGANIC POULTRY PRODUCTION

1) The purpose of feed use is to provide quality production while meeting the nutritional needs of animals in various developmental stages, rather than maximizing production.

2) Animals should be fed with organically produced feed raw materials (Yenice, 2002; Tekeli, 2004; Peker, 2021; Öztürk et al., 2013).

3) Animals should preferably be fed with the feed provided from the business where they are raised, and if this is not possible, they should be fed with feed provided from other units or businesses that act in accordance with the regulations (Yenice, 2002).

4) On average, up to 30% of ration formulas may contain substances in the transition period. If the feed materials come from the same business, this rate can be increased to 60%.

5) If the farmer cannot obtain his feed from organic production only, limited use of classical feed raw materials is allowed. The maximum use rate of traditional feed raw materials allowed for each year is 10% for ruminant animals and 20% for other species. These figures are calculated on an annual basis as a percentage of dry matter content of feed raw materials of agricultural origin (Yenice, 2002).

6) In case of loss in feed production due to exceptional weather conditions, the use of conventional feed raw materials may be allowed in the disaster area and for a short time at the rate to be determined by the control and/or certification body.

7) The feed formula used in the fattening phase of poultry should contain at least 65% grain.

8) Forage, green or dry grass and silage should be added to the poultry rations.

9) Antibiotics, coccidiostats, drug substances, other substances that improve growth or production are not used in animal nutrition. (Tekeli, 2004; Eleroğlu et al., 2014).

10) Synthetic feed additives and genetically modified organisms cannot be used (Anonim, 2018; Yenice, 2002; Tekeli, 2004).

3. FEED RAW MATERIALS AND FEED ADDITIVES THAT CAN BE USED IN POULTRY FEED

A) Grain and its by-products

Corn and wheat (as grain, bran, embryo and gluten), sorghum, barley and triticale (as grain), oat (as grain, broken, shell and bran), rice (as grain, broken, bran and embryo), rye (grain and bran) (Yenice, 2002; Baran, 2019).

B) Oilseeds and their by-products

Rapeseed, soybean, sunflower seed, cottonseed, flaxseed, sesame (as seed and embryo) (Yenice, 2002; Baran, 2019).

C) Legume seeds and by-products

Chickpea seeds, vetch seeds, vetch (treated at suitable temperature), peas, broad beans

D) Roughage

Alfalfa meal, alfalfa, grass meal, silage, fodder root crops (Yenice, 2002; Baran, 2019).

E) Other plants and their by-products

Molasses produced from seaweed composition and used in feed (obtained by drying and crushing seaweed and washed to reduce its iodine content), plant powders and plant residues, spices and herbs

F) Fish and their by-products

Fish, fish oil and unrefined fish oil, fish meal.

G) Mineral additives

Sodium; Unrefined sea salt, coarse rock salt, sodium sulfate, sodium carbonate, sodium bicarbonate, sodium chloride (Yenice, 2002); Calcium; Shells of aquatic animals (squid bones), calcium carbonate, calcium lactate, calcium gluconate; Phosphorus; Bone dicalcium phosphate; Magnesium; Anhydrous magnesium oxide, magnesium sulfate, magnesium carbonate; Sulfur; sodium sulfate

Trace Elements

Iron (iron carbonate, ferrous sulfate); Iodine (calcium iodate, potassium iodide); Cobalt (cobalt sulfate, cobalt carbonate); Copper (copper oxide, copper carbonate, copper sulfate); Manganese (manganese carbonate, manganese oxide, manganese sulfate); Zinc (zinc carbonate, zinc oxide, zinc sulfate); Molybdenum (ammonium molybdate);

Selenium (sodium selenate, sodium selenite); Volcanic origin clinoptilolite (at least 85% clinoptilolite)

H) Vitamins, provitamins and chemically defined substances with similar effects

Synthetic vitamins equivalent to natural vitamins can be used for those naturally derived from feed raw materials and for monogastric animals. The certification body determines the terms of use of synthetic vitamins (Yenice, 2002).

I) Enzymes

3-phytase (produced from Aspergillus niger)

J) Microorganisms

Bacillus cereus, Bacillus subtilis

K) Protectors

Formic acid (E 236), acetic acid (E 260), lactic acid (E 270), propionic acid (E 280) for silage alone

L) Binders, anti-caking agents and thickeners

Colloidal silica, sepiolite, bentonite, pure clay, perlite.

4. FREE PRODUCTION MODEL IN ORGANIC POULTRY BREEDING

In this type of housing system, the number of animals per m^2 should not exceed 7.

In the sections prepared to have a maximum of 25 animals per square meter in the poultry house, a roost distance of 15 cm per chicken should be placed (Yenice, 2002).

Free production is defined as keeping chickens on the ground away from the artificial environment and grazing in the open area.

It is a well-known practice that chickens housed in a temporary coop or barn collect grain left in the field after harvest or remove pests present in the field.

It is known that after the cattle are moved to taller pastures alternately, the remaining short grass is evaluated by the chickens and turned into products.

On the other hand, it is observed that chickens naturally scratch the remaining part of the cows with their scratching instinct.

The chickens, which eliminate the crustaceans and pests that are not allowed to live by the breeders, and make biological control naturally, contribute to the mixed economy of the farm (Yenice, 2002).

5. FREE BROILER BREEDING

If free broiler breeding is to be carried out, the animals to be used must be suitable for this. Generally used for this purpose, hybrid or traditional heavy pure breeds such as Light Sussex, Dorking, and broad-breasted Indian (Cornish) chicks may also be suitable (Yenice, 2002).

Those who show leg weakness in rapid growth should not be used as material.

The ISA 657 red feather broiler and Shaver Redbro have been developed specifically for off-peak production. Although they grow slower than the white-haired Cobb and Hubbard broilers, they adapt more quickly to outdoor conditions.

Although the recommended flock size is 200 broilers in a house, the allowed number is up to 500 (HAYGEM, 2018; Uruk and Yenilmez, 2018).

Many laying barns are also suitable for free-range broiler production. If organic free broiler production is to be done with a certificate, chicks should be taken at the daily age (Yenice, 2002).

6. CHICK PERIOD

One-day-old chicks should be kept in a warm environment until they have completed their feathering. Hosts can be used for this purpose, but are not required

The important thing is dry and protected from pests; It is the preparation of a shelter with insulation and ventilation.

Heating lamps are needed to warm the chicks. Lamps should be hung at a height that will not disturb the chicks. It is possible to use electricity or propane gas as a heat source.

Care should be taken to ensure that the heat source is quiet and not bright enough to cause stres (Yenice, 2002). The heat generation of the heat source should be gradually reduced as there will be a reduction in the temperature requirements with the growth of the chicks. For this, it

is gradually pulled up and finally removed completely (Yenice, 2002; Baran, 2018).

Young broilers, whose temperature requirement has been eliminated, are placed in the hen house as in free egg production. If a large number of broilers are to be raised in the hen, it is necessary to distribute them to different compartments in the hen, provided that they comply with organic standards (Yenice, 2002; Baran, 2018).

High wire mesh may be needed against foxes.

7. FEEDING

Chicks need feeders and drinkers placed on the ground and suspended. It is important that the chick feeds are broken and mixed in the beginning, in terms of facilitating feed intake (Yenice, 2002; Baran, 2018).

The feed must not contain coccidiostat.

The content of the organic ration; cereals, full-fat soybeans, field beans, fish meal, alfalfa and mineral-vitamins (Baran, 2019).

Special feed factories can be used to prepare organic or natural feed. Natural feed preparation is more expensive than other feed preparation.

The amount of feeding for table broiler production is done both indoors and outdoors (*ad-libitum*).

In the production made in France, the baits are placed in big buckets that are opened from the bottom outside. These feeders were placed in

the grazing area appropriately and the chickens were fed only with the corn placed in them as well as their grazing.

The corn, which is roughly ground with an electric grain grinder, is reduced to the size that the chickens can consume. Chickens fed corn-weighted rations eventually develop golden skin. Water and insoluble grit should always be ready, and shade should be built where feeders and waterers are located to protect animals from hot weather (Yenice, 2002).

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CHAPTER 9

FEEDING IN ORGANIC LIVESTOCK

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1. INTRODUCTION

Feeding has an important place in the realization of organic animal husbandry in organic agriculture. According to the organic livestock criteria, the nutrition of animals is very important both in terms of allowing people to be fed with more reliable healthy foods and in terms of the welfare of the animals.

In organic animal nutrition, it is imperative to pay attention to the quality and amount of water and feed, the way they are given and the additives used.

Water quality, quantity, method of delivery: The drinking water of animals should have the same hygienic qualities as the drinking water of humans; Particular attention should be paid to the nitrate content. Animals should be allowed to drink as much water as they can consume and whenever they want (Baran, 2018; Özen, et al., 2010).

Feed quality, quantity, method of delivery: Feed quality has a significant impact on animal health (Baran, 2019). Therefore, in organic ruminant feeding, newborn puppies should be fed primarily with colostrum to strengthen their immune systems, mother's milk until their rumen develops, that is, until they consume enough dry food, or, if this is not possible, with milk obtained from the same flock (Baran, 2018). For this purpose, good quality organic dense feed should be available from the 2nd week in front of the young animals so that they can get used to the food. After weaning, young ruminants should be fed with

organic roughage and concentrate feeds to meet their nutritional needs (Özen, et al., 2010; Öztürk et al., 2013; Peker; 2021).

In organic animal nutrition, roughage and concentrate feeds should be of vegetable origin; producers should obtain these feeds from their own holdings or from nearby establishments as much as possible. In order to prepare balanced rations from roughage used in ruminant animals such as cattle, sheep and goats, especially those rich in protein should be preferred. For this purpose, legumes should be used to obtain both hay and silage (Baran, 2019; Özen, et al., 2010).

It is also important for organic businesses to have organic meadows and pastures. Since organic meadows and pastures support the immune systems of animals thanks to fresh air and daylight, animals should be able to use these areas when climatic conditions are suitable. Organic animals can be kept in the same pasture with conventional animals of the same species, under certain conditions. These conditions are at different times, the land has completed the transition period, the conventional animals that will use the land come from extensive production, and it is approved by the authorized institution that organic and conventional animals are not grazed at the same time (Özen, et al., 2010).

While organic cereals can be used directly as a source of energy, the pulp must not have been treated with chemical solvents during production or processing in order to be used as an organic protein source. Organic milk and dairy products, other marine animals and their products can be used as organic feed. However, fishmeal is prohibited

from being added to the feed of ruminants. The use of slaughterhouse by-products and cadaver flours is also prohibited (Özen, et al., 2010).

In organic nutrition, in addition to salt, various macro and micro elements and non-synthetic vitamins can be used in the rations. Although synthetic vitamins equivalent to natural vitamins can be used for monogastric animals, only vitamins A, D and E can be allowed in ruminants with the approval of the authorized body (Özen, et al., 2010).

It is recommended that the amount of organic roughage and dense feed to be given to animals should be used at levels that will not affect animal health. This type of feeding is very compatible with the digestive physiology of ruminants. Forage-based feeding is important in terms of preventing acidosis caused by rapid and excessive consumption of grains (Baran, 2019). While cereals and pulp are essential to meet the nutritional requirements of poultry, roughage such as fresh grass, silage or hay can also be used (Özen, et al., 2010; Yenice, 2002).

The way feed is given to animals also affects animal health. Short feeding times and feeding in a certain order causes injuries because strong animals want to consume first. For this reason, in organic feeding, cattle and small cattle should be able to consume their feed whenever they want, just like chickens (Öztürk et al., 2013; Peker, 2021).

In organic feeding, it is allowed to use probiotics, enzymes and organic acids as feed additives in the rations (Özen, et al., 2010; Yenice, 2002).

Features that shelters should have in order to increase the performance of animals:

In order to obtain high efficiency from animals, the housing conditions must meet the needs of the animal. Closed, stuffy, dark, urine and gas odor and sweating shelters that do not meet the needs of the animal are not suitable.Airtight concretes, coatings such as nylon, pitch, etc., which are not suitable for thermal insulation and construction and roof materials are not suitable (Özen, et al., 2010).

The air flow inside the shelter will clean the polluted air and should not disturb the animal. However, the animal should never stay in a drafty environment. One of the most important sources of disease in animals is unsuitable shelter (Baran, 2018). However, in organic livestock farming, an environment that meets the physiological needs of the animal and is comfortable is essential. These environments can usually be found easily in open or semi-open systems. In other words, if the animal's feet are in the soil, if there is sun and fresh air on it, and if there is food in front of it, this animal is both happy and gives a higher yield compared to the indoor environment. As long as ideal care and feeding conditions are followed, it does not get sick easily. This constitutes one of the basic principles of organic animal nutrition.

The ideal ambient temperature of dairy cattle is between 10-20 ^{o}C. However, in our country, even the doors and windows are closed so that the animals do not get cold (Baran, 2018). As a result, sweating occurs inside, water drips on the animal, and the animal is found inside at a temperature of 20-25 ^{o}C, mixed with gases from urine and manure.

FEATURES THAT MUST BE FOUND IN ORGANIC LIVESTOCK

1. A transition period should be implemented for animal production and animal feed should be produced on the farm.

2. Genetically modified plants and their by-products should not be used as feed (Tekeli, 2004; Yenice, 2002).

3. Animals should have an area where they can roam freely.

4. In order to keep the pollution of the soil, environment and ground water at a minimum level, there should be a harmony between the number of animals and the size of the land owned by the enterprise.

5. Number of animals; The problems that may arise from overgrazing should be determined by considering the side effects of erosion and farm manure on the environment.

6. Ecological enterprises should make plans to store and evaluate solid and liquid animal feces in order not to cause pollution of water with nitrogen compounds.

7. In organic livestock breeding, all animals in the enterprise should be cared for in accordance with EU Regulation**.**

TRANSITION TO ORGANIC LIVESTOCK

1. In organic livestock breeding, animals that are resistant to the environment, climatic conditions and diseases should be selected for breeding or production, and breeds adapted to the region should be

considered. Breeding animals should be provided from organic farming establishments.

2. When a livestock enterprise switches to organic livestock; In all areas used for feeding animals, the organic farming rules specified in the plant production part of the regulation are valid.

3. When animal products are wanted to be sold under the name of organic; The time period in which each animal group must be bred according to this regulation is different.

In cattle (Bison breeds) intended for meat production, 12 months, at least ¾ of their life must have been fed according to this regulation; (Tekeli, 2004; Özen, et al., 2010).

6 months in small cattle ruminant (sheep, goat) and calf fattening for meat production (Özen, et al., 2010);

2 months for lamb and kid fattening and 6 months for milk producing animals (Özen, et al., 2010; Tekeli, 2004).

10 weeks (2.5 months) for fattening (chicken meat) poultry; In poultry for egg production, it is 6 weeks (1.5 months) (Tekeli, 2004).

4. Regardless of the above-mentioned items, in case of switching to organic agriculture in all animals, pasture and/or forage crops, the transition period will be 24 months under the following condition;

However, 24 months after the transition to ecological production, pastures, forage crops and animals can be marketed as organic.

5. When starting organic livestock and forming a herd, if there are not enough organically raised animals, conventionally raised animals can be taken with the permission of the control body under the following conditions; Layer broilers before the start of the guide laying period (up to 18 weeks of age); broiler chicks (when they leave the conventional holding) must be less than 3 days old (Özen, et al., 2010).

Buffalo cubs (malak) and calves should not be older than 6 months, calves to be fattened should not be older than 4 months, lambs and kids to be fattened should not be older than 4 weeks, animals to be used for breeding should not be older than 14 months, female lambs and goats should not be older than 60 days (Tekeli, 2004).

6. According to an exception in the EU Regulation, in case of a large number of animal deaths due to health reasons or catastrophic situations and there is not enough number of animals from organic livestock farming, conventional animals can be taken with the permission of the control body in order to renew or regenerate the herd, under the following conditions; The chick taken in egg and fattening poultry should not be older than 3 days.

7. Another exceptional case; With the approval of the control body, if organically grown animals cannot be found, non-organic animals at the rate of 10% for heifers and cattle and 20% for sheep and goats can be purchased after passing health controls (Özen, et al., 2010; Tekeli, 2004).

8. In enterprises that have less than ten big heads and less than 5 small heads, the criteria specified in Article 5 (above) are not taken into account, and only 1 animal can be purchased from abroad depending on the animal type per year (HAYGEM, 2018; Özen, et al., 2010).

FEED SUPPLY AND ANIMAL NUTRITION IN ORGANIC ANIMAL PRODUCTION

ITEM 17 – (1) Feed supply and animal feeding rules in organic animal production are as follows:

1. An enterprise engaged in organic animal breeding, pastureand pastures must comply with organic farming rules (Tekeli, 2004). The total number of livestock of the holding is calculated on the basis of 2 cattle units per hectare.

2. The purpose of using feed is to ensure quality production. Force-feeding of animals is prohibited (Tekeli, 2004).

3. Except for pet and fur animals, in organic animal breeding, animals are fed with organically produced coarse and concentrated feed (Öztürk et al., 2013; Peker, 2021). In ruminant rations; roughage such as silage and fresh hay should be at least 60% in the dry matter of the ration (Aksu, 2016).

4. On average, 30% of the ration dry matter may contain transitional substances. This rate can be increased up to 60% if the feed materials in the transition process are obtained from the enterprise where the animals are raised (Yenice, 2002).

5. The nutrition of the puppies is primarily provided with mother's milk. If this is not possible, the offspring are fed with milk obtained from the same herd. Depending on the species, the minimum period of time during which the offspring should be fed with milk; 90 days in cattle and foals, 45 days in ovine animals.

6. Enzymes, preservatives, microorganisms, binders, anti-caking agents, antioxidants, silage additives, products used in animal feeding are used if they are included in the section (C) of Annex 7 of the Regulation on the Principles and Practice of Organic Agriculture. For example, formic acid, acetic acid, lactic acid, propionic acid can be used as preservatives for silage (Tekeli, 2004).

7. GMO products cannot be used as feed and feed additives. Antibiotics, coccidiostatics, other growth or production enhancing substances are not used in animal nutrition (Anonim, 2018; Eleroğlu et al., 2014; Tekeli, 2004; Yenice, 2002).

8. In the event of a decrease in feed production due to natural disasters, the use of conventional feedstuffs in animal nutrition is allowed in the disaster area for a short time at a rate to be determined by the Ministry.

9. Animals are primarily fed with organic feed provided from the farm where they are raised, and if not possible, with the feed provided in the Annex-5 section of this regulation, provided by other businesses acting in accordance with the provisions of this regulation.

10. Organically produced feeds or products obtained from them can be transported together with conventionally produced feeds in a way that

does not cause mixing and contamination. The vehicles to which the feeds will be transported are cleaned with the substances given in the 1st part of Annex-7 of this regulation. The amount of product during transport and the amount of product in delivery must be recorded.

11. According to the Veterinary Services, Plant Health, Food and Feed Law No. 5996 and other relevant legislation (Amended expression: OG-6/10/2011-28076), the organic product certificate issued by the authorized institution of the raw materials included in the ration for the feeds to be produced organically in feed factories. After receiving the ration formulas are registered by the Ministry. However, after this process, organic feed production is started in feed factories under the control of the authorized institution (HAYGEM, 2018).

12. The authorized institution grants parallel production permission to the enterprises in the event that an agricultural research is carried out on organic and non-organic animals of the same species, provided that the following conditions are met.

a) Appropriate measures are taken to ensure that the distinction between animals, animal products, fertilizers and feeds is well made in each unit and these are notified to the authorized institution in advance.

b) The entrepreneur informs the authorized body in advance when it comes to the distribution or sale of animals or animal products.

c) The entrepreneur notifies the authorized institution about the exact quantities of the products produced in the production unit and the measures taken to distinguish the products**.**

The requirements for organically produced or processed feeds are as follows:

1) Conventional feed and organic feed cannot be processed in the same line in the same factory.

2) The substances included in the composition of the products or any other substance used in the preparation of these products must not have undergone ionizing radiation-irradiation applications.

3) Organic feeds must be labeled. In organic compound feeds, conventional or transitional feeds can also be included in allowable amounts. In this case, organic and/or transitional feed amounts should be stated as a percentage of dry matter on the organic compound feed labels. The label must also contain the name of the authorized body.

4) Organically produced feeds and conventionally produced feeds are physically kept and stored in separate places.

5) Equipment used in organic feed preparation is separated from all kinds of equipment used in conventional feed preparation.

6) Conventional and organic feed cannot be prepared in the same line in conventional feed preparation units. However, before starting to prepare feed in the feed preparation unit, organic feed is prepared in conventional feed preparation units, provided that the feed preparation

unit is cleaned with the substances given in the 1st part of Annex-7 of this regulation.

Animal health and veterinary response

ITEM 18 - (1) Animal in organic animal breedingn health and veterinary intervention rules are stated below.

a) Disease preventive measures in organic animal breeding are as follows:

1) In organic animal breeding, preventive medicine is essential in animal health.

2) Appropriate breeding breeds are selected.

3) Animals are provided with access to the walking areas or pastures for regular exercise to increase their natural immunity and the use of quality feed.

4) Appropriate settlement frequency is provided to prevent health problems in animals due to overcrowding.

b) If an animal becomes ill or injured despite all preventive measures, it is isolated in a suitable shelter and treated immediately.

c) The principles and procedures of using veterinary medicinal products under the supervision of a veterinarian in organic livestock farming are as follows:

1) Allopathic products, phytopathic products, except for chemically synthesized veterinary medicinal products, provided that they have a therapeutic effect on the animal species treated and are suitable for the treatment conditions, in the 3rd part of Annex-5 and 1st part of Annex-6 of this regulation listed products are used. (Özen, et al., 2010).

2) In cases where the use of the above-mentioned substances is insufficient in the fight against disease or injury, and for the purpose of treatment, in order to prevent the animal from suffering, chemical composition drugs or antibiotics are used in a controlled manner with the permission of the authorized institution.

3) Chemically synthesized veterinary medicinal products or antibiotics cannot be used for anti-disease applications.

d) In organic animal breeding, the genetic structure of animals cannot be changed and genetically modified organisms cannot be used as inputs in organic animal production. Animal breeding with gene technology methods is not allowed. The use of growth or production enhancing substances and the use of hormones or similar substances to control reproduction or for other purposes are prohibited (Baran, 2019;Yenice, 2002). However, hormones can be given to the sick animal as a veterinary practice for therapeutic purposes.

e) When veterinary medicinal products are used; The diagnosis, the intervention method, the dose of the drug, the active substance of the drug, the duration of treatment and the product

used together with the residual purification time of the drug are recorded.

f) The time between the last application of veterinary medicinal products given to an animal under normal conditions and the date of obtaining organic products from these animals is twice the application in conventional farming in organic farming or 48 hours in cases where no residue purification period is specified (Özen, et al., 2010).

g) If more than three chemically synthesized veterinary medicinal products or antibiotics are administered to an animal or animal group within a year, or the productive life span is less than one year, excluding vaccination applications, parasite treatment or the programs determined as mandatory by our country, If animals have been treated more than once, the animals in question or the products obtained from these animals cannot be sold as organic products and are taken into the transition process again (Özen, et al., 2010).

CONCLUSION AND RECOMMENDATIONS

Expanding organic animal husbandry in our country; It will enable the protection of nature and the eco-system, increasing the income level of small farmers, preventing migration from the village to the city, producing healthier products for people, especially babies and children, and providing a healthier diet. However, this requires adequate training,

good supervision and a very good organization from production to marketing.

Organic agriculture and animal husbandry will be positively affected by the promotion of farm tourism, which has developed in the world and in our country in recent years. In the Eastern Anatolia, Central Anatolia and Mediterranean regions, which have high organic livestock potential in Turkey, first of all, organic sheep and goat production should be started. In addition to organic meat, milk and dairy products, organic egg production and consumption should be encouraged.

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CHAPTER 10

SOME ETIOLOGICAL FACTORS OF NEONATAL CALF DIARRHEA

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INTRODUCTION

As in the world, one of the most important problems in cattle breeding in our country is calf deaths (Terzi et al. 2021, Akyüz et al. 2017). According to researches, calf losses in developed European countries are between 10-15% and 61%. Even in farms with very good management conditions, this rate usually does not fall below 5%. It has been reported that mortality and morbidity rates can reach 50% and 100%, respectively, in herds where these conditions are met (Terzi et al. 2021). While calf deaths are limited to 6-7% in the United States, it can reach 10% in state enterprises and 50% in individual enterprises in our country (Akyüz et al. 2017). Diarrhea symptom accounts for 60% of neonatal calf deaths. Reasons such as calf death, treatment and protection costs, growth retardation in the growth period and selling animals below their value are the most important economic problems in farms (Ok et al. 2009, Terzi et al. 2021). It is reported that the annual economic loss in the neonatal period due to calf deaths in Turkey is around 525 million Euros (Terzi et al. 2021).

The neonatal period (newborn) covers the period under investigation for 0-28 day old calves and lambs (Gökçe et al. 2010). One of the most important causes of illness and death in newborn calves is severe diarrhea, and this disease picture is called neonatal diarrhea syndrome (Sears and Kirkpatrick 2001). calf diarrhea is characterized by multiple and watery stools due to infectious and non-infectious causes. Diarrhea is seen in newborn calves 2-10 days after birth, most frequently in the neonatal period (Radostits et al. 2006). Diarrhea is a symptom of

various diseases that occur in pets due to infectious and non-infectious causes, characterized by frequent and watery stools (Özkan and Akgün 2004, Terzi et al. 2021, Prietto et al. 2022).

Diarrhea is the most common enteropathogen, resulting in growth retardation and weight loss, and is a serious problem (Wang et al. 2020). The most common diarrheal agents worldwide in newborn calves are Cryptosporidium spp. (Crypto), bovine rotavirus (BRV), bovine coronavirus (BCoV), and enterotoxigenic Escherichia coli F5 (K99) (ETEC) have been reported (Conrady et al. 2021). These enteric pathogens are known as co-occurring infections in calves (Conrady et al. 2021).

In this book chapter, the common etiological factors of problems in the neonatal period will be examined.

INFECTIOUS ETIOLOGICAL FACTORS

Calf diarrhea is one of the most serious problems of the livestock industry (Ertaş and Ayan 2021, Terzi et al. 2021, Al-Alo et al. 2017). Due to its high prevalence and mortality, treatment costs and low growth rate, it causes significant economic losses in livestock (Al-Alo et al. 2017, Caffarena et al. 2021, Ertaş and Ayan 2021).

Diarrhea develops as a result of increased secretion and decreased absorption in the intestines. E. coli, Camplyobacter spp and Salmonella produce enterotoxins.

These enterotoxins cause increased secretion in the intestines. In the intestines, the cell structure does not deteriorate, but the membrane activity is deteriorated. Sodium, potassium and chlorine secretion increase due to this deterioration. Severe inflammation occurs in the intestines in salmonellosis and clostridiosis. Enteric viruses and protozoa cause destruction of absorptive villous epithelial cells. These factors cause intestinal malabsorption. Dehydration, metabolic acidosis, hypochloremia, hypokalemia and hyponatremia develop in animals as a result of diarrhea. In addition, cardiovascular collapse occurs. In the advanced stages of the disease, circulatory failure and shock develop (Mulcahy et al. 2010). Bacteria, viruses and parasites play a role in infectious agents.

These infectious agents cause diarrhea in calves alone and/or as mixed infections (Hall et al. 1992, Radostits et al. 2006, Altuğ et al. 2013). If we list the infectious causes leading to calf diarrhea; bacteria (E. coli, Salmonella, Cl. perfiringes, Campylobacter jejuni, Chlamydia), viruses (Rotavirus, Coronavirus, BVD virus, Adenovirus, Parvovirus, Astrovirus, Calcivirus, Bredavirus), protozoans [Cryptospiridium parvum (C. parvum), Coccidia, Giardia] and helminths (Neoaskaris vitullorum) (Şentürk 2012, Mulcahy et al. 2010). In the studies, it was determined that the most common cause of calf diarrhea is E. coli from bacterial agents, rota and coronaviruses from viral agents, and Cryptosporidium, Toxocara and Eimeria from parasitic agents (Altuğ et al. 2013). It is reported that diarrhea caused mostly by E. coli, Cryptosporidium, Rota and Coronaviruses are encountered in the first

four weeks of life (Al-alo et al. 2017, Altuğ et al. 2013). In addition, mixed infections are more common (Ok et al. 2009). Diarrhea in neonatal calves (first 4 weeks after birth) is seen as a result of increased secretion or decreased absorption. Enterotoxigenic Escherichia coli (E. coli), Salmonella and Campylobacter species cause secretory, protozoa and enteric viruses cause malabsorptive diarrhea. In diarrhea, watery stools, decreased milk intake, changes in the small intestinal flora, loss of extracellular electrolytes (sodium, potassium, chlorine) and bicarbonate are observed. As a result of these changes, dehydration, metabolic acidosis, electrolyte abnormalities, hypothermia and septicemia are observed in calves with diarrhea (Başoğlu et al. 2004).

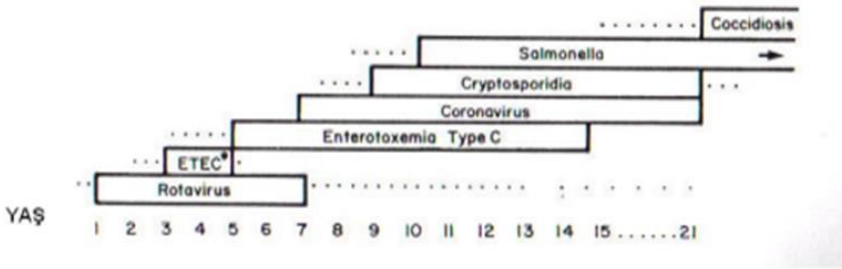

Figure 1. Age predisposition according to the agent in calf diarrhea (Naylor 1996)

In the table given as the age predisposition according to the agent in calf diarrhea (Naylor 1996), the active ingredients are described according to the age of the calf. In the bottom row, which is indicated as age, how many days old the calf is, and in the upper columns, the etiological factors are given. According to this table, it is seen that the

factors can be seen alone or as a mixture. In addition, it is clear that disease factors play an active role in the neonatal period (0-28 days).

E. Coli Diarrhea

Enterotoxigenic E. coli (ETEC) strains cause diarrhea in humans and animals. ETEC is the most isolated bacteria from diarrhea cases originating from E. coli in farm animals (Sancak and Gülhan 2021). Enterotoxigenic Escherichia coli is the predominant pathogen of colibacillosis in calves and is most commonly seen in the first four days of the neonatal period (Naylor, 2002). There are two types of colibacillosis, septicemic and enteric (Mulcahy et al. 2010). The most common entropatogens causing diarrhea are enterotoxigenic E. coli (ETEC). They adhere to and colonize intestinal epithelial cells without invasion and produce enterotoxins that cause watery diarrhea in newborn calves (Foster and Smith, 2009, Smith et al. 2009). In this form, severe weakness, coma, subnormal fever, cooling of the skin, pallor of the mucous membranes, mild convulsive movements and apnea are observed. Diarrhea does not usually occur. The abdomen is tense as the intestines are filled with fluid. The prognosis in these calves is poor. Death occurs within 2-6 hours (Smith et al. 2009). In calves older than two days old, in cases where Rotavirus and ETEC progress together, it can cause diarrhea that can cause death (Mulcahy et al. 2010).

Rotavirus and Coronavirus Diarrhea

The main viral agents of diarrhea in newborns are Rota- and Coronaviruses, Parvo-, Astro-, Caliciviruses, Bovine viral diarrhea virus, bovine virus are other viral agents in these cases. Bovine coronavirus (BCV) was first described in the USA as a diarrheal disease in 1973 by Mebus et al. The causative agent has been reported to be the cause of gastrointestinal tract infections called "winter dysentery" or "epizootic diarhea", as well as subclinical infections in adult cattle (Benfield et al. 1990, Alkan 1998). Bovine rotavirus (BRV) was first reported by Mcbus et al. It was defined as the causative agent of diarrhea in calves by experimentally infecting stools taken from calves with diarrhea and calves that did not receive colostrum. Corona- and rotavirus infections are mostly seen in young animals. Newborns are generally susceptible to infection in the first week of their lives, and BCV infection is frequently detected in calves aged 3-21 days (Alkan 1998). Clinically, an odorless diarrhea with a light yellow color and sometimes fresh blood drops is observed in rotavirus cases, and large-volume dark yellow and sometimes green diarrhea has been detected in corona virus cases (Şentürk 2012).

Cryptosporidiosis Diarrhea

Protozoans due to Cryriptosporidium species are important pathogens among the primary etiological agents of neonatal diarrhea syndrome (Ertaş and Ayan 2021, Babaç 2014). Cryptosporidiosis is common all over the world. And it is a zoonotic disease found in more than 100

species. Organisms of the genus Cryptosporidium; They are coccidian protozoans that cause disease in many hosts such as mammals, reptiles, birds and fish (Ertaş and Ayan 2021, Deveci 2014). This parasite is a common pathogenic protozoan with many different species established. Cryptosporidium species are known to be an important cause of diarrhea and gastroenteritis in humans and animals. In recent years, this parasite has managed to attract attention due to the fact that it spreads through water and causes serious disorders, especially in those with immune deficiency. Because of this location, they are distinguished from other intracellular parasites. Because while other types of parasites localized in the cell, they settle in the cytoplasm of the cell. Parasites of the genus Cryptosporidium infect both people with good immunity and people with immunodeficiency. Causes asymptomatic infection or spontaneous diarrhea in healthy persons It can cause severe and chronic diarrhea, pancreatic, biliary and respiratory tract infections in people with immune deficiency, and even the disease can result in death (Ertaş and Ayan 2021). In recent years, the importance of C. parvum in the etiology of calf diarrhea has begun to increase. Calves infected with C. parvum may be asymptomatic, as well as clinical symptoms of diarrhea and dehydration (Mulcahy et al. 2010). Special drugs are insufficient for the treatment of the infection, and vaccine studies have not yielded sufficient results. The disease can be brought under control by examining the infection, which is diagnosed with appropriate diagnostic methods, supportive treatment, hygiene and appropriate farm management. Sanitation and quality colostrum management are

important in the prevention of clinical disease. Sunlight and drying are effective in killing oocysts (Viel et al. 2007, Paul et al. 2009).

Noninfectious Etiological Factors

Neonatal (newborn) calf diseases and related calf losses are an important issue in Veterinary Medicine. Calves up to one month old are classified as neonatal (Sancak and Gülhan 2021). Diarrhea is seen in newborn calves 2-10 days after birth, most frequently in the neonatal period (Hall et al. 1992; Radostits et al. 2006). The causes of diarrhea in newborns are very diverse, and infectious agents, environment, nutrition and hygienic factors play a role in the emergence of the disease (Benfield et al. 1990, Alkan 1998). It occurs as a result of non-infectious causes (poor management of the enterprise, adverse environmental factors, malnutrition of mothers in the dry period, poor quality or inadequate colostrum drinking) (Mulcahy et al. 2010, Şentürk 2012).

One of the most important resources that enables a newborn calf to cling to life is the first breast milk, namely colostrum. Collostrum is a miraculous food (Şentürk 2012). Timely colostrum intake is the simplest and most effective method of preventing diarrhea in calves (Zhang et al., 2013). In the weakest period of their life, calves are immune from the colostrum they receive from the mother. Adequate nutrition with colostrum containing high quality and protective immunoglobulin concentration (>1500 mg/dl) is essential for immunity to be at desired levels (Sancak and Gülhan 2021). The transfer of maternal immunoglobulins from mother to calf is defined as “passive

transfer". This is essential for the protection of neonatal calves from environmental pathogens (Weaver et al., 2000). Maternal immunoglobulin quality and first feeding time are the most important factors affecting passive immunity (Sayber and Kabu 2021).

When calves are born in a contaminated environment, they are vulnerable to diseases because they do not have enough immunity to use and the intestinal flora is in suitable conditions for pathogens. Breathing air, uterus, umbilical cord and contaminated colostrum are important routes of infection entry for calves.

Infections are more common in calves less than two weeks old and with insufficient colostral IgG concentration (Constable, 2007, Akyüz et al., 2017).

Conclusion

Neonatal calf diarrhea is probably the leading cause of death in calves less than one month old and is becoming a worldwide concern for dairy and beef cattle production (Prietto et al. 2022).

Diarrhea in newborn calves; It is reported that it is one of the main causes of calf deaths worldwide as well as material damage to the cattle industry (Von Buenau et al. 2005, Kozat and Tuncay 2018) due to the high morbidity and mortality (Walker 1998).

It is stated that rapid identification of etiological factors contributes to effective treatment in order to reduce the losses caused by diarrhea in

newborn calves (Kalınbacak 2003; Murat and Balıkçı 2012, Kozat and Tuncay 2018).

Mothers of calves should be vaccinated against diarrhea agents seen in the neonatal period. If a vaccine containing these antigens has been given before, a single dose is given to the mothers in the 8th month of pregnancy, if not, 2 doses are given to the mothers in the 7th and 8th months of pregnancy. this ensure the formation of high antibody titrations against the agents mentioned in colostrum. In the dry period, BVD, IBR collostridium spp. Similar to the administration of PL-3 BRSV pastorella vaccines, the creation of high immunoglobulins in colostrum may enable newborn calves to survive the neonatal period and even the first 3-4 months of their lives with less risk (Şentürk 2012).

The main purpose of veterinary vaccines is to improve the health and welfare of pets, to increase livestock production effectively by reducing costs, and to prevent the transmission of zoonotic diseases from both domestic animals and wild animals to humans (Sancak and Gülhan 2021).

As a result, neonatal calf diarrhea is still up to date. And it is obvious that this problem has seriously damaged the country's economy. In my opinion, protection and control studies for this and efforts to prevent these losses should be accelerated.

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CHAPTER 11

SOME FREQUENTLY USED NSAIDS IN VETERINARY AND HUMAN HEALTH

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Introduction

Nonsteroidal anti-inflammatory drugs (NSAIDs); are used extensively in human medicine due to their analgesic, anti-inflammatory and antipyretic effects. NSAIDs are also defined as non-narcotic analgesics (Salt and Bilgili 2013; Turgut et al. 2018). NSAIDs are among the most widely used and most frequently prescribed drug groups worldwide in veterinary medicine as in human medicine (Gül, 2012; Eminler et al., 2014; Aslan and Gürsoy, 2014). Regardless of the cause, the fact that the inflammatory process prevents the negative effects on the organism causes veterinarians to include NSAIDs in many treatment protocols (Aslan and Gürsoy, 2014). Today, NSAIDs have an important place among the "over the shelf over-the-counter" drug groups, which can be advertised more and are more easily accessible, especially as a result of developing communication tools. In an Italian survey conducted on this subject, it was seen that 15% of the participants used such a drug in the last week (Eminler et al., 2014). While most of the drugs in this group have analgesic, antipyretic and anti-inflammatory effects, a few of them have only analgesic and antipyretic effects. XIX. in the field of human and veterinary medicine. It is reported that acetylsalicylic acid, one of the drugs used for this purpose, was discovered by Frederic Von Heyden in 1874 (Salt and Bilgili 2013). 23 years after this date, Aspirin, an acetyl derivative of salicylic acid, entered the market by Bayer, and aspirin has been the leading non-narcotic pain reliever for more than 80 years (Uzunismail, 2003; Satmış and Bilgili 2013). Vane et al., in a study they conducted in 1998, suggested that the worldwide

consumption of Acetyl salicylic acid (ASA) is $15x10^{12}$ tablets per year (Güçlü et al., 2012).

NSAIDs exert their effects by inhibiting the cyclooxygenase (COX) enzyme involved in prostaglandin synthesis (Karademir and Boyacıoğlu 2014; Yaman et al. 2017; Turgut et al. 2018; Alkan and Erdem 2018). The COX enzyme has three different isoforms, namely COX-1, COX-2 and COX-3 (Karademir and Boyacıoğlu 2014; Association et al., 2017; Alkan and Erdem 2018). COX-1 is a constitutive (essential) enzyme and is involved in the synthesis of prostaglandins, which are effective in many physiological processes. COX-2 enzyme; is an inducible enzyme and is mainly synthesized in many cells in relation to the inflammatory process. When various cytokines, mitogens, endotoxins or lipopolysaccharides are encountered in the body; The amount of COX-2 enzyme increases dramatically in relation to inflammation (Dernek et al., 2017; Alkan and Erdem 2018). In recent years, besides COX-1 and COX-2 enzymes, a third uncharacterized cyclooxygenase enzyme (COX-3) has been found. This enzyme has been isolated at high concentrations in dogs, especially from cerebral cortex and heart tissue (Kim et al., 2010; Alkan and Erdem, 2018). NSAIDs inhibit the COX enzyme and prevent thromboxane A2 formation. These drugs cause a prolongation of bleeding time by disrupting thromboxane-induced platelet aggregation and predisposing a systemic bleeding tendency (Turgut et al. 2018). It has been reported that the use of NSAIDs does not cause cardiovascular thromboembolism and myocardial infarction as adverse effects in

animals, unlike the situation in humans (Turgut et al. 2018). The analgesic efficacy of NSAIDs is similar. However, there are differences in side effect profiles. Although there are oral and rectal forms of many NSAIDs, their parenteral forms are becoming widespread (Erdine, 2003).

NSAIDs, which have a ceiling effect in analgesia, are advantageous because they do not have side effects such as tolerance and respiratory depression. When other techniques are applied as an extension of multimodal analgesia techniques, NSAIDs can reduce the opioid requirement by 20-60%. In this way, it is thought that they can reduce the morbidity due to opioids (Erdine, 2003 ;Paksoy, 2006). NSAIDs are frequently used as first-line agents in the symptomatic treatment of many different inflammatory conditions in human medicine. This group of drugs is used for chronic and acute pain in the treatment of rheumatic diseases such as rheumatoid arthritis and osteoarthritis (Crofford, 2013).

In this study, it is aimed to give information about the use of some commonly used NSAIDs in veterinary and human medicine.

Meloxicam

Meloxicam is an enolic acid derivative of the oxicam group, an anti-inflammatory drug. (Turgut et al. 2018). NSAIDs, which are widely used in humans, cats, dogs, cattle, pigs and sheep, are an effective drug (Yipel and Güngör 2021).

Meloxicam is an injectable formulation in the enolic acid group of NSAIDs approved for intravenous and subcutaneous administration in animals in the USA, EU and Turkey (Karademir and Boyacıoğlu 2014; Akın and Karadermir 2017). It exerts its analgesic, anti-inflammatory and antipyretic effects by selectively inhibiting the COX-2 enzyme (Salt and Bilgili 2013; Özyurtlu et al. 2016; Karademir and Boyacıoğlu 2014; Turgut et al. 2018; Lemonier et al., 2022). Although meloxicam is a selective COX-2 enzyme inhibition, COX-2 is not specific (Karademir and Boyacıoğlu 2014; Ahmad et al 2015). It has been reported that the drug selectively inhibits the COX-2 enzyme at therapeutic doses, but this specificity decreases at high doses. The drug is available in parenteral formulation and oral liquid suspension. It is not recommended to use the drug together with anticoagulants, corticosteroids, diuretics and another nonsteroidal anti-inflammatory drugs and in animals sensitive to meloxicam (Karademir and Boyacıoğlu 2014).

Its half-life is 13 hours in cows (Özyurtlu et al. 2016). COX-1:COX-2 is a preferred COX-2 NSAID with a selective quasi-maximal inhibitor concentration and prevents pain and inflammation associated with COX-2 activity while allowing sufficient activity of COX-1 to repair enteric mucosa (Lemonier et al., 2022). Cattle can mask pain and stress as an important component of survival. The development of appropriate bovine pain model systems and robust markers are essential for demonstrating and pharmacological pain relief (Olson et al. 2016).

Meloxicam is well absorbed after use by all routes of administration, is highly (>99%) bound to plasma proteins, and is excreted in the feces and urine after being converted to inactive metabolites in the liver (Gates et al 2005). The most common known side effects of NSAIDs are on the gastrointestinal tract.

In addition, it is stated that it is necessary to pay attention to its effects on tissue damage, especially kidney and liver, and on blood profile as a result of long-term use (Huntjens et al 2005; Satilmis and Bilgili 2013; Turgut et al 2017). In recent studies, meloxicam has been used in sheep at a dose range of 0.5 mg/kg and 2 mg/kg (Paull et al 2008; Colditz et al 2019; Woodland et al 2019). The drug is absorbed in rates close to 100% from the digestive tract following oral administration and food does not affect the absorption of the drug. It has been reported that meloxicam reaches peak plasma concentration in approximately 7.5 hours following oral administration at a dose of 0.2 mg/kg. The half-life of the drug is species-specific, for example, after 0.2 mg/kg administration, it was determined as 24 hours in dogs and approximately 3 hours in horses (Karademir and Boyacıoğlu 2014). Meloxicam is mostly used in human medicine in the treatment of rheumatological diseases such as rheumatoid arthritis, osteoarthritis, ankylosing spondylitis. Oral tek doz olarak 7,5 mg verilmektedir. İhtiyaç halinde bu doz 15 mg’a yükseltilebilir. However, 7.5 mg is used in the elderly. There is also a suppository form. Its side effects are similar to the side effect profile of NSAIDs; abdominal pain, anemia, edema (Khalil and Aldosari, 2020).

Ketoprofen

Ketoprofen is a benzoylphenylpropionic acid derivative drug (Lemonier et al., 2022; Karademir and Boyacıoğlu 2014). The primary mechanism of action of ketoprofen is that it inhibits the COX enzyme in arachidonic acid metabolism and reduces prostaglandin production. The drug inhibits the COX enzyme non-selectively; that is, it has been reported that it inhibits COX-1 more than COX-2 in some species, and COX-2 more than COX-1 in some other species. It has been reported that ketoprofen is rapidly absorbed from the gastrointestinal tract following oral administration. It has been stated that although foods reduce the maximum plasma concentration of the drug, it does not affect its bioavailability much. Ketoprofen, which is produced as a tablet for cats and dogs, is completely absorbed from the gastrointestinal tract and can be administered with food. Ketoprofen is widely preferred for pain or inflammation associated with musculoskeletal disorders such as lameness, myositis, joint, muscle, bone and soft tissue inflammations in cats and dogs. It is generally used to control postoperative pain in cats and dogs. Ketoprofen is recommended as an analgesic for cats and dogs at a dose of 2 mg/kg initially, then it can be administered at a dose of 1 mg/kg per day for 7-14 days (Karademir and Boyacıoğlu 2014). When used together with corticosteroids and other nonsteroidal anti-inflammatory drugs, it should not be used together because it increases the risk of gastrointestinal ulcer and renal capillary necrosis (Langston 2004; Karademir and Boyacıoğlu 2014). Ketoprofen is a non-selective

NSAID (Lemonier et al., 2022). In rats, a 2 mg/kg subcutaneous dose of ketoprofen reduced behavioral pain symptoms in a laparotomy model (Büyükçoban et al. 2021).

Similarly in human medicine, ketoprofen is a drug from the group of non-steroidal anti-inflammatory drugs (NSAIDs) with analgesic, anti-inflammatory and antipyretic properties. It is widely used because of its rapid absorption and crossing the blood-brain barrier. Ketoprofen has side effects such as headache, drowsiness, cardiovascular problems, increased liver enzymes, platelet dysfunction, skin sensitivity. It can cause renal failure, electrolyte imbalance and hypertension due to inhibition of renal prostaglandin synthesis (Kuczyńska and Nieradko-Iwanicka, 2021). It can cause renal failure, electrolyte imbalance and hypertension due to inhibition of renal prostaglandin synthesis (Kuczyńska and Nieradko-Iwanicka, 2021). Ketoprofen doses range from 6.5 mg to 150 mg. In studies, the use of a single oral dose of 50 mg of ketoprofen provided a better level of pain relief than placebo (Gaskell et al., 2017).

Diclofenac sodium

Diclofenac is a phenylacetic acid derivative NSAID. It is structurally related to meclofenamate sodium and mefenamic acid, but unlike this anthranilic acid (2-aminobenzoic acid derivatives), diclofenac is a 2-aminobenzeneacetic acid derivative. Diclofenac sodium is among the NSAIDs are commonly used in veterinary medicine. Its harmful side effects such as gastrointestinal upset, cardiopulmonary depression. And inhibition of antibody production limit its use (Buhari et al., 2020).

Diclofenac sodium, an anti-inflammatory and analgesic that is consumed in large quantities every year in the world, has been widely detected in wastewater, natural water bodies, and even drinking water due to its high solubility and polarity in water (Lonappan et al., 2016). Chronic exposure to diclofenac sodium may cause hemodynamic changes in human health and the risk of thyroid tumors, so there has recently been great concern over the removal of diclofenac sodium from aqueous solution (Wu et al., 2020).

Diclofenac sodium is a non-steroidal anti-inflammatory drug with antipyretic, anti-inflammatory and analgesic effects. It is effective in relieving pain and inflammation because it inhibits COX-2. However, since it also inhibits COX-1, gastrointestinal side effects occur. Since it is a non-selective NSAID, it causes serious side effects such as kidney dysfunction and stomach ulcers. Since it contains highly soluble salts, its absorption in oral administration is quite rapid.

Intravenous and topical applications are also available. In a single dose, the effect lasts for about 6-8 hours (Ulubay et al., 2018). It is used in the treatment of diseases such as rheumatoid arthritis, lupus erythematosus, psoriatic arthritis, ankylosing spondylitis, gout and rheumatic fever (Kołodziejska and Kołodziejczyk, 2018). In human medicine, the usual starting dose of diclofenac sodium in adults is 75 mg twice daily or 50 mg 3 times daily, although this dose may be increased to 200 mg daily if necessary.

Diclofenac sodium and diclofenac potassium are rapidly and almost completely absorbed from the gastrointestinal tract in humans, but

undergo first-pass metabolism in the liver (McLean et al. 2018). There is also the use of a single dose of 100 mg diclofenac sodium (Kaplan and Eroğlu, 2016). Studies show that the use of diclofenac 150 mg per day in the treatment of pain and physical disability caused by osteoarthritis is more effective than commonly used NSAIDs such as ibuprofen, naproxen and celecoxib, which are used at maximum doses (Kołodziejska and Kołodziejczyk, 2018).

Indomethacin

It is an indomethacin methylated indole acetic acid derivative NSAID. It has an effect about 10 times stronger than aspirin. Indomethacin is a nonsteroidal anti-inflammatory drug (NSAID) with very strong antipyretic, analgesic and anti-inflammatory activity. By inhibiting cyclooxygenase (COX), it prevents the production of prostaglandins from arachidonic acid (Lucas, 2016). Indomethacin can cause undesirable effects on the digestive system such as nausea, vomiting, abdominal pain, ulcers and stomach bleeding (Taşdemir and Boyacıoğlu 2019).

The full tocolytic dose for indomethacin in humans is recommended as 200 mg (Avcı 2019). Although the therapeutic range for the anti-inflammatory effect of indomethacin is not certain, a therapeutic range of 0.5-3 μg/mL has been suggested (Lucas, 2016).

Naproxen sodium

Naproxen is a propionic acid derivative. It has been reported that the use of high doses of naproxen causes cartilage degeneration by reducing

glycosaminoglycan synthesis in dogs (KiceraTemple et al., 2019). In humans and dogs, naproxen is metabolized in the liver. The main excretion route in humans is urine, and in dogs it is partially biliary and enterohepatic circulation (Khan and McLean, 2012). It has been reported that 5 mg/kg dose causes gastrointestinal lesions in dogs, 22 mg/kg dose causes duodenal ulcer, perforation and peritonitis, and renal failure in addition to gastrointestinal findings in cats (Fitzgerald et al., 2006). It has been reported that emetic, activated carbon, intravenous fluid therapy and therapeutic plasma exchange applications give positive results in cases of naproxen toxication (Fitzgerald et al., 2006; Kicera-Temple et al., 2019; Gülersoy et al. 2021).

Naproxen sodium is a drug from the NSAID drug group and is sold as a prescription drug. However, it is approved for over-the-counter use in many countries. In human medicine, the maximum total daily over-the-counter dose is 440-660 mg every 8-12 hours. The prescription dose differs from the over-the-counter dosing regimen, usually 500 mg two to three times a day, with a maximum total daily dose of 1500 mg (Angiolillo & Weisman, 2017).

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CHAPTER 12

AVIAN IMMUN SYSTEM ANATOMY

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INTRODUCTION

One of the most important problems for people to survive is the need for basic food sources. In line with this need, the importance of animal foods is also increasing. The largest source for increasing species diversity in animal production is avians. In parallel with the increase in the preference of avians as a nutrient, poultry medicine has become an important branch of veterinarians today. Avian physicians have to deal with diseases invading flocks on avian farms. In order for every living species to continue its extinction, it must be in stable harmony with its environment. For this reason, in order for a living thing to continue its individual existence and therefore to maintain its biological life, it must be able to distinguish between substances related to itself and non-self, that is, from the environment (Neumann 1998). Mucous membranes constitute the largest area associated with the environment and the most important entry areas for pathogenic microorganisms. Mucosal membranes have developed some defense mechanisms. These defense mechanisms are called MALT (mucous-associated lymphoid tissue) for short. Digestive tract associated lymphoid tissue (GALT) is the most important member of MALT (Çolakoğlu and Dönmez 2018). CALT (conjunctiva associated lymphoid tissue) is the immune barrier found in the harderian glands, which is the secondary lymphoid organ (Bejdic et al. 2018). He lymphatic system plays an important role in body defense. This system is an additional pathway that transfers protein molecules and large particles, other name tissue fluid, that cannot enter the venous capillaries, into the blood circulation. The lymphoid system

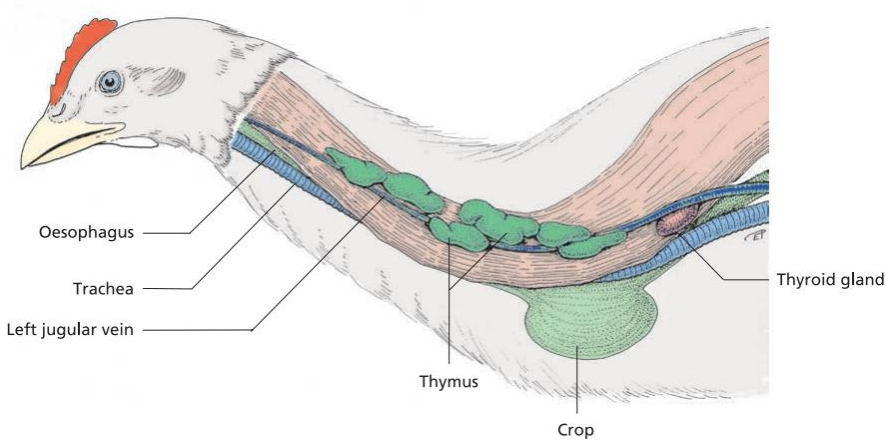
also has functions such as producing and storing lymphocytes, making antibodies, carrying hormones, and contributing to the spread of infections and malignant diseases. The lymphatic system contains lymph vessels, lymph nodes, and lymphatic fluid (Dursun 2008). Lymph fluid contains plasma proteins, electrolytes, lipids, hormones, lymphocytes, etc. Lymphocytes attached to the thymus are T cells. The lymphocytes attached to bursa fabricii are B lymphocytes. Unlike T lymphocytes, B lymphocytes have a binding surface for IgA-M-G (Ringer 2011). The part from the lymph vessels to the lymph nodes is called the afferent, and the part from the lymph nodes to the large lymph vessel, where the lymph is poured, is called the efferent lymph vessel (Dursun 2008). The lymphoid system consists of primary lymphoid organs and secondary lymphoid organs. Primary (central) lymphoid organs are bone marrow, bursa fabricius, and thymus. These organs are responsible for creating an immune response (Ringer 2011). Secondary (peripheral) lymphoid organs consist of spleen, lymph node (found only in waterfowl), and lymph follicles (follicles located in organs) (Aslan 2018). Lymphatic organs in poultry class; lymphatic heart, mural lymph formations in lymph vessels and bursa fabricius (König et al. 2016).

There are studies on avians. (Çalışlar 1986, Gültekin 1966, McLelland 1990). However, in the literature reviews, it has been seen that there are limited number of studies that synthesize traditional and current information about the anatomy of the avian lymphoid system. Therefore, I think that this book chapter will contribute to this shortcoming to some extent.

1.Primary Lymphoid Organs

1.1.Thymus

It is double in chickens and consists of pale red or yellowish irregular lobes. Its volume and shape can vary in adult birds. It consists of 3-8 lobes running along the thyroid gland and v. Jugularis (Dursun 2008). Goose, wild duck, peking duck, guinea fowl have 6-9, 5-6, 4-7, 7 lops on the right side, 5-9, 5-7, 4-6, 6 lops on the left, respectively (Aslan 2018). It is in the neck area from head to chest. In roosters, it reaches a maximum weight of 15.76 g at 17 weeks of age. Then it starts to shrink gradually. It is 2.2 g in 13-19 week old roosters and 0.6 g in hens of the same age. They must be at least 16 months old for the entire lobe to disappear. Like mammals, it gets smaller with age and disappears completely in the elderly. Its histological structure is the same as that of mammals (Dursun 2008). Each lobe consists of lobules separated from each other by connective tissue. The lobules consist of outer dense cortex and inner light colored medulla. Dense groups of T-lymphocytes and epithelial reticular cells are found in the cortex. In the medulla, there are reticular cells, macrophages, plasma cells, mast cells, erythrocytes, granulocytes, myoid cells, and sensitive corpuscles (Aslan 2018).

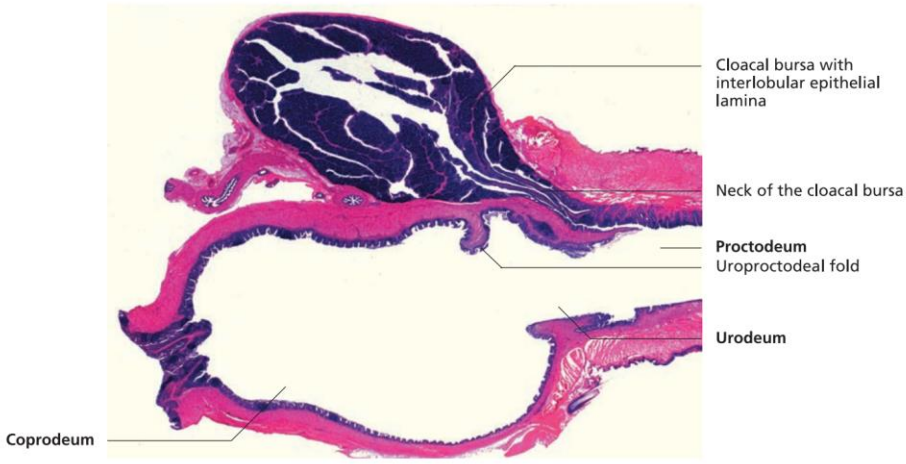


Figüre 1: Thymus in chicken (König et al. 2016)

1.2.Bursa Cloacalis (Bursa Fabricii)

It is one of the primary lymphoid organs of avians (Aslan 2018). It is responsible for the maturation of B lymphocytes. It is rounded like a diverticulum in the dorsal of the proctodeum in chickens, cylindrical in geese, elongated cecum-like in ducks, rounded in turkeys, but tapered cranial length, and elongated in starlings (Karadağ Sarı and Kurtdede 2006). It has a maximum length of 3 cm, a width of 2 cm and a weight of 3 g. Involution begins at the beginning of sexual maturity. In geese and ducks, involution begins a little later than in chickens (Karadağ Sarı and Kurtdede 2006). It reaches its maximum size at 16 weeks of age. In 10-month-old birds, bursa fabricii is hidden within 1-2 mm of connective tissue on the dorsal wall of the cloaca. Then it disappears completely. It reaches its maximum size of 5 cm in length and 7 mm in diameter in a six month old duck (Karadağ Sarı and Kurtdede 2006). In

cases where this organ is well developed, there is a walled cavity containing a small diverticulum. This diverticulum provides the connection between the dorsal wall of the proctodeum and the bursa fabricii. The wall of Bursa fabricii consists of 12-14 longitudinal layers (Dursun 2008). The wall of Bursa fabricii consists of tunica mucosa, tunica muscularis, and tunica serosa layers. There are plicae extending towards the lumen and varying according to bird species (Aslan 2018). Bursa fibricii is of great importance in the detection of viral infections (Demiraslan and Dayan 2021).



Figüre 2: Histological section of the bursa cloacalis in chicken (König et al. 2016)

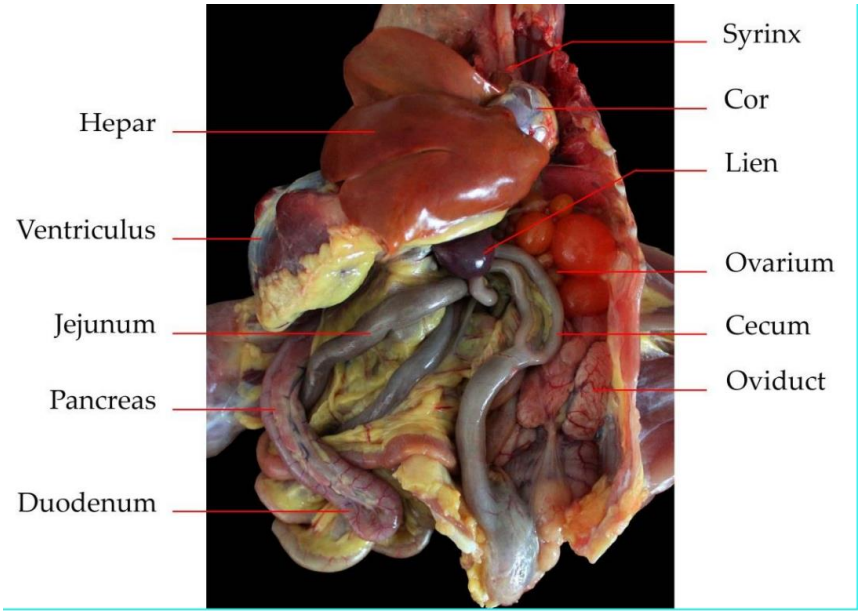
2.Secondary Lymphoid Organs

Secondary (peripheral) lymphoid organs consist of spleen, lymph node (found only in waterfowl) and lymph follicles (follicles located in organs) (Aslan 2018). According to another source, secondary

lymphoid organs are spleen, bone marrow, Harderian gland (eye socket), pineal gland (brain), mucosal surface lymphoid tissues (MALT), bronchial lymphoid tissues (BALT), intestinal lymphoid tissues (GALT) were evaluated as connective lymphoid tissues (CALT) (Sarıca et al. 2009).

2.1. Lien (Spleen)

In chickens, it is reddish-brown, round and has an average diameter of 1.5 cm (Dursun 2008). The spleen of waterfowl is triangular (Aslan 2018). It has also been reported to be oval in pigeon, triangular in goose and duck (Demirslan and Dayan 2021). It weighs 3 g in chickens and 4.5 g in roosters (Dursun 2008). It has been reported that the length of the spleen is 10.32±0.78 mm, its width is 6.60±0.50 mm, its height is 5.55±0.26 mm, and its weight is between 0.26±0.06 g (Kara et al. 2021). It is located to the right of the junction of the glandular stomach and the muscular stomach. Equal amounts of red and white pulp make up 85% of the spleen. There is no direct relationship between arteries and veins in the spleen. Terminal capillaries open into the space between splenic cord cells. The white pulp consists of two types of vessels, the diffuse lymphoid tissue surrounding the a.centralis and its branches, and the centrum germinativums in the same region. While the diffuse lymphoid tissue around the a.centralis in the white pulp consists of thymus-derived T lymphocytes, the cells in the centrum germinativum originate from bursa cloacalis (Aslan 2018). The spleen is an erythropoietic organ in the embryo, and a lymphopoietic organ in adults, which also serves as a blood reservoir (Dursun 2008).



Figüre 3: Spleen in chicken (Demiraslan and Dayan 2021)

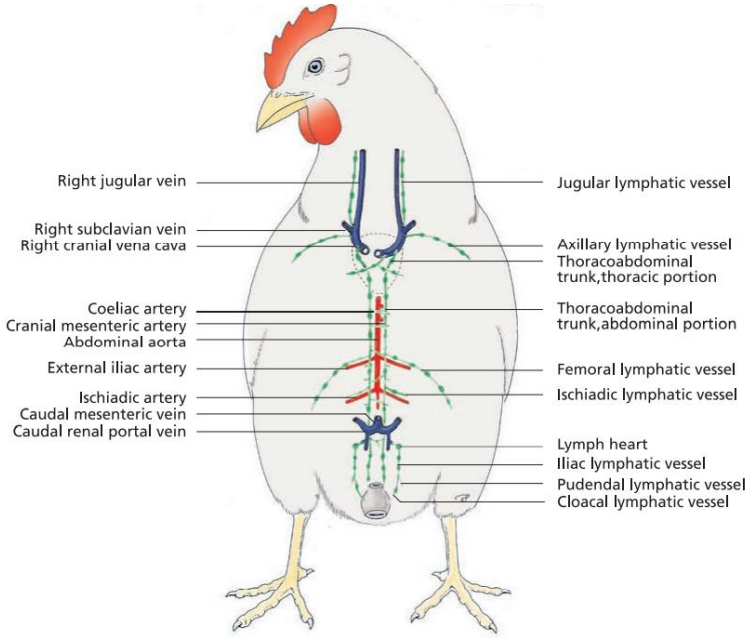
2.2.Lymph Nodes

Chicken and turkey do not have lymph nodes (Dursun 2008). According to one source, it is found only in waterfowl (Aslan 2008). Other avians have two pairs of lymph nodes, lymphonodus cervicothoracicus and lymphonodus lumbaris. Lymphonodus cervicothoracicus vena (v.) vertebralis at the junction of the v.jugularis, they are usually found in pairs on the caudal of the neck. Although its volume varies, it is 1.5-3 cm long and 2.5 cm wide. Efferent lymphatic vessels come from vas lymphaticum jugulare and vas I. vertebrale. The efferent vein opens into the truncus thoracoabdominalis. Lymphonodus lumbaris is found in pairs on both sides of the aorta between the kidneys and the sacrum. Its extremitas cranialis continues to arteria (a.) iliaca externa, while its

extremitas caudalis continues to a.ischiadica. It is 2.5 cm long and 5 mm wide. While the afferent vessels are vas I. iliacum externum and vas I. ischiadicum, the efferent vessel opens to the truncus thoracoabdominalis (Dursun 2008). The presence of anatomical structures called lymph plexus, which is shaped by the intertwining of very small lymph vessels in poultry, has been mentioned instead of lymph nodes in mammals (Gofur 2020).

2.2.1.Lymph Vessels

In avians, lymphatic vessels are less numerous than in mammals. The muscle enlargements that occur in the lymphatic vessels in some avians are called the lymphatic heart (McKibben and Harrison 2011). This organ is located longitudinally dorsoventrally. Its length was determined as 2 mm in chickens, 5 mm in ducks, 15 mm in swans, and 25 mm in ostrich species. The lymphatic heart is located at the level of the first caudal vertebra, adjacent to the ileum. Lymph flows into the dorsal pelvic veins through the double venous angle draining into the veins and the lymph hearts located in pairs as an alternative route. Persistence of lymph hearts after hatching varies according to species (König et al. 2016). The valves in the lymphatic vessels prevent the backflow of lymph fluid. The flow direction of the lymph fluid is from the periphery to the centre. The largest lymphatic vessel in avian is the truncus thoracoabdominalis. Only the head, heart, lungs and a part of the stomach are directly opened to the venous system (Dursun 2008).



Figüre 4: Large lymph vessels in chicken (König et al. 2016)

Truncus thoracoabdominalis is the body's largest lymphatic vessel, usually found in pairs in avians. It receives lymph from organs and extremities in the cavum abdominis. The ductus thoracoabdominalis may be single at the starting and ending point. It starts from the plexus lymphaticus celiacus, which is densely located around the aorta. Ductus thoracoabdominalis continues as sinister and dexter. It ends by opening to v. cava caudalis. Ductus thoracoabdominalis pours lymph from 14 lymph vessels into v.cava caudalis. The pars thoracica of vas I. celiacum esophagus receives lymph from the ventriculus muscularis, ventriculus glandularis, duodenum, ileum, caecum, lien, pancreas, and hepar. Vas l. mesentericum craniale receives lymph from the jejunum, ileum, cecum, testis, ovary, and pars cranialis of the oviduct. Vas l. mesentericum caudale drains lymph from the rectum. Vas l. Adrenale

consists of one or two vessels that drain the lymph of the glandula adrenalis. The vas l. ovaricum drains the lymph of the ovary and the cranial part of the oviduct through the a.mesenterica cranialis. The vas l. testicularia consists of four or five vessels that drain the lymph of the testis. The vas l. renalia consists of six vessels that drain the lymph of the kidneys. The vas l. ureterodeferentialia drains the ductus deferens, ureter, medial and caudal parts of the kidneys. Vas I. iliacum externum is the continuation of the vas l. femorale. The vas l. iliacum internum drains the lymph of the ductus deferens or the caudal 1/3 of the oviduct, caudal of the rectum, bursa cloacalis, and the end of the ureter. It is continuation of the vas l. ischiadicum. The vas l. ischiadicum is the continuation of the vas l.popliteum formed by the union of the vas l.tibiale caudale and the craniale. The vas l. mesentericum caudale carries the lymph of the rectum. The vas l. pudendum carries the lymph of the bursa cloaca. Was l. sacrale medianum drains the coccygeal and cloacal structures by flowing with the a.sacralis mediana. Vas lymphaticum jugulare is formed by the union of the vas l. cephalicum rostrale and caudale. It drains the lymph of the head, neck, esophagus, thymus, thyroid gland, ingluves, and trachea. It receives vas l. caroticum, vas l. vertebrale, vas l. thyroideum, vas l. ingluvialia, vasa l. esophagealia, vas l. esophagotracheale (Nickel et al. 1977). Vas lymphaticum jugulare ends by opening into the truncus thoracoabdominalis or v. cava cranialis at the cranial junction of the v. subclavia and v. jugularis. The vas l.radiale and ulnare from the wing unite to forms vas l.basilicum. Vas l.basilicum combines with vas l.brachiale profundum and vas l.brachiale to form vas lymphaticum

subclavium. Vas lymphaticum subclavium opens into the truncus thoracoabdominalis by taking vas l.pectorale commune, vas l.sternoclaviculare and vas l.axillare from the chest. Vasa lymphatica thoracica interna accompanies v.thoracica interna by draining the lymph of lungs and musculi abdominalis. It ends by opening to v.cava cranialis or near the vein (Dyce et al. 2018). Vas lymphaticum cardiacum commune carries the lymph of the heart. It is formed by the union of the vas l. cardiacum dextrum and sinistrum. It ends by opening to ventriculus dexter or the v. cava cranialis dextrum. Vas lymphaticum pulmonale commune is formed by the union of the vas l. pulmonale profundum dextrum and sinistrum. It progresses together with v. pulmonalis dexter and sinister. It ends by opening to the v. cava cranialis. Vas lymphaticum proventriculi contains the lymph of the cranial part of the ventriculus glandularis. It progresses with v. proventriculus cranialis. It ends by opening to v. cava cranialis sinister or truncus thoracoabdominalis sinister (Dursun 2008).

2.3.Mural Lymph Nodes

They are found in the walls of lymphatic vessels in avians. They are arranged in a round or oval shape along the longitudinal axis of the vessels. They are considered to be the avians equivalent of the lymph nodes in the large intestine of mammals. They are irregularly localized at a distance of several millimeters from each other. These distances are shorter in lymph vessels in the extremity than in the wings and neck. It is usually embedded in the wall of lymphatic vessels. Sometimes it can

protrude into the vessel lumen. It has the same structure as the lymph nodes of avian and has little or no filtration capacity (Dyce et al. 2018).

Lymphonodi aggregati canalis alimenteri is found in the submucosa or lamina propria of the digestive tract, in the lymphoid tissue from the pharynx to the cloaca. Lymphonodi pharyngeales consists of esophageales and cecales. These lymph nodes are located on the walls of the organs mentioned. These formations consisting of lymphoid tissues are called tonsils in some regions. Cecal tonsils are located in the wall of the cecum at the junction of the cecum and ileum. Cecal tonsils are important as a source of antibodies in the body's defense (Nickel et al. 1977).

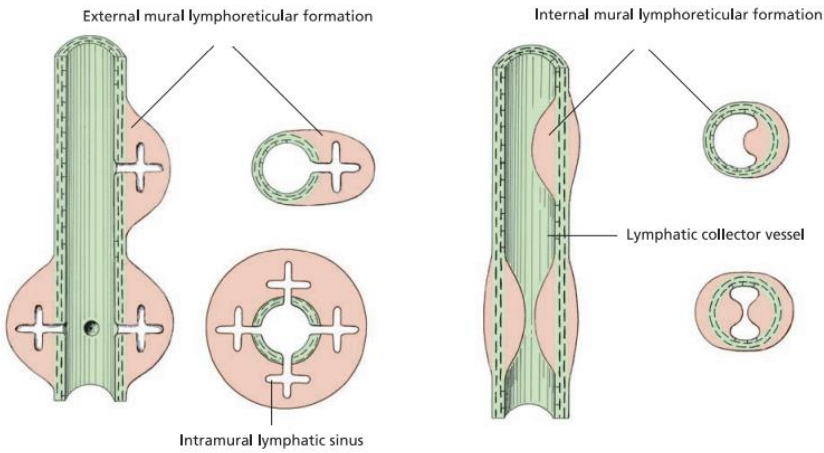


Figure 5: Schematic of the mural lymph vessels (König et al. 2016)

CONCLUSION

Avian medicine has become an important branch that veterinarians turn to, in parallel with the preference of avians as food, their breeding as ornamental animals and the increasing interest in wild birds. It is necessary to take samples from immune system organs in viral, bacterial and infectious diseases in avians. For an accurate immune system evaluation, it is necessary to have sufficient knowledge about the anatomy of the organs of the relevant system. There are studies on avians. However, in the literature reviews, it was seen that the studies in which traditional and current information about the anatomy of the avian lymphoid system were synthesized are limited in number. I think that with the book section presented in line with this need, it will contribute to this deficiency to some extent.

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