T.R.
ERCIYES UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF AGRICULTURAL SCIENCES AND TECHNOLOGIES

THE EFFECTS OF AGE, GENDER AND BODY CONDITION SCORE ON MEAT QUALITY AND BLOOD COMPONENTS OF BUFFALOES

By
Aisha Ali AHMED

Supervisor
Prof. Dr. Yusuf KONCA

Master Thesis

September 2023
KAYSERİ

T.R.
ERCIYES UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF AGRICULTURAL SCIENCES AND TECHNOLOGIES

THE EFFECTS OF AGE, GENDER AND BODY CONDITION SCORE ON MEAT QUALITY AND BLOOD COMPONENTS OF BUFFALOES

By
Aisha Ali AHMED

Supervisor
Prof. Dr. Yusuf KONCA

Master Thesis

This study was supported by the Scientific Research Projects Unit of Erciyes University with the project number FYL-2023-12289.

September2023
KAYSERİ

COMPLIANCE WITH SCIENTIFIC ETHICS

I certify that all data used in this study were collected based on ethical and academic standards. I also declare that, in accordance with these rules and codes of conduct, I have fully cited and referenced all materials and results that are not part of this study.

Name- Surname: Aisha Ali AHMED

Signature:

APPROVAL OF COMPLIANCE WITH THE DIRECTIVE

The master thesis titled "**The Effects of Age, Gender and Body Condition Score on Meat Quality and Blood Components of Buffaloes**" was prepared by Erciyes University Graduate Thesis Proposal and Thesis Writing Directive.

Prepared by	Supervised by
Aisha Ali AHMED	Prof. Dr. Yusuf KONCA

Doç. Dr. Özhan ŞİMŞEK
Anabilim Dalı Başkanı

ACKNOWLEDGMENT

First and foremost, all praises to ALLAH and his blessing for the successful completion of this thesis successfully.

I want to express my deepest appreciation to my supervisor, Prof. Dr. Yusuf KONCA for their tremendous advice, knowledge, and never-ending support.

I am grateful tothe Erciyes University Scientific Research Projects Coordination Office (BAP)for providing me with financial support for the project (FYL-2023-12289), and opportunities to pursue this research.

I also extend my gratitude to the friends and all those who supported and guided me throughout the journey of completing this thesis.

My sincere appreciation goes to my Parents and family for their unending support, love, and understanding at all times. Without their assistance and encouragement, this accomplishment would not have been possible.

YAŞ, CİNSİYET VE VÜCUT KONDÜSYON PUANININ MANDALARIN ET KALİTESİ VE KAN BİLEŞENLERİ ÜZERİNE ETKİLERİ

Aisha Ali AHMED

Erciyes Üniversitesi, Fen Bilimleri Enstitüsü
Yüksek Lisans Tezi, Eylül 2023
Danışman: Prof. Dr. Yusuf KONCA

ÖZET

Bu çalışma, Kayseri'de kesime gönderilen erkek ve dişi mandaların bazı karkas, et kalitesi ve kan bileşenlerinin belirlenmesi amacıyla yapılmıştır. Çalışmada 28 dişi, 6 erkek olmak üzere toplam 34 manda değerlendirildi. Bu amaçla mezbaha padoklarında mandaların vücut kondisyon skorları (VKS) belirlendi. Kesim sonrası boyun damarından kan örnekleri alınmış, baş, deri, bacak ve iç organların ayrılmasının ardından sıcak karkas ağırlıkları kaydedilmiştir. Karkaslar 4°C'deki soğuk odada 24 saat dinlendirilmiş, *Longissimusdorsitoracic* kasından dikey kesitle 250 adet et örneği alınmış, numaralı torbalara konularak doğrudan laboratuvara aktarılarak analizleri yapılmıştır. Et örneklerinde Weende analizleri (kuru madde, ham protein, yağ, kül), ette pişme ve çözülme, renk ve pH değerleri ve kan analizleri yapıldı. Mandaların ortalama yaşı dişilerde 40 ay, erkeklerde ise 26 aydı. Mandaların VKS'si dişilerde 4,0, erkeklerde 3,0 olarak belirlendi. Dişi ve erkeklerde sırasıyla sıcak karkas ağırlıkları 244,33 ve 211,30 kg, deri altı karkas yağ kalınlığı ise 9,35 ve 7,39 mm; et pH değerleri 5,49 ve 5,49; kuru madde etindeki ham protein %43,32 ve %41,49; ham yağ sırasıyla %19,36 ve %14,89 ve ham kül %3,18 ve %2,87. Et rengi parlaklık (L*) değerleri 40,62 ve 42,07; kırmızılık (a*) 20,63 ve 17,44 ve sarılık (b*) 12,20 ve 11,19; pişirme kaybı %40,99 ve %40,34, çözdürme kaybıdişilerde ve erkeklerde sırasıyla %20,97 ve %23,65 olarak belirlendi. Mandaların kan serumu değerleri açısından bakıldığında total protein, AST, kreatinin, sodyum ve bakır değerlerinin erkeklerde dişilere göre daha yüksek olduğu ($P<0.05$), serum glukoz, trigliserit, kolesterol, HDL, LDL, klorür, kalsiyum değerlerinin erkeklerde daha yüksek olduğu belirlendi. Serum fosfor, çinko ve ALT değerleri cinsiyetler arasında farklılık göstermedi. Bu sonuçlara göre dişilerde VKS, etin yağ oranı ve karkas ağırlığı daha yüksek; serum protein, AST, kreatin, sodyum ve bakır değerleri ise erkeklerde dişilere göre daha yüksekti. Vücut kondüsyon skoru, sıcak karkas ağırlığı ve yağ oranı ile kan lipit bileşenleri arasında bazı korelasyonlar bulunmuştur.

Anahtar Kelimeler: Manda, Et kalitesi, Kan, Cinsiyet, Sürdürülebilirlik

THE EFFECTS OF AGE, GENDER AND BODY CONDITION SCORE ON MEAT QUALITY AND BLOOD COMPONENTS OF BUFFALOES

Aisha Ali AHMED

Erciyes University, Institute of Applied Sciences
Master's Thesis September 2023
Supervisor: Prof. Dr. Yusuf KONCA

ABSTRACT

The study was conducted to determine some carcass, meat quality and blood components of male and female buffaloes sent to slaughter in Kayseri. A total of 34 buffaloes (28 female, 6 male) were evaluated in the study. For this purpose, body condition score (BCS)of buffaloes were determined in slaughterhouses paddocks.Blood samples were taken from the neck vein after slaughter, then hot carcasses weights were recorded after separation of head, skin, legs and visceral organs. Carcasses were rested in cool room at 4 °C, for 24 hours, 250 meat samples were taken from the *Longissimus dorsi thoracic* muscle by vertical section, placed in numbered bags and transferred directly to the laboratory and analysed. Weende analyses (dry matter, raw ash, crude, protein, and fat), cooking and freezing losses, color and pH analyses of meat samples and blood components were determined. The average age of buffaloes was 40 months for females and 26 months for males. The BCS of buffaloes were determined as 4.0 for females and 3.0 for males. Hot carcass weights for females and males were 244.33 and 211.30 kg, subcutaneous carcass fat thickness of 9.35 and 7.39 mm; meat pH values of 5.49 and 5.49; crude protein in dry matter meat 43.32% and 41.49 %; crude fat 19.36 and 14.89%, and crude ash 3.18 and 2.87%respectively. Meat color brightness (L*) values were 40.62 and 42.07; redness (a*) 20.63 and 17.44, and yellowness (b*) of 12.20 and 11.19; cooking loses 40.99 and 40.34%, and freezing losses 20.97 and 23.65% for female and males respectively. In terms of blood serum values of buffaloes, total protein, AST, creatinine, sodium, and copper values were found to be higher in males than females ($P<0.05$), serum glucose, triglyceride, cholesterol, HDL, LDL, chloride, calcium, phosphorus, zinc, and ALT values did not differ between genders. According to these results, BSC, meat fat ratio, and carcass weight were higher in females, and serum protein, AST, creatinine, sodium, and copper values were higher in males than females. There were some correlations between BSC, hot carcass weight and fat ratio and also in blood lipid components.

Keywords: Buffalo, Meat quality, Blood, Gender, Sustainability

CONTENTS

THE EFFECTS OF AGE, GENDER AND BODY CONDITION SCORE ON MEAT QUALITY AND BLOOD COMPONENTS OF BUFFALOES

COMPLIANCE WITH SCIENTIFIC ETHICS ii
APPROVAL OF COMPLIANCE WITH THE DIRECTIVE iii
ACCEPTANCE AND APPROVAL iv
ACKNOWLEDGMENT v
ÖZET vi
ABSTRACT vii
CONTENTS viii
ABBREVIATIONS x
LIST OF TABLES xii
LIST OF FIGURES xi
INTRODUCTION 1

CHAPTER 1

GENERAL INFORMATION AND LITERATURE REVIEW

1.1. Information on meat production 4
1.2. Influences of different diets on buffalo meat quality 14
1.3. Animal age and meat quality 16
1.4. Management practice on meat quality 18
1.5. Body condition score and meat quality 18
1.6. Buffalo Meat product 18

CHAPTER 2

METHOD AND MATERIAL

2.1. Material 20
2.2. Methods 20
2.2.1. Determination of body condition score (BSC) of buffaloes 20
2.2.2. Determination of hot carcass (HC) weight of buffaloes 20
2.2.3. Meat sampling 21
2.2.3. Chemical analyses of meat samples 21
2.2.3.1. Determination of dry matter of meat samples 21
2.2.3.2.Determination of crude protein of meat samples 21

2.2.3.3. Determination of crude fat 22
2.2.3.4. Determination of crude ash 22
2.3. Determination of meat color of meat 22
2.4. Subcutaneous fat thickness, mm 22
2.5. Determination of cooking loss of meat samples 23
2.6. Determination of meat thawing loss 23
2.7. Determination of fatty acid composition of carcass fat 23
2.8. Determination of blood analyses 23
2.9. Statistical analysis 24

CHAPTER 3

RESULTS

3.1. Buffalo carcass and physico-chemical composition of L*ongissimus dorsi thoracic* meat 25
3.2. Buffalo L*ongissimus dorsi thoracic* meat fatty acid composition 29
3.3. Buffalo blood components 31
3.4. Correlations between carcass traits and blood components 34

CHAPTER 4

DISCUSSION

CHAPTER 5

CONCLUSION AND RECOMMENDATION

REFERENCES 46
CURRICULUM VITAE (CV) 57

ABBREVIATIONS

a*	Red - greenness value of meat
ALT	Alanine transaminase
AST	Aspartate aminotransferase
b*	Brightness value of meat
BCS	Body Condition Score
BW	Body Weight
CL	Cooking Loss
CP	Crude Protein
CW	Carcass Weight
DL	Drip Loss
DM	Dry matter
HDL	High-Density Lipoprotein
L*	The lightness value of meat
LDL	Low-Density Lipoprotein
LT	Longissimus Dorsi Thoracic Muscle
TC	Total Cholesterol
TG	Total Triglyceride
WHC	Water Holding Capacity

LIST OF FIGURES

Figure 2.1. Fat extraction machine 22

Figure 2.2. Blood serums separation 24

LIST OF TABLES

Table 3.1. Effects of gender on body condition score, fat thickness, and pH values of Longissimus dorsi thoracic muscles 25

Table 3.2. Effect of gender on Longissimus dorsi thoracic muscle crude ash, and fat content, % 26

Table 3.3. Effect of gender on Longissimus dorsi thoracic muscle color traits..... 27

Table 3.4. Effect of gender on Longissimus dorsi thoracic muscle cooking loss, freezing loss of buffaloes 28

Table 3.5. Effect of gender on Longissimus dorsi thoracic muscle fatty acid composition of buffaloes (% of total fatty acids) 29

Table 3.6. Effect of gender on blood components of buffaloes 31

Table 3.7. Effect of gender on blood mineral concentrations of buffaloes..... 32

Table 3.8. Effect of gender on blood creatinine, AST, and ALT concentrations of buffaloes..... 33

Table 3.9. Correlations between BSC, carcass and meat values in females 34

Table 3.10. Correlations between carcass traits and serum components values in females 35

Table 3.11. Correlations between BSC, carcass and meat values in males 36

Table 3.12. Correlations between carcass traits and serum components values in males 37

INTRODUCTION

According to the records of FAO, it is estimated that the world population will reach 9-10 billion by 2050 and the food demand need will increase about 50% (FAOStat, 2019), 2019). Cattle are the primary source of red meat production worldwide, followed by pork, sheep, goat, and buffalo meat production (FAOStat, 2019).

The world buffalo population is estimated at 208 million head and distributed in 77 countries on 5 continents (Minervino et al., 2020).Asiancountries (India, Pakistan, and China) have more share of buffalo production (96.4%) while Africa (2.9%) (mostly in Egypt), Europe (Italy, Georgia, Romania,Bulgaria and Turkiye) and Latin America (Brazil, Colombia,Venezuela, andArgentina). Swamp buffaloes are evaluated for meat production and draught purposes while river-type buffaloes are used for milk production (Hegde and Abdullah-Al-Zabir, 2019). There are 72 types of buffalo breeds in the world, 57 of which are living in Asia (Yilmaz Adkinson and Konca, 2021a). The number of buffaloes in Turkey is 178397 heads and the amount of milk obtained is about 80 thousand tons (FAOStat, 2019). The amount of meat obtained from buffaloes in the world was reported as 4290212 thousand tons, and buffalo meat production in Turkey in 2000, 2010, and 2019 was reported as 4047, 3387, and 73 tons, respectively (FAO, 2021). However, although a serious decrease was reported in the amount of buffalo meat produced in Turkey in 2019, considering the total buffalo presence, it is thought that the number of slaughtered buffaloes is incorrect because it is processed as beef in agricultural statistics.

Buffaloes are very suitable animals for feeding under unsuitable conditions than other animal groups and have high disease resistance, and herd management flexibility, so,they have advantageous traitscompared to cattle breeding (Wanapat and Kang, 2013). Buffaloes’productive life is longer than other species such as cattle and sheep (Banerjee, 1998).

However, due to some aggressive behavior traits, less milk production(Yilmaz Adkinson and Konca, 2021a)and lower growth rate and dressing percentage(Yilmaz Adkinson and Konca, 2021b;Guerrero-Legarreta et al., 2020)of buffaloes have negative aspects of them(Soysal, 2014). Buffaloes have not been considered sufficient attention and breeding and feeding studies have not been carried out like other animals(Barile, 2005). However, buffaloes show better growth rates than cattle in hot and harsh tropical climates and poor feeding conditions. Buffaloes are different from cattle due to their ability to digest lower quality feeds (Kennedy, 1995), their higher presence of protozoa in the rumen (Franzolin and Dehority, 1999) and the difference in rumen microorganisms and their potential to degrade lignin(Zhong et al., 2021). However, it is emphasized that when buffaloes' negative feeding and housing conditions are corrected, their long birth intervals, low performance and breeding conditions compared to cattle can be improved by correcting their negative conditions (Oswin Perera, 1999).

Inmost of the countries where buffalo production is widespread on the farm, older (end of the productive period) and culled buffaloes have been selected for slaughter and meat from them (Nanda and Nakao, 2003; Di Stasio and Brugiapaglia, 2021). InIndia, 85% of the buffalo meat is obtained from culled animals ofherds (Kiran et al., 2016).Therefore, most consumers described buffalo meat as dark red and undesirable color (Naveena et al., 2016). It is almost impossible to find buffalo meat on the sales shelves in markets in Turkiye, and butchers'reports and some papers(Soysal, 2014) stated that buffalo meat is mostly processed into products such as sausage, pastrami and salami and buffalo meat offered for slaughter at a lower price (usually 10-20% low)than beef and sheep(Yilmaz Adkinson and Konca, 2021b).

Some studies have reported that the tenderness of buffalo meat is like cattle meat and has advantages due to its low cholesterol concentration (Paleari et al., 1997). To show the quality and sensory traits of buffalo meat, studies beef meat and buffalo meat have been compared and many similarities revealed between them in terms of meat quality criteria and sensory attributes (Joksimovic and Ognjanovic, 1977;Neath et al. 2007; Tateo et al., 2007). It is stated that buffalo meat has physicochemical, biochemical, and technological properties comparable to beef (Kandeepan et al., 2009).Cruz-Monterrosa et al. (2020) reported that buffalo meats are better for health due to their low fat and cholesterol content and are suitable in terms of not causing cardiovascular and cerebrovascular diseases.

Fhaisol et al. (2021) determined the difference between the meat samples from buffalo, cattle, goat, and sheep and they found buffalo meat is leaner compared to these animals.

The negative aspects of buffalo meat (Nanda and Nakao, 2003) have been highlighted in studies conducted so far. However, in the studies conducted in Turkiye, it is observed that buffalo meat is sold instead of beef and sometimes even its sensory properties are emphasized compared to beef. Breed, genetics, breeding system, and slaughter age can affect meat quality and composition in animals (Joele et al., 2015). (Lapitan et al., 2008)indicated that at a younger age buffaloes have a good capacity to produce good-quality meat(Guerrero-Legarreta et al., 2020).

In this study, it was investigated the effects of age and gender on meat quality (dry matter, crude protein,crude ash, and crude fat, cooking and freezing losses, color, and pH) of Anatolian buffaloes slaughtered in Kayseri and surrounding provinces. Also, in buffalo blood serum, glucose, protein, lipid, and mineral profileswere determined.

CHAPTER 1

GENERAL INFORMATION AND LITERATURE REVIEW

1.1. Information on meat production

Meat is one of the basic foods for humans. It is among the recommendations of the World Health Organization (WHO) and scientists that half of the daily protein consumption of a healthy person should be of animal origin. It is thought that meat is a source of important essential nutrients, and it is necessary to benefit from this product with the increase in consumption. The fat-free nature of buffalo meat can increase its use in different products, and it is a good binder and suitable for the development of value-added meat products in the industry due to its dark red appearance (Naveena and Kiran, 2014).

Meat is the main food and it has a good and balanced nutritional quality, and its consumption increasing in developed nations at a 2.1% rate annually (Cruz-Monterrosa et al., 2020). According to the Food and Agricultural Organization (FAO, 2000), buffalo are a valuable resource that is "undervalued." Due to its lower fat, lower cholesterol, and other healthy qualities, buffalo meat has grown in favor in various locations in Middle and Southeast Eastern Asia, and Africa (Naveena and Kiran, 2014a).

There are approximately 208 million buffaloes in the world and more buffaloes are kept producing milk. At the same time, approximately 4.3 million meat (in 2019) obtained from buffaloes makes a significant contribution to this sector (Stasio and Brugiapaglia, 2021). However, its contribution to meat production is not stable since the meat obtained from buffaloes is from old animals selected from the herd. In addition, the meat from buffaloes is of poor quality because the color is dark red and not tender (Di Stasio and Brugiapaglia, 2021).Similarobservationswere made by Stasio and Brugiapaglia (2021)and they reported that buffaloes' meat mostly coming from aged animals towards the end of their working lives and to a lesser amount from young animals. As a result of this buffalo meat source quality parameters are lower than beef quality. Because buffalo

meat quality decreased animal age increased due to connective tissue increase (Kandeepan et al., 2013).

In a review, conducted by Yilmaz Adkinson and Konca (2021), it was determined that the amount of red meat production in the world was in a continuous increase when calculated based on 1980, and this increase increased by 36.6% in approximately 40 years. On the other hand, the rate of change in the amount of cattle, sheep, goat, and buffalo meat production between 1980 and 2019, respectively; 28.82%, 41.08, 134.54 and 89.26%. World buffalo meat production increased by 167% between 1980 and 2019, with a similar increase of 204.66%, 162.97, and 414.68 in Africa, Asia and Europe, respectively. In Turkey, buffalo meat production increased by 7.36% between 1980 and 1990, but this change resulted in a 99.32% decrease in 2019 compared to 1980 (Adkinson and Konca, 2021).

One of the crucial factors negatively affecting buffalo production is the low carcass yield percentages. The slaughter yield of river buffaloes 50-55%in swamp buffaloes 48-49%,andin Chinese binlangjang buffaloes 52-55%and the carcass yield of buffalo decreases with the increase of age (Li et al., 2018). Cattle's carcass yield is about 50-55% (Duru and Sak, 2017) and buffaloeshave similar carcass yield. On the other hand,Irurueta et al. (2008) reported that according to the USDA cattle carcass characteristics scale, buffalo carcasses have lesser eye muscle area and less marbleization than cattle carcasses.

Giuffrida-Mendoza et al. (2015) reported that the percentage of fat and cholesterol in fresh muscle in buffalo and Brahman cattle species did not differ between species and slaughter age. In addition, it has been shown that buffalo calves grown in intensive conditions with good quality feeds containing sufficient protein and energy can gain a body weight of around 0.9 to 1.0 kg per day (Ranjhan, 2013). In a study, they reported that when buffalo calves were slaughtered at 300, 350, 400 and 450 kg live weights, the boneless meat ratio ranged from 36.6 to 39.0%, and the bone ratio ranged from 9.3 to 11% (Rashad et al., 2019). Studies have indicated that feeding methods and slaughter age (20 to 34 months) do not significantly affect the tenderness and palatability of buffalo meat and have shown that it is similar to cattle slaughtered at close age (Charles, 1982).

In freshbuffalo meat myoglobin content variesfrom 2.7 to 9.4 mg/g depending on animal age and muscle type, and the meat becomes darker with age (Valin et al., 1984). Irurueta

et al. (2008) reported that meat redness (a*) rangesbetween 12.0 and 20.0 for buffalo meatsof different ages. Buffalo meat is dark red, and oil is white and hard (Joksimovic and Ognjanovic, 1977). Abdolghafour and Saghir (2014) reported that the dark red color of buffalo meat is due to less intramuscular fat or more pigmentation.

Although the nutrients it contains are important in the choice of red meat, however, the color and brightness of the meats areamong the important factors affecting consumer's purchasing preferences(Banović et al., 2009; Saleem et al., 2021). In addition, sensory characteristics such as firmness, juiciness, smell, and flavor after purchase also affect meat purchase preferences (O'Quinn et al., 2018).

Considering the slaughter age in buffaloes, it has been shown that young buffalo's meat may be lighter in color and their meat quality characteristics may be higher than older(Kandeepan et al., 2013; Ilavarasan et al., 2016). Buffaloes, which are used as pack animals, are sent to slaughter when they get old and lose their working ability (Tuyen and Ly, 2001) and in India, females with low reproductive performance and aggressive males over 6 years old are sent to slaughter and used for meat export (Eguienta et al., 2002). Today, buffalo meat is sold at a lower price than beef due to consumer habits and traditional thinking (Ly, 2001).

Because buffalo meat is like beef in terms of water-holding capacity (WHC), tenderness, and marbling (intramuscular fat distribution) (Lapitan et al., 2007), it can be sold as a substitute for beef. Buffalo meat is of superior quality due to its red color, low fat and cholesterol, low connective tissue, high protein, high WHC and emulsifying capacity (Kandeepan et al., 2013).

Since the pH value of the meat determines the color of the meat, it affects the purchasing preference of the consumers and while the consumers generally prefer normal red color of meat, and preference for dark red meat is low (Acebrón and Dopico, 2000). The chemical composition and quality characteristics of buffalo meat may change according to buffalo species and breed, age, nutritional density, management system, and environmental conditions (Abdolghafour and Ahmad Saghir, 2014), stress during slaughter and preservation of meat (Ziauddin et al., 1994). Valin et al. (1984) reported that the pH value and collagen amount of buffalo beef were lower than those of cattle, but there was no difference between species in terms of ligament collagen between muscles.

Ziauddin et al. (1994) reported that the presence of collagen in buffalo meat slaughtered at a young age is lower than in older buffaloes. Researchers have reported that the rate of cooking loss and thermal contraction in the muscles of older animals is higher than that of younger animals. Abdolghafour and Saghir (2014) suggest that buffalo meat is dark red, has good binding properties, and can be preferred in the manufacture of products. Buffalo meat can be used in the production of ready-to-eat products such as sausages because of dark meat has good binding properties(Anjaneyulu et al., 2007).

In a study (Spanghero et al., 2004), it was found that the colors of buffalo meats were darker red and softer than cattle (a*=redness: 23.7 vs. 18.8; breaking strength: 46.3 vs. 68.8 N for buffalo and cattle, respectively).

Turan et al. (2021) reported that male and female buffalo and ages lower than 2 and older than two years were evaluated. Older animal's hot and cold carcass weights were higher than young animals, however, young animals' meat color lightness (L*) and hook angle (H*) values were higher than older animals. Male buffaloes had lower redness (a*) meat color and chroma (C*) compared to female genders. In meat samples drip loss, shear force, and expressed juice did not affect gender and old of buffaloes.

Buffaloes are able to adapt to various farming methods, and with less competition from human nutrition can turn low-quality, high-fiber feedstocks into high-quality goods, including meat. Despite the weight growth and dressing percentages being relatively lower than in cattle, the meat is marked by greater nutritious qualities (low fat and cholesterol contents, high-quality protein, and unsaturated fatty acids). Additionally, using the right production techniques might enhance its sensory qualities. To address the growing need for food for human use, buffalo meat may be thought of as a good choice(Guerrero-legarreta et al., 2020). Additionally, understanding which gender and slaughter age produced meat of higher quality will help water buffalo farmers manage their output more effectively.

When compared to Anatolian water buffaloes' male and female buffalo carcasses characteristics with 10 carcasses from each gender(Ekiz et al., 2018a), investigated with the exception of warm carcass weight, which was 13% greater in males than in females. The final pH and lightness (L*) values of male water buffalo meat was greater than those of females, but the redness (a*) values were lower. In addition, the sensory qualities of

meat were unaffected by gender. In contrast to these results, Zardari et al. (2017) reported that gender had an impact on carcass quality; regardless of breed, males had a considerably greater dressing percentage than females. Males were also found to have a larger percentage of muscle (67.5% vs. 62.5%) and a lower percentage of fat (12.5% vs. 19.5%), although the percentage of bone remained unaffected (Abdallah et al., 1982).

The chemical composition of river buffalo meat is generally comparable to that of beef, according to research on the *Longissimus thoracis*etlumborummuscles. Total protein concentration varies from 19 to 24 g/100 g of meat, with younger animals having lower levels, which is associated with greater water content (Aziz et al., 2014;Li et al., 2018).

Meat quality characteristics of musculus*Longissimus dorsi thoracic* of male Anatolian buffalo were examined according to their slaughter weights (200 to 350 kg) and (Aksoy et al., 2021a) investigated that there were no obvious significant changes in the total cholesterol contents between the slaughter weight groups and higher protein content in the lower -weight group.

To determine the acceptability of the meat for creating processed meat products, the processing properties of the meat from young male, old male, and old female buffaloes were compared(Kandeepan et al., 2009). They reported that meat from young male buffalo that had been raised intensively had greater levels of moisture, collagen solubility, and water-holding capacity. Sensory evaluation of pressure-cooked meat pieces of old male and female buffaloeswas found to be noticeably tougher.

To compare the softness and other qualities of beef and water buffalo meat after postmortem aging (Neath et al., 2007) investigated that lactic acid levels showed the postmortem pH drop of buffalo meat was significantly slower than that of beef. According to this study, water buffalo meat was softer than Brahman beef, which may have been because of the different pH decreases and how it has an impact on muscle protease activity.

The mineral content variation according to species, age, and gender was determined using the longissimus dorsi thoracic water buffalo and cattle. Uzca and Rinco, (2007) reported that age had an impact on the mineral composition without any obvious patterns; at 24 MOA, the Na and K levels reseat weaning, buffalo longissimus dorsi thoracis showed

greater levels of K, Mn, Fe, Zn, and Cu (P 0.05). At postweaning ages, phosphorus concentration was greater.More than 25% of an adult's daily need for K, P, Fe, and Zn comes from meat from both species.

Buffaloescan survive even in regions where the production of other farm animals is not possible. However, this situation causes their care to be neglected constantly. Buffalo meat is sold at a lower price due to some negative perceptions, such as not being tasty, and having a tough and unpleasant odor. Therefore, it prevents sustainable water buffalo production with all the practices. However, studies show that buffalo meat has some superior properties and is healthy compared to beef. In Turkey, water buffaloes are not given as much care as cattle, and they are housed in unsuitable shelters and given low-quality feed. This situation may have negative effects on the productivity and health parameters of these animals. In field studies, it is observed that concentrated feed, vitamin, and mineral premixes are not given to buffaloes or given less. It is thought that unsuitable feeding can significantly adversely affect the blood components of buffaloes and worsen meat quality.El Debaky et al. (2019) noted that buffaloes are adapted to drought and provide highly nutritious meat, milk, and milk products such as yogurt, butter, cream, and cheese. In addition, their ability for disease resistance, longevity, milk and meat production and quality, fertility, heat tolerance, and better feed efficiency from poor quality feeds are unique and have big economic value. Uriyapongson, (2013)and Spanghero et al. (2004)reported that buffalo meat has less intramuscular fat and more pigment, therefore, it is darker in color compared to beef. Its protein content variesfrom 18 to 24% and fat 1 to 3% in meat and low triglyceride and cholesterol compared to beef. However, panelists' results showed that river buffalo meat was less acceptable than beef in terms of tenderness(Uriyapongson, 2013).

Bertoni et al. (2020) in some countries, cattle and buffalo are produced on the same farm. Buffaloes make better use of low-quality grasses or by-products than cattle. Among the significant disadvantages of buffaloes compared to cattle, the breeding season is seasonal. At the same time, the skin and epidermis of buffaloes are thin, their hairs are sparse, and they need a water source to protect themselves from the heat, but despite all this, they are more resistant to the effect of heat than cattle. Although milk production is low due to udder structures and the location of alveolus in their mammary glands, the incidence of mastitis is lower than in cattle (Bertoni et al., 2020).

Saleem et al. (2021) noted that 18 months old male fattening and two different buffalo breeds fed for 3 months (31 Nili-Ravi buffalo bulls (NRBB), and 35 male Kundhi buffalo bulls (KBB) were slaughtered in 150 and 149 kg live weights. M. latissimus dorsi, M. pectoralisdescendance, and *M. obliquusexternusabdominis* muscles were evaluated as collected sensory. At the same time, a survey was conducted with people who buy meat. According to the survey results, the first thing people pay attention to when purchasing meat is the color of the meat, and they prefer the color of the meat to be light. According to the results of the research, it was determined that the buffalo meat of the Kundi buffalo breed was more attractive than the Nili Ravi buffalo.

Naveena and Kiran, (2014b) reported that buffalo haveadvantages in terms of a good digestibility of poor-quality pasture, the adaptation ability to harsh climatic conditions, satisfy growth rate, disease resistance, and good increase ratio in body weight gain. The fact that buffaloes are well reared in adverse breeding and feeding conditions can cause them to provide a good income to farmers in rural areas, to provide good food, and to improve living conditions.

Fhaisol et al. (2021) compared the meat quality characteristics of buffaloes (24 months old) reared in farms with and without a health program after slaughter in different storage periods (1, 7, and 14 d). It was observed that the animal's meat with the health program had better WHC, however, drip loss and cooking loss were significant only at 14. day but generally insignificant.

Rodas-González et al. (2015) reported that a total of 132 male water buffalo and Brahman crossbred and purebred cattle (Brahman) were grown (similar age and fed condition and half of them castrated at 7 months age) and slaughtered at 7-, 17-, 19- and 24-months ages. According to research results, buffaloes get faster weight and heavier carcasses however low carcass yield (%) compared to Brahman cattle. In buffaloes, head, skin, and internal organ weight were high percentages. Also, in buffaloes back fat and fat ratio were higher percentage than in cattle. Back fat thickness and fat ratio in young animals were lower than in the aged ones. As the age increased, slaughter and carcass weight and carcass yield were higher.

One of the most important differences between buffaloes fed under the same conditions compared to beef cattle is that their live weight gains are low (930 g vs 1040 g/day) and

therefore they need to be fed for a longer time to reach the same weight. At the same time, the shorter carcass, excess carcass fat, low unsaturated fatty acids, high stearic fatty acid content, and dark meat color cause a decrease in meat quality. When compared in terms of sensory characteristics, it was determined that buffalo meats had a lower preference for beef (Spanghero et al. 2004). However, (Naveena and Kiran 2014b) reported that the red color of buffalo meats, such as low-fat content, provides an advantage in processing other meat products.

Roy et al. (2020)conducted a study to evaluate the performance and carcass quality of cattle (Pabna) and buffalo (Native, swamp type) fattened for 120 days, it was determined that the live weight and carcass characteristics of buffaloes were higher, but their carcass yields (52.1 vs 55.3) were lower. The meat-bone ratio was found to be better in cattle than in buffalo (5.33 vs 1.00), and it was determined that the color of buffalo meat was dark red, and this thickness increased with age. It was determined that the intramuscular fat rate (0.44 vs. 3.31%) and the marbling rate (3.85 vs. 5.00) were lower in buffalo meat compared to cattle. Researchers have reported that although the carcass yield of buffalo meat is lower than beef, it is superior in terms of marbling score, yield grade, and fat ratio.

Andrade et al. (2021)noted that in female buffalo meat via decreasing pH and glycogen content, rigor is formed earlier than the meat of male buffaloes (5-6 h vs 9-10 h, for female and male), the fat ratio is higher in male carcasses than females (1.41 vs 3.58%). and insoluble collagen (1.18 vs 1.58 mg g-1), but higher myofibrillar fragmentation (334 vs 295), soluble collagen (5.16 vs 20.38%), and shear force (39.38 vs 25.92 N) sarcomere length (1.65 vs 1.84 μm) were determined.

(Khan et al., 2021)reported that body condition score, pH, dry matter, crude protein, cooking loss, and drip loss of fresh meat, however, in buffalo meats lightness was lower and redness was higher than in cattle. In buffalo meat iron, crude ash, and high-density lipoprotein (HDL) contents were higher than in cattle meat, however, triglyceride was lower than cattle meat. In blood tests, there were no differences in total cholesterol, total triglyceride HDL, and low-density lipoprotein (LDL) content of serums. Researchers concluded that buffalo meat was better than cattle meat due to nutritive values and physiochemical properties.

(Ekiz et al., 2018b) reported that there was a significant difference between the gender of buffalo in terms of hot carcass weight and male buffalo's carcass were higher than female buffalo carcass. Gender did not influence carcass characteristics, except warm carcass weight, which was 13% higher in males compared to females. Male buffalo carcass lightness (L*) and pH of meat were higher than female carcass but lower redness of meat (a*) from females. There were no significant differences carcass measurements, expressjuice, Walterblatzer score, cooking loss, odor, tenderness, juice, fat colorparameters* and b* were not significant between the genders. Gender did not affect meat sensory characteristics. Meat from male water buffaloes had higher proportions of C14:0, C18:3 n-3, C20:2 n-6, C20:3 n-3 and C20:4 n-6 and Σn-3 fatty acids and lower Σn-6/Σn-3 ratio compared with female water buffaloes.

(Aksoy et al., 2021b) investigated effects of different slaughter weights (SWs) of Anatolian Buffaloes (n = 20). Anatolian Buffalo calves weaned 5-month ageswith a body weight of 100 kg and fed until 200, 250, 300, and 350 kg BW and slaughtered. The meat pH values at 24 h and color parameters (a* and b*) and WHC were not influenced by the slaughter weight (SW). The fat content of carcass wasincreased, and (PUFA)/ (SFA) rations decreased with the increase of slaughter weight. Meat total cholesterol was not influenced by SW. The authors decided that meat quality was better in slaughter timebuffaloes 200 kg BW (lowest) in terms of WHC, CP, and PUFA/SFA ratio.

(Camcı and Erdem, 2022) noted that buffaloes' slaughter age did not affect the carcass quality characteristics, however, the fattening period was effective on the carcass weight.

(Hassan et al., 2018)investigated that imported buffalo and beef meat (chunkmuscle) fromBrazil and India andresults showed that Indian-origin buffalo meat was higher in crude protein, total soluble protein, fat, and lower collagen solubility. Brazilian meats were good in appearance, juiciness, and tenderness scores according to sensory evaluation, and low shear force, a* value, and high L* values. However, there were no differences between the country of origin on TBA and fatty acid profile.

(Lapitan et al., 2008) compared the carcass and meat quality in crossbred cattle and crossbred water buffalo at the same younger age and fed with high roughage in the Philippines. A total of 20 animals (10 cattle and 10 buffalo) were evaluated at 22 months old. In water buffalo, SW was higher thanin cattle, and in buffalo dressing percentage

ratio was lower than in cattle. The lean yield was higher in cattle than in buffaloes. The fiber diameter of loin in buffalo meat was smaller than cattle. Regarding carcass and meat quality, the crossbred water buffalo was comparable or slightly superior to the crossbred cattle in tenderness, sensory score of color and flavor.

(Rébak et al., 2021) noted that slaughtered buffaloes with 12-15 months and 380 kg body weight were evaluated for carcass traits in Argentina. These buffaloes'meats contained 28.09% DM, 71.91%, CP, 1.94% EE, and 1.23% ash. In meat samples determined that 18.59% saturated and 81.4% unsaturated and77.34% monounsaturated and 4% polyunsaturated fatty acid.

(Juárez et al., 2019)compared bison (Bison bison), buffalo (Bubalusarnee), and yak (Bosgrunniens) meat species with beef cattle (Bostaurus and Bosindicus). The hardness of water buffalo and yak meat was increased by the increase of animal slaughter ages. There were some differences in meat color according to myoglobin concentration.

Mello et al. (2018) compared qualitative characteristics of the longissimus muscle from buffalo and cattle. For this purpose,40 Mediterranean × Murrah crossbred buffaloes and 40 Nellore cattle were evaluated. Animals were 21 months and had initial average body weights of 350 kg and 305 kg respectively and were confined for 102 days. Buffalo hada lower dressing percentagethan cattle (52.1 vs. 57.2%) and buffalo meat had greater fat cover (13.8 vs. 8.1 mm), and lower cooking loss (29.42% vs. 31.31%), cooling loss (1.3% vs. 1.8%), lower collagen content (4.81% vs 5.73%), and higher moisture (75.13% vs 74.55%) than cattle meat. No difference was observed between buffalo and cattle cold carcass weight, carcass meat fat, tenderness, and omega-6: omega-3 fatty acid percentage. The buffalo carcass provides a higher yield of cuts than beef meat and a lower ratioof PUFA polyunsaturated fatty acids, making it less susceptible to rancidity and buffalo meat is a rich source of C18:0 and C18:1n9c fatty acids to prevent cardiovascular diseases.

Canozzi et al. (2016)evaluated of sensory traits of buffalo and cattle raised at pasture. A nine-point hedonic scale was used to assess odor, color, tenderness, succulence, and overall appearance betweencattle and buffaloes. Authors found that Brangus cattle and buffaloes meat'stenderness is better than Angus cattle.

Valin et al. (1984)compared buffalo and cattle meat and a higher proportion of fat was observed in buffaloes than in cattle. Buffaloes' muscle pH value was lower than cattle and a smaller amount of collagen in the muscles.

Gecgel et al. (2019)evaluated that buffalo meat from different locations in Istanbul Turkiye. They noted that the slaughtered male buffalo's average age was 24 months and live weighed between 420 to 440 kg. They found that wide range in pH (5.03 to 5.46), moisture (48.60 to 59.73%), protein (15.12 to 17.65%), fat (18.90 to 30.02%), ash (2.48 to 3.56%),color parameters L* (24.38 to 33.50), a* (9.88 to 13.81), and b* (5.66to 8.53) were found in meats. The fatty acid composition changed in a wide range too, with total SFAs (40.73 and 60.28%), total MUFAs (38.32 and 55.15%), total PUFAs (1.34 and 4.46%), and total UFAs (39.72 and 59.27%).

1.2. Influences of different diets on buffalo meat quality

Feeding is one of the crucial factors affecting carcass characteristics in animals. The fact that the feeds are high in energy can cause more fat storage in the carcass and increase the tenderness of the meat due to its fatness. At the same time, it can be effective in the purchase of meat and the processing of meat and other products, due to the fact that the colored substances in the feed are transported and stored with oil.

Junior *et al.*(2017)assessed meat quality characteristics of Twenty-four Murrah buffaloes (8 to 10 months and BW 300 kg) fed 125 days with different ratios of cactus pear cottonseed completely replaced inconcentrate diet (0, 33, 66, and 100% ratio based on total DM of the diets). Consequently, Warner-Bratzler Shear Force and color indexes were reduced. At the same time cooking loss, WHC, pH at 0 and 24 h post-mortem, and dry matter, crude proteinlipid, and minerals were not influenced by cactus pear+cottonseedreplacements. In conclusion, the authors foundthat feeding cactus pear+cottonseed completely replacing high concentrate diet enhances the color index of meat without altering the sensory characteristics of meat.

Batista et al. (2020) evaluated the carcass and meat quality of four groups of Murrah buffaloes fed (0, 250, 500 or 750 g/kg) a dry matter of a 3: 2 blend of spineless cactus-cottonseed for 125 days and weighed 287.8 ± 1.8.As a result color index and fat ratio of meat were significantly raised, in contrast, the shear force was reduced ($P \leq 0.05$).In the

end, the researchers decided that replacing the high-concentrate diet with the spineless cactus and cottonseed did not have any negative impact on the desirability of the meat, and was accepted as averagely liked in addition it enhanced the fat content, tenderness, and color index of the meat.

Contò et al. (2022) reported that feeding of male buffaloes with corn silage (CS), polyphote hay (PH), and pasture (PA)and slaughtered at 250 kg of weight and evaluatedfeeding effect on carcass and meat quality. Feeding withthe PA group had a higher meat ratio compared to the CS group (60.59% vs. 58.46%, respectively) fat ratio waslower than the CS group and redness and shear force were higher than the CS group. However, feeding with CS had lower levels of FUFA, and n-3 ratio.

Iommelli et al. (2021)examined the impact of two diets on meat quality of 6-month-old buffalo bulls (n 20) that wereslaughtered at a weight of 400 kg. The authors noticed that statistically there were no differencesbetween the two diet groups in terms of chemical composition and fatty acid profile of longissimus dorsi muscle.In addition,it is recommended that further specific investigations should be accomplished on the activation of different diets to the metabolic pathways of buffaloes.

Azmi et al. (2021)showed that the diet with bypass fat had higher carcass weights, meat: fat ratio, pH at 24 h, moisture and crude protein of LTL, ST and SS than concentrate feeding. There were some differences in in bypass fat and concentrate feeding of buffaloes (Murrah and swamp buffalo) in terms of hot and cold carcass weight, and total fatty acid, and reduced levels of ash of LTL and CP of LTL and ST were observed in Murrah cross when compared to swamp buffaloes.

de Albuquerque Borges et al. (2022)replaced spineless cactus with wheat bran in the diet that was divided into four groups at increasing levels (0%, 33%, 66%, and 100%) and applied to twenty murrah buffaloes at 18 months of age that was weighted 292.9±57.3 kg and slaughtered after 90 days to evaluate its effect on buffalo meat characteristics. As a result, the increasein the cactus levels caused a significant decrease in hot and cold carcass weight, however, it did not change the quality of meat and the control treatment, and the 33% replacement level showed no discernible variation. Therefore,it declared that it is possible to substitute wheat bran with spineless cactus up to 33% in sugarcane-based diets for buffaloes without changing the quality of the meat.

Cifuni et al. (2014) determined theeffects of feeding with alfalfa and corn silage of male Italian Mediterranean buffaloes (246 kg live weight) on meat quality, and fatty acid profiles of buffalo meat for 368 days. The authors did not notice any difference between the groups in live and carcass weight. On the otherhand, diets had a significant effect on meats' chemical composition. Animals fed with maize-silage had meat with higher fat content compared to AH. Consequently, leading to a lower ratio of polyunsaturated to saturated fatty acids which is not as good for human health compared to the meat from animals fed the AH diet.

Gómez et al. (2020) studied the addition of vitamin E and its impact on growth performance and meat quality of 15 male Murrah buffalo calves weighed 194.0±0.64 kg and aged 14–15 months and slaughtered at weight of 350 kg. Animals divided into three groups according to supplement (0, 300 and 600 IU vitamin E (α-tocopherol acetate).

1.3. Animal age and meat quality

Slaughtered animal age is one of the most effective factors on meat quality. As the age of the animal increases, the hardening of the meat, the hardening of the collagen layers, the increase in breaking strength, the decrease in the water-holding capacity and the darkening of the color of the meat are among the causes of negative factors (). The slaughter age of buffaloes coincides with advanced ages. In countries such as India and Pakistan, where buffalo production is widespread, buffaloes are slaughtered at advanced ages at the end of the yield period. This naturally causes low-quality meat of buffaloes to be produced. On the other hand, in beef production, intensive fattening is applied after weaning and male cattle are sent to slaughter at a younger age than buffaloes. As a result of this, there is a softer sensory perception ofbeef, and it is mentioned that hard meat is in buffaloes. In countries where water buffalo production is less, such as Turkey, water buffalo meat is not included in the malaria sections, it is either sold under the name of beef or used as another product in the production of beef products. Since buffalo meat is not directly sold, many people do not know enough about the taste and appearance of buffalo meat.

Ilavarasan et al. (2016)investigated buffalo age (young, 12-8 months, and adult above 3 years) on quality traits and nutritional value of the meat of Toda buffaloes. The authorsdetermined that young buffalo meatsampleswere higher than older buffaloes. In

young buffalo meat ’slightness (L*), yellowness (b*), moisture, essential amino acids, fatty acids such as linolenic acid, linoleic acid, eicosatetraenoic acid (EPA), docosahexaenoic acid (DHA), total MUFA, total unsaturated fatty acids (UFA), total SFA and cholesterol ratios were better than adults. The authors concluded that young buffalo (12-18 months) meat quality is better than older animals above 3 years old.

Li et al. (2018) aimed to evaluate the effects of age on dressing and meat % percentage, and physical and chemical characteristics of biceps femoris and longissimus dorsi muscles. So, from Binlangjangbuffaloes, 20 adult bulls, 57 reserve bulls, 22 suckling,and 41 weaned calveswere selected and slaughtered. It is determined that slaughter and meat quality traits obviouslychange with age. Carcass yield decreased by increase of age (from 54.93% to 51.22%). However, carcass meat yield and meat percentage showed an increase in age (62.95–75.34%vs. 34.58–38.59% respectively). Backfat thickness, marbling, and rib eye area increased with age. Meat dry matter content was low at birth, and then gradually significantly increased. The meat protein, fat, cholesterol and inosine acid were changed for 3 and 12 months. The authors recommended that slaughter age after 24 months is suitable for slaughter performance and meat quality parameters.

Holló et al., (2014)showed that male calves that were reared roughage until slaughter and weighed 196.0 kg. Asthe result indicated the pH, color,protein, fat, and ashwere found to be non-significant in addition longissimus muscle had low intramuscular fat and high variation between 0.3–1.1 %.

Appa Rao et al. (2009)investigated the age effect on buffalo meat quality and compared it to meats of buffalo slaughtered at different ages (6 months to 2 years, 2 to 4 years, and above 4 years). In male buffaloes’ meat’schroma and water-holding capacity values are higher than females. The shear force value of the buffalo meat increased with increasingage.The tenderness, juiciness, and general acceptability of meats of buffalo slaughtered at 2 to 4 years old were better than others.

Valin et al. (1984) reported that buffalo has bigger head and skin weight that cattle. Also a higher ratio of fat in 11th ribs of buffaloes than of cattle. Buffalo meat’s pH24 values were lower than cattle meat pH24.

1.4. Management practice on meat quality

Higher moisture content, water holding capacity, collagen solubility, sarcomere length and myofibrillar fragmentation index were determined in the meat of buffaloes raised under intensive conditions. a decrease in quality was observed (Kandeepan et al. 2013).

Joele et al.(2017) compared two rearing systems of buffaloes (the traditional system (TS) and the Traditional + Silvopastoral System (TSPS)in Murrah and Mediterranean buffaloes. The findings showed that there were no significant differences between the rearing system in terms of meat physico-chemical traits of buffalo meats. However,the odor of buffalo meat reared in the TS system was favorable tothe TSPS system.

1.5. Body condition score and meat quality

Aslam et al. (2020) divided forty Kundi buffaloes into four equal groups according to their gender and body condition score (BCS),in order to study the impact of these factors onthe physical characteristics of meat. Sampleswere collected from trapezius cervicalis, *Longissimus dorsi*, and semitendinosus muscles. The findings revealed that *Longissimus dorsi* had the highest quality characteristics in each group**.** Inaddition, meat from male buffaloes and those with a BCS greater than 4 had higher quality traits when compared to the female buffaloes and those with a BCS between 1 and 4.Consequently,the authors declared that when considering meat quality and animal selection; gender and BCS can serve as useful factors.

1.6. Buffalo Meat product

Jaspal et al. (2021) studied wet aging of meat by evaluating its impact on meat quality traits of Longissimus lumborum (LL) and Gluteus Medius (GM) muscles of buffalo bulls. Six aging periods were established (0 day (d) = control, 7 d, 14 d, 21 d, 28 d, and 35 d) and physicochemical parameters were studied. The pH, color redness (a *), yellowness (b *) and cooking loss were raised, however, the lightness (L *) and hue angle (h *) values declined in all aging periods. To enhance meat quality traits of Longissimus lumborum (LL) authors recommended 28 days of aging and 21 days for Gluteus Medius (GM) muscle.

Therefore, in this study, changes in meat quality due to adverse conditions provided to buffaloes were examined and mineral deficiencies related to feeding in blood parameters were determined.

CHAPTER 2

METHOD AND MATERIAL

2.1. Material

Buffalo meat to be used in the research was obtained from slaughterhouses in Kayseri and its surrounding provinces. The meats and blood samples were brought to the laboratory with ice trays and meats. The initial pH values and color values were determined, and samples were taken for dry matter, cooking loss, thawing loss, and water holding capacity.

2.2. Methods

2.2.1. Determination of body condition score (BSC) of buffaloes

Buffalo animals brought from farms to the slaughterhouse for slaughter and kept in paddocks. Buffaloes were evaluated according to the following criteria's one hour before in slaughterhouse paddock via subjective evaluation by 2 people according to their body condition 8 parts. Body condition score of buffalos were determined according to 5 scoring system as it: score 1: indicates emaciated, 2: indicates thin, 3: indicates average, 4: indicates fat and 5: indicates obese condition. Eight skeletal check points were examined and merits within each area were used to indicate the body condition according to (Anitha et al., 2011).

2.2.2. Determination of hot carcass (HC) weight of buffaloes

To determine the HC weights of buffaloes, animals were slaughtered and head, feets, skin and internal organs removed and weighted with electronic balance, and recorded their weights.

2.2.3. Meat sampling

In a commercial slaughterhouse, hot carcasses of buffalos were taken directly to the resting and cooling rooms at 4 C, and after being kept there for 24 hours, 250 get samples were taken from the *Longissimus dorsi thoracic* muscle by vertical section, placed in numbered bags and transferred directly to the laboratory. pH and color measurements were made immediately in the laboratory, and shell oil thickness was recorded. Subsequently, samples were taken for further analysis and direct measurements and analyzes were made.

2.2.3. Chemical analyses of meat samples

Proximate analyses of *Longissimus dorsi thoracic* muscle such as moisture, total nitrogen, crude fat, and ash were done according to the Association of Official Analytical Chemists (AOAC, 2013).

In the study, 10 samples of each gender and at least 5 samples from each of the buffaloes from different age groups were taken according to their availability. Samples were taken from the waist (from the *Longissimus dorsi* muscle) meats.

To determine meat quality traits, about 250 g samples were cut from the *Longissimus dorsi thoracic* (LT) muscle at the level of the 13^{th} thoracic vertebra. The ultimate pH and color measurements were performed at 24 and 48 hours after slaughter. To determine pH, the probe was inserted into the center of the breast muscle, 0.5 to 1 cm below the surface of the muscle, and then the ultimate pH value was read when the probe was stable.

2.2.3.1. Determination of dry matter of meat samples

After weighing 5 g of the meat samples, they were dried in a drying oven at 70 °C for 72 hours and weighed again. The KM ratio was determined by calculating the percentage difference between the initial weight and the final weight of the meat.

2.2.3.2.Determination of crude protein of meat samples

The total nitrogen content of meat samples were determined by Velp-Dumas equipment (Italy) and protein content was calculated as nitrogen × 6.25.

2.2.3.3. Determination of crude fat

The oil in the feed was extracted using petroleum ether by the Soxhlet method by Velp fat extractor (Velp™ Scientific SER148/6 Solvent Extractor) and calculated as its %.



Figure 2.1. Fat extraction machine

2.2.3.4. Determination of crude ash

The dried (in DM) meat samples were weighed and burned at 550 °C for 5 hours in ash oven (Protherm Furnaces, Turkiye). The crude ash ratio was determined by calculating the percentage difference between the initial and final weights.

2.3. Determination of meat color of meat

After keeping the carcass for 24 hours, after measure pH (Thermo Orion Scientific, USA), meat's brightness (L*), redness (a*), and yellowness (b*) were determined by color meter (Konica Minolta CR-400, Japan).

2.4. Subcutaneous fat thickness, mm

Subcutaneous thickness was determined by measuring the thickness of fat remaining in the upper part of the carcass muscle with a digital caliper.

2.5. Determination of cooking loss of meat samples

Cooking loss of meats (3 replicate each) was determined according to Honikel (1998). According to method, freshly cut meat samples (50 mm thick) weighed (initial weight) and put in a thin plastic bag and placed in a continuously hot water-bath and cooked with internal temperature reach 75°C for 30 min. Then meat samples cooled for 30 min in laboratory and meat taken from nylon bags and blotted dry and re-weighed. The cooking loss is expressed as a percentage of the initial sample of meat weight.

2.6. Determination of meat thawing loss

Thawing loss of meats (3 replicate each) was determined according to Honikel (1998). According to the method, freshly cut meat samples (50 mm thick) weighed (initial weight) and put in a thin plastic bag and placed in a freezer -20 °C for 24 h. Then meat samples take out from freezer and melted for 1 h and blotted dry and re-weighed. The thawing loss is expressed as a percentage of the initial sample of meat weight.

2.7. Determination of fatty acid composition of carcass fat

The fatty acid profile of the samples taken from the belly fat in the carcass was determined in a gas chromatography device (Shimadzu CS 2010) according to the instructions specified in the catalog.

2.8. Determination of blood analyses

Blood samples were collected from the veins of slaughtered animals during the bleeding time. The blood samples immediately were brought to the laboratory and separated their serum via centrifuge at 2500 g for 5 min. Serums were put in a -80 freezer until analysis day. In serum samples, glucose, protein-lipid, and mineral profiles were determined in the laboratory by auto-analyzer with using commercial kits.



Figure 2.2. Blood serums separation

2.9. Statistical analysis

In the study, data from male and female buffaloes were evaluated in two ways. For carcass and meat physico-chemical properties, a multiple comparison test was carried out in a randomized trial design with the One Way Anova procedure using the SPSS program (version 22, IBM Co., USA). Duncan test was applied to determine the differences between the averages. The significance level was considered $P>0.05$.

In addition, the correlation tests were conducted separately for males and females for the relationships between carcass values and meat characteristics, and related parameters determined in meat components and blood.

The results of statistical analysis were presented as mean values and standard error of means in the tables.

CHAPTER 3

RESULTS

This experiment was carried out to evaluate the effect of gender and age on buffalo meat quality and physicochemical traits. The data were summarized below.

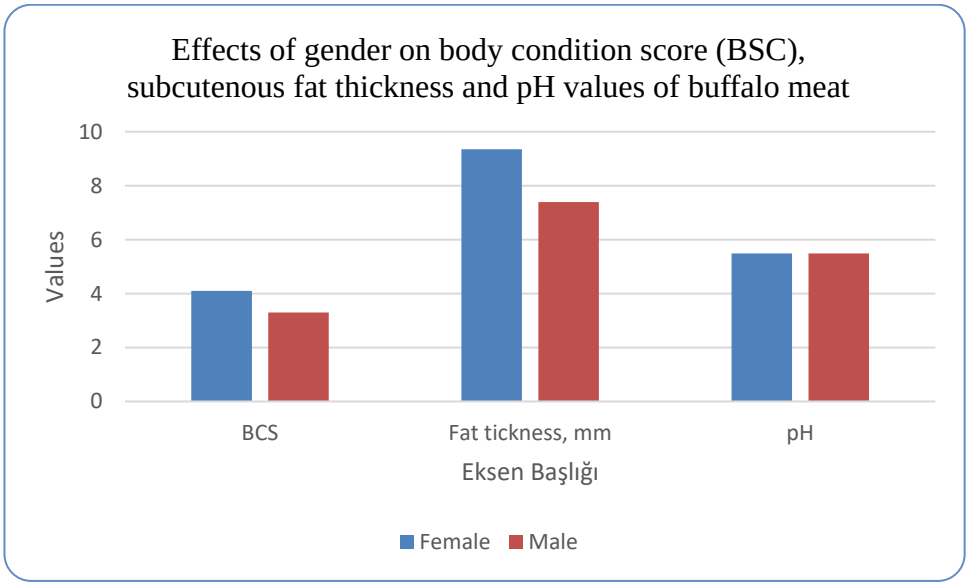
3.1. Buffalo carcass and physico-chemical composition of L*ongissimus dorsi thoracic* meat

Effects of gender on body condition score (BSC), fat thickness, and pH values of *Longissimus dorsi thoracic* (LDC) samples are given in Table 3.1. Differences in BCS between females and buffalo sent to slaughter were significant and BSC was higher in females than males ($p<0.05$). There was no significant difference between buffalo breeds in terms of hot carcass weights, carcass subcutaneous fat thickness, and meat pH at 24 hours.

Table 3.1. Effects of gender on body condition score, fat thickness, and pH values of L*ongissimus dorsi thoracic* muscles

Gender	BCS	Hot carcass weight, kg	Fat thickness, mm	pH
F	4.0±0.17a	244.33±09.08	9.35±0.52	5.49±0.03
M	3.0±0.15b	211.30±014.32	7.39±0.47	5.49±0.04
Av.	3.5±0.16	238.43±08.16	9.01±0.45	5.49±0.03
P	0.042	0.123	0.096	0.917

[a,b]: Differences between means with different letters in the same column were found to be statistically significant. F: female, M: male, P: probability, BCS: Body condition score.

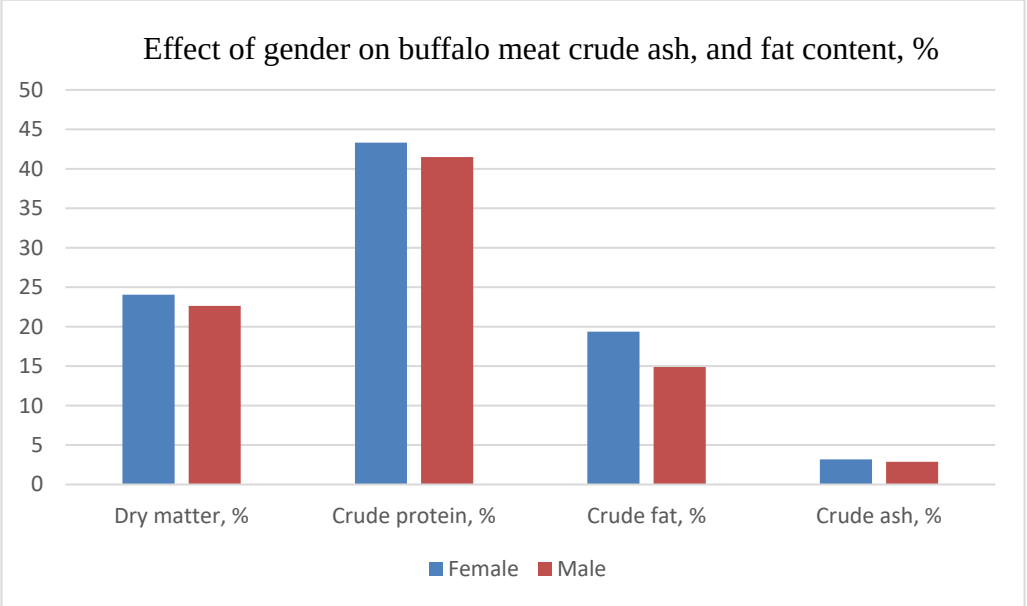


Differences in terms of effects of gender on *Longissimus dorsi thoracic* meat dry matter crude protein, crude ash, and fat content ratio (%) are given in Table 3.2. Although the fat percentage in the meat of female buffaloes was numerically higher than that of males, it was not found to be statistically significant. Crude ash values in meat samples were significantly higher in females than in males (P<0.05).

Table 3.2. Effect of gender on *Longissimus dorsi thoracic* muscle crude ash, and fat content, %

Gender	Dry matter, %	Crude protein, %	Crude fat, %	Crude ash, %
Female	24.05±0.59	43.32±1.00	19.36±2.73	3.18±0.16a
Male	22.63±0.56	41.49±2.05	14.89±4.26	2.87±0.45b
Av.	23.80±.50	43.01±0.90	18.57±02.36	3.12±0.17
P	0.287	0.453	0.479	0.523

[a,b]: Differences between means with different letters in the same column were found to be statistically significant. F: female, M: male, P: Probability

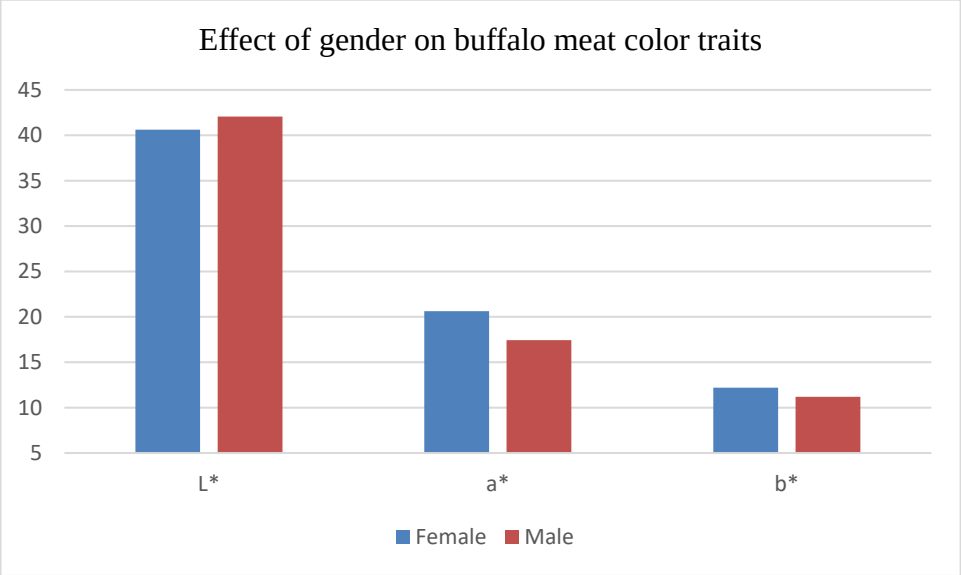


The effect of gender on the *Longissimus dorsi thoracic* meat samples' meat color traits is presented in Table 3.3. The *Longissimus dorsi thoracic* meat samples of male and female buffaloes' L*values were not different. However, the redness value (a*) of meat in females was found to be statistically significantly higher than in males ($P<0.05$). The differences in terms of blindness value (b*) determined from *Longissimus dorsi thoracic* meat samples of male and female buffaloes are not significant.

Table 3.3. Effect of gender on *Longissimus dorsi thoracic* muscle color traits

Gender	L*	a*	b*
Female	40.62±01.17	20.63±0.67	12.20±0.32
Male	42.07±0.60	17.44±01.08	11.19±0.58
Av.	40.88±0.97	20.07±0.62	12.02±0.29
P	0.578	0.046	0.180

[a,b]: Differences between means with different letters in the same column were found to be statistically significant. F: female, M: male, P: probability, L*: lightness, a*: redness, b*: yellowness.

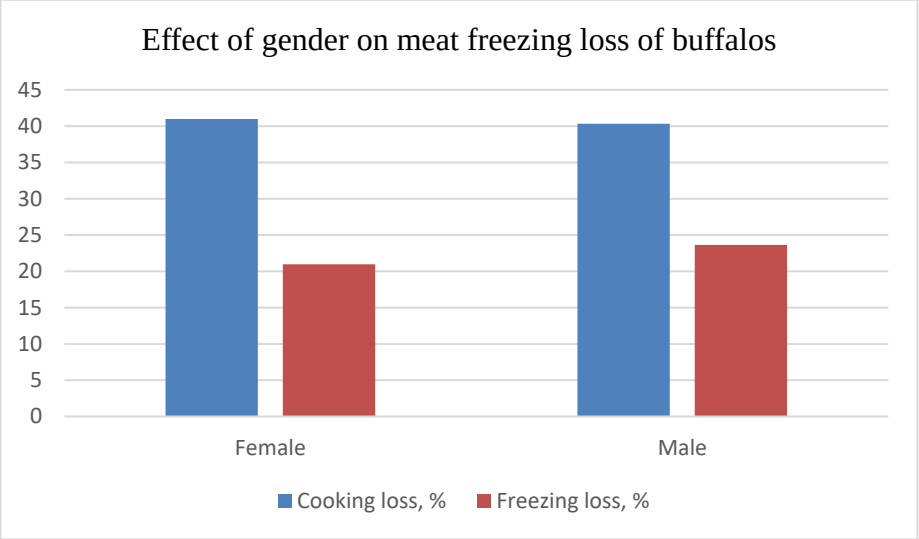


The effect of gender on *Longissimus dorsi* thoracic meat cooking loss and freezing loss of buffaloes are given in Table 3.4. No significant difference was found in terms of cooking and thawing losses of buffalo meats in terms of female and male genders (P>0.05).

Table 3.4. Effect of gender on *Longissimus dorsi thoracic* muscle cooking loss, freezing loss of buffaloes

Gender	Cooking loss, %	Freezing loss, %
Female	40.99±0.95	20.97±04.76
Male	40.34±01.74	23.65±08.07
Av.	40.87±0.83	21.44±04.13
P	0.770	0.809

F: female, M: male, P: Probability



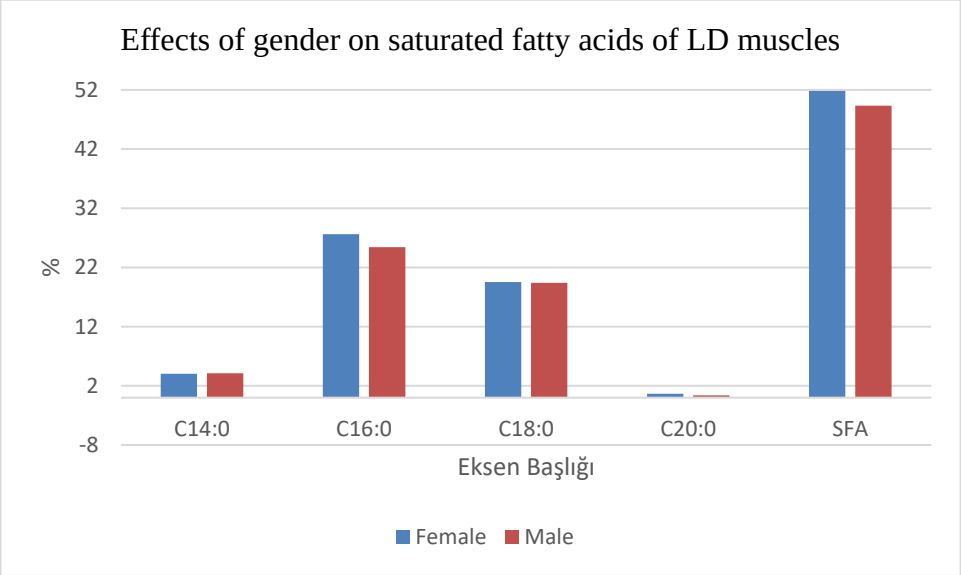
3.2. Buffalo L*ongissimus dorsi thoracic* meat fatty acid composition

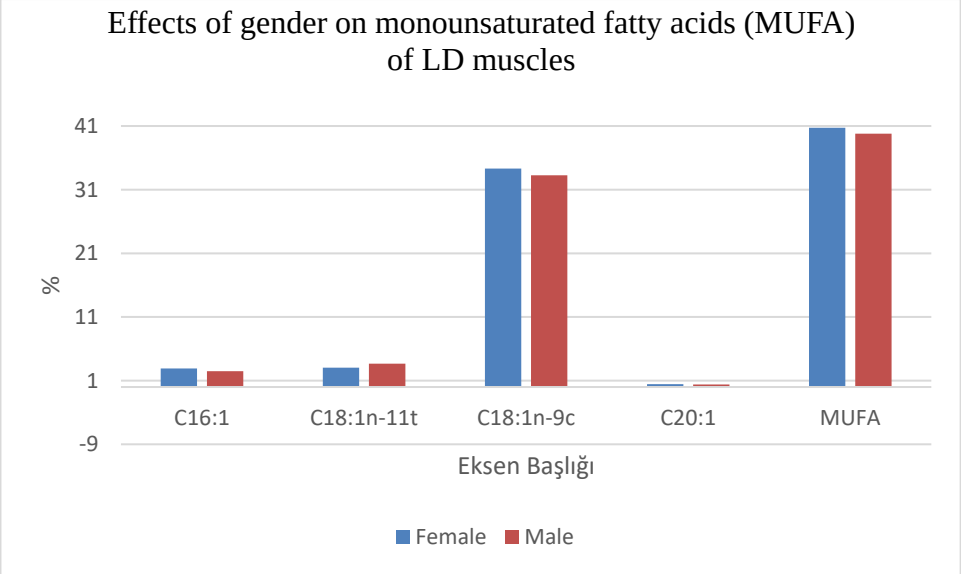
The effects of gender on *Longissimus dorsi thoracic* on the meat fatty acid composition of buffaloes are presented in Table 3.5. There were no statistical differences between the female and male buffaloes in terms of meat fatty acid composition (P<0.05).

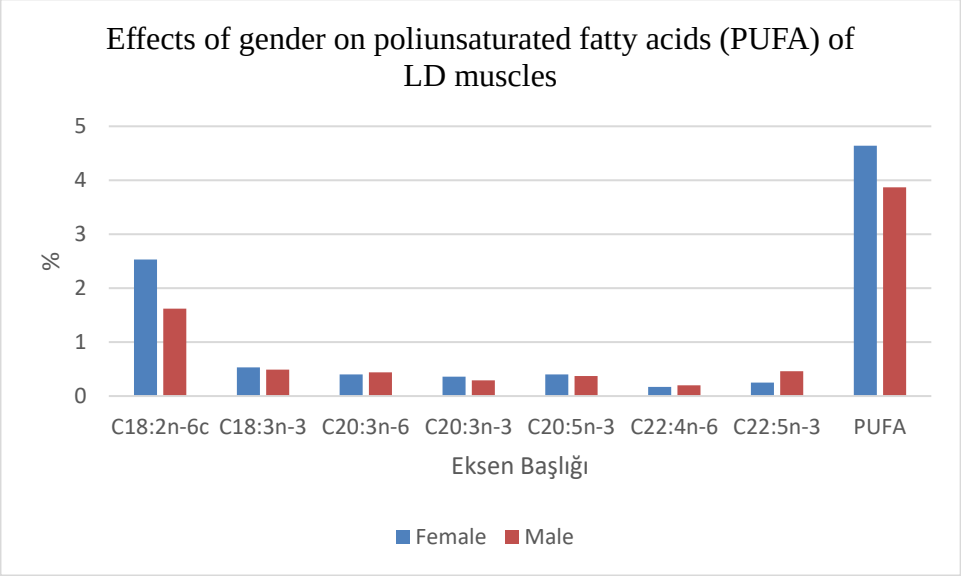
Table 3.5. Effect of gender on *Longissimus dorsi thoracic* muscle fatty acid composition of buffaloes (% of total fatty acids)

Fatty acids	Female	Male	Average	P
C14:0	4,04±0.70	4.12±11.48	4.07±0.65	0.957
C16:0	27.61±61.63	25.42±42.17	26.92±91.30	0.448
C16:1	2.91±9.39	2.48±4.48	2.78±7.30	0.531
C18:0	19.53±51.70	19.40±42.66	19.50±51.40	0.971
C18:1n-11t	3.05±0.53	3.67±61.22	3.24±2.49	0.589
C18:1n-9c	34.31±33.16	33.25±22.73	34.07±02.50	0.867
C18:2n-6c	2.53±5.40	1.62±6.29	2.27±2.31	0.188
C20:0	0.65±6.14	0.40±4.07	0.57±5.10	0.267
C20:1	0.45±4.05	0.39±3.12	0.43±4.05	0.615
C18:3n-3	0.53±5.13	0.49±4.11	0.52±5.08	0.812
C20:3n-6	0.40±4.12	0.44±4.11	0.42±4.08	0.818
C20:3n-3	0.36±3.09	0.29±2.10	0.34±3.07	0.592
C20:5n-3	0.40±4.18	0.37±3.14	0.39±3.12	0.918
C22:4n-6	0.17±1.06	0.20±2.11	0.18±1.05	0.849
C22:5n-3	0.25±0.09	0.46±0.23	0.32±0.95	0.329

F: female, M: male, P: Probability


Effects of gender on saturated fatty acids of LD muscles
52
42
32
22
12
2
-8
%
C14:0
C16:0
C18:0
C20:0
SFA
Eksen Başlığı
Female
Male


Effects of gender on monounsaturated fatty acids (MUFA) of LD muscles
41
31
21
11
1
-9
%
C16:1
C18:1n-11t
C18:1n-9c
C20:1
MUFA
Eksen Başlığı
Female
Male


Effects of gender on poliunsaturated fatty acids (PUFA) of LD muscles
5
4
3
2
1
0
%
C18:2n-6c
C18:3n-3
C20:3n-6
C20:3n-3
C20:5n-3
C22:4n-6
C22:5n-3
PUFA
Eksen Başlığı
Female
Male

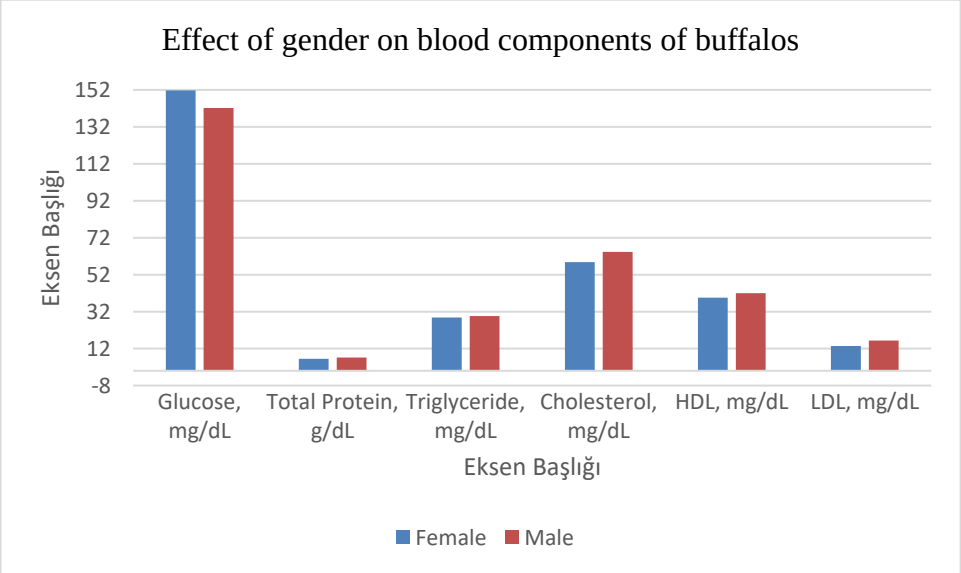
3.3. Buffalo blood components

The effects of gender on the blood components of buffaloes are given in Table 3.6. Differences in glucose, triglyceride, cholesterol, LDL, and HDL values in the blood of male and female buffaloes were not found to be significant (P>0.05), however, serum total protein values in males were found to be statistically significantly higher than in females. (P<0.05).

Table 3.6. Effect of gender on blood components of buffaloes

Item	Glucose, mg/dL	Total Protein, g/dL	Triglyceride, mg/dL	Cholesterol, mg/dL	HDL, mg/dL	LDL, mg/dL
Female	151.76±15.42	6.46±.26b	28.86±1.69	58.81±3.19	39.60±2.54	13.44±1.20
Male	142.21±13.89	7.17±.21a	29.63±1.62	64.32±3.00	42.03±2.00	16.36±1.45
Av.	147.23±10.34	6.80±.18	29.23±1.16	61.43±2.22	40.76±1.63	14.83±.95
P	0.651	0.041	0.744	0.219	0.463	0.126

[a,b]: Differences between means with different letters in the same column were found to be statistically significant: female, M: male, P: probability HDL: high-density lipoprotein, LDL: low-density lipoprotein.

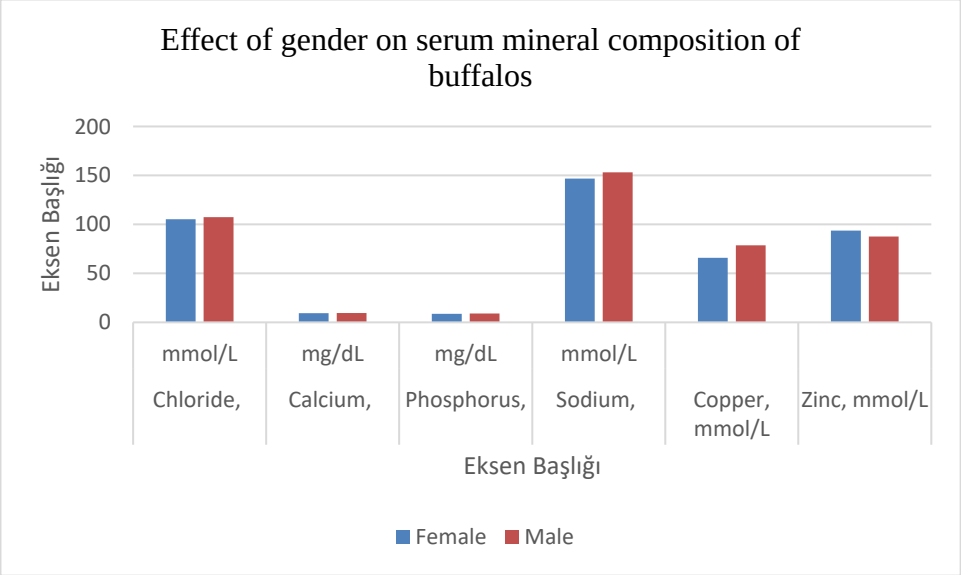


The effect of gender on the blood mineral concentrations of buffaloes is shown in Table 3.7. No statistically significant difference was determined in terms of blood chloride, calcium, phosphorus, and zinc in males and females. However, blood sodium and copper levels were statistically significantly higher in males than females (P<0.05).

Table 3.7. Effect of gender on blood mineral concentrations of buffaloes

Item	Chloride, mmol/L	Calcium, mg/dL	Phosphorus, mg/dL	Sodium, mmol/L	Copper, mmol/L	Zinc, mmol/L
Female	105.29±6.84	9.35±0.19	8.68±1.20	146.76±.87b	65.95±2.54b	93.62±3.94
Male	107.42±5.64	9.54±0.22	9.08±1.04	153.16±2.36a	78.74±4.07a	87.68±2.53
Av.	106.30±4.42	9.44±0.14	8.87±0.79	149.80±1.30	72.03±2.53	90.80±1.99
P	0.813	0.519	0.805	0.012	0.010	0.138

[a,b]: Differences between means with different letters in the same column were found to be statistically significant. F: female, M: male, P: Probability

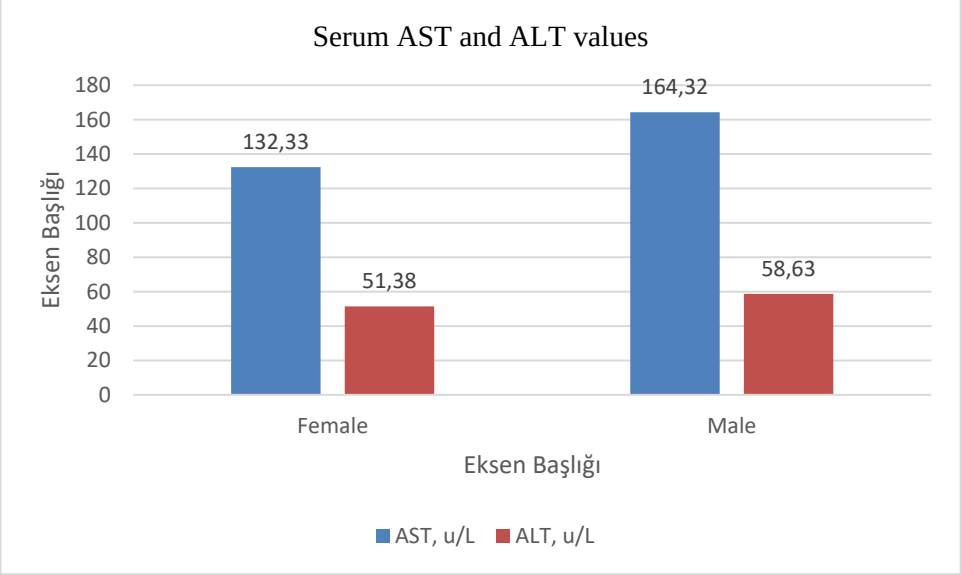


Effects of gender on blood creatinine, AST, and ALT concentrations of buffalo are presented in Table 4.8. Creatinine and AST values in female buffaloes were statistically significantly lower than in male buffaloes (P<0.01). Blood ALT values did not show a statistically significant difference between genders.

Table 3.8. Effect of gender on blood creatinine, AST, and ALT concentrations of buffaloes

Item	Creatinine, mg/dL	AST, u/L	ALT, u/L
Female	1.26±0.04b	132.33±7.99b	51.38±2.82
Male	1.60±0.09a	164.58±8.16a	58.63±3.77
Av.	1.42±0.06	147.65±6.20	54.83±2.36
P	0.001	0.008	0.127

[a,b]: Differences between means with different letters in the same column were found to be statistically significant. F: female, M: male, P: probability. AST: Aspartate aminotransferase, ALT:Alaninaminotransferaz.



3.4. Correlations between carcass traits and blood components

Correlations between BSC, carcass and meat values in females are given in Table 3.9. A significant relationship was found between body condition score and hot carcass weight (HC) ($P<0.05$), but a negative relationship was found between MDM. A significant correlation was found between subcutaneous fat thickness and HC ($P<0.05$). There were negative correlations between meat dry matter (MDM) and meat fat (MFAT) % and between MFAT and HC. Also there were negative correlations between meat protein (MPR) content and HC and between meat ash (MASH) content and HC and MPR.

Table 3.9. Correlations between BSC, carcass and meat values in females

		BCS	HC	FT	MDM	MFAT	MPR	MASH
BCS	P.Cor.	1						
	Sig.							
	N	21						
HC	P.Cor.	0.539*	1					
	Sig.	0.014						
	N	20	23					
FT	P.Cor.	0.430	0.453*	1				
	Sig.	0.052	0.030					
	N	21	23	28				
MDM	P.Cor.	-0.171	0.061	0.028	1			
	Sig.	0.458	0.783	0.886				
	N	21	23	28	28			
MFAT	P.Cor.	0.040	-0.230	0.105	-0.134	1		
	Sig.	0.865	0.291	0.595	0.496			
	N	21	23	28	28	28		
MPR	P.Cor.	0.211	-0.069	0.146	0.124	0.192	1	
	Sig.	0.359	0.753	0.458	0.529	0.329		
	N	21	23	28	28	28	28	
MASH	P.Cor.	0.251	-0.032	0.156	0.041	0.171	-0.197	1
	Sig.	0.272	0.885	0.428	0.835	0.383	0.315	
	N	21	23	28	28	28	28	28

*. Correlation is significant at the 0.05 level (2-tailed), BSC: body condition score, HC: hot carcass weight, FT: subcutaneous fat thickness, MDM: meat dry matter, MFAT: meat fat, MPR: meat protein, MASH: meat ash.

The correlations between carcass traits and serum components values in females are shown in Table 3.10. As can be seen from the table, negative correlations were found between meat fat content and serum triglyceride, total cholesterol, HDL and LDL. Significant positive correlations were detected between blood total cholesterol level and serum HDL and LDL levels (P<0.01). Different levels of correlations were detected among other criteria.

Table 3.10. Correlations between carcass traits and serum components values in females

		FT	MFAT	TRG	TC	HDL	LDL
FT	P.Cor.	1					
	Sig.						
	N	28					
MFAT	P.Cor.	0.105	1				
	Sig.	0.595					
	N	28	28				
TRG	P.Cor.	0.175	-0.161	1			
	Sig.	0.372	0.413				
	N	28	28	28			
TC	P.Cor.	0.328	-0.283	0.258	1		
	Sig.	0.089	0.145	0.184			
	N	28	28	28	28		
HDL	P.Cor.	0.325	-0.244	0.147	0.899**	1	
	Sig.	0.092	0.211	0.456	0.000		
	N	28	28	28	28	28	
LDL	P.Cor.	0.141	-0.182	0.090	0.658**	0.278	1
	Sig.	0.473	0.354	0.647	0.000	0.151	
	N	28	28	28	28	28	28

**. Correlation is significant at the 0.01 level (2-tailed).FT: fat tickness, MFAT, meat fat, TRG: serum trigliceryde, TC: serum total cholesterol, HDL: serum high density lipoprotein , LDL: serum low density lipoprotein.

The correlations between BSC, carcass and meat values in males are presented in Table 3.11. Unfortunately, negative correlations were determined between BSC and MDM, MPR, and MASH, and between HC and MDM and MASH. Additionally, negative correlations were found between FT and MFAT, MPR and MASH. However, a significant negative correlation was found between FT and MDM (P<0.05).

Table 3.11. Correlations between BSC, carcass and meat values in males

		BSC	HC	FT	MDM	MFAT	MPR	MASH
BSC	P.Cor.	1						
	Sig.							
	N	5						
HC	P.Cor.	0.818	1					
	Sig.	0.182						
	N	4	5					
FT	P.Cor.	0.601	0.784	1				
	Sig.	0.283	0.116					
	N	5	5	6				
MDM	P.Cor.	-0.655	-0.598	-0.893*	1			
	Sig.	0.231	0.286	0.016				
	N	5	5	6	6			
MFAT	P.Cor.	0.257	0.358	-0.171	0.425	1		
	Sig.	0.676	0.554	0.746	0.401			
	N	5	5	6	6	6		
MPR	P.Cor.	-0.803	0.359	-0.007	0.258	-0.073	1	
	Sig.	0.102	0.553	0.989	0.622	0.891		
	N	5	5	6	6	6	6	
MASH	P.Cor.	-0.774	-0.615	-0.744	0.890	0.536	0.326	1
	Sig.	0.226	0.385	0.256	0.110	0.464	0.674	
	N	4	4	4	4	4	4	4

*. Correlation is significant at the 0.05 level (2-tailed).P.Cor.: Pearson correlation. *. BSC: body condition score, HC: hot carcass weight, FT: subcutaneous fat thickness, MDM: meat dry matter, MFAT: meat fat, MPR: meat protein, MASH: meat ash.

Correlations between carcass traits and serum components values in males are given in Table 3.12. Negative correlations were found between subcunous fat tickness and MFAT, TRG, TC, HDL and LDL in male males. Again, between MFAT and TC, HDL and LDL of male buffalos; Negative correlations were determined between serum triglyceride ratio and TC, HDL and LDL, and between TRG and HDL and LDL. However, significant positive correlations were detected between TC and HDL and LDL and between HDL and LDL ($P<0.01$).

Table 3.12. Correlations between carcass traits and serum components values in males

		FT	MFAT	TRG	TC	HDL	LDL
FT	P.Cor.	1					
	Sig.	1.00					
	N	6					
MFAT	P.Cor.	-0.171	1				
	Sig.	0.746					
	N	6	6				
TRG	P.Cor.	0.170	0.264	1			
	Sig.	0.747	0.613				
	N	6	6	6			
TC	P.Cor.	-0.090	-0.658	-0.644	1		
	Sig.	0.866	0.156	0.168			
	N	6	6	6	6		
HDL	P.Cor.	-0.143	-0.597	-0.800	0.972**	1	
	Sig.	0.787	0.211	0.056	0.001		
	N	6	6	6	6	6	
LDL	P.Cor.	-0.276	-0.559	-0.795	0.959**	0.987**	1
	Sig.	0.596	0.249	0.059	0.002	0.000	
	N	6	6	6	6	6	6

**: Correlation is significant at the 0.01 level (2-tailed). FT: fat tickness, MFAT, meat fat, TRG: serum trigliceryde, TC: serum total cholesterol, HDL: serum high density lipoprotein , LDL: serum low density lipoprotein.

CHAPTER 4

DISCUSSION

It is well known that when cattle are slaughtered at an advanced age, there is a significant decrease in meat tenderness due to the hardening of the connective tissues surrounding the muscle fibers(Kiran et al., 2016; Gurunathan Kandeepan et al., 2009), and in this case, mostly young animals are fattened and slaughtered around one to two years of age.

However, in some countries, the slaughter of animals that have been culled from the herd and the animals that have reached the end of their productivity may be among the reasons for low meat quality. However, in Turkey, male buffaloes are taken to fattening like beef cattle and when they are between 1-3 years old, female buffaloes are sent to slaughter either due to low productivity or culling, but before they are too old. For this reason, when they are offered for sale, they have similar characteristics as beef cattle and can be sold instead of beef. It is known that the meat of young animals is superior to the meat of old animals in terms of quality. Lapitan et al. (2008) indicated that at a younger age buffaloes have a good capacity to produce good quality meat. As the age of animals increases, the myofibrils surrounding the muscles harden, so the tenderness increases in aged meats and the meat becomes tougher and tasteless (Robertson et al., 1986).

In this experiment, hot carcass weight determined that 244.33 kg for females and 211.30 kg for male buffaloes. The das whose data were used in this study consisted of animals brought to slaughter after feeding in the intensive system, and the carcass weight determined in males was lower than in females. Contrary to the results found in our study Ekiz et al. (2018b)reported that in buffaloes fed in an intensive system, the hot carcass weight was determined as 288.20 and 325.40 kg for females and males, respectively, which is opposite to the values in the current study. Turan et al. (2021)in their study, they found the warm carcass weights for females and males as 192.00 and 189.11 kg, respectively, and considering the age, the carcass weight was determined as 153.68 kg in

the young and 223.27 kg in the elderly. However, the low carcass weights given in this second study are probably related to the low slaughter weight. In a study with Murrah buffaloes Melo et al. (2023) an average slaughter weight of 275.2 to 315.0 kg, warm carcass weights were determined as 128.3 and 150.9 kg, respectively.

The most obvious difference whether the carcass has a fatty appearance or not is its subcutaneous fat thickness. It is a well-known fact that the thickness of the subcutaneous fat increases with intensive feeding. In this study, the older females were fattened, and the young ones consisted of males with lower condition scores than females. While the thickness of the subcutaneous fat determined in the females was 9.35 mm, it was determined as 7.39 mm in the males. As body weight increases, subcutaneous fat increases. In a study (Melo et al. 2023), subcutaneous fat thickness at low carcass weight was 4.6 mm in buffaloes with a slaughter weight of 275 kg (128.3 kg of hot carcass weight) and 8.6 mm in buffaloes with a slaughter weight of 342 kg (165 kg hot carcass weight) measured.

In this experiment, there were no significant differences among the dry matter, crude protein, crude fat, ash, and pH values of buffalo meat. Female and male buffaloes' meat chemical composition was not significant between the gender groups due to their same environmental condition (grown on the same farms). Animals' feeding status is the same, therefore they will consume the same amount of minerals and water. There may be some advantages and disadvantages of low or high dry matter in meat. The juiciness of meats can significantly affect their tenderness, loss of cooking and thawing, and palatability. Under normal conditions, it may be desirable to have high values such as crude protein, fat, and ash other than water, but it may negatively affect consumption as it can reduce the firmness and juiciness of the meat. In this study, the DM rate in meats were found around 22%.

Buffalo meat has a high-quality protein, like beef. Meat in human nutrition valuable source of essential amino acids necessary for various physiological functions. Buffalo meat has a similar chemical composition to beef but there are some differences between them due to the species(Lapitan et al., 2008;Neath et al., 2007), diet (Azmi et al., 2021), and other factors(Ramírez Toro et al., 2011). Buffalo meat protein is higher in young buffaloes than in aged buffaloes(Aksoy et al., 2021b). Turan et al. (2021) noted that hot

carcass weights were superior in old buffaloes when compared to younger male water buffaloes. Guerrero-Legarreta et al. (2020) reported thatbuffalo meat has good nutritional properties (high-quality protein, low fat and cholesterol, and unsaturated fatty acids). Sensory traits of buffaloes may be improved by an appropriate production system. Therefore, to meet the increasing demand for meat for human nutrition, buffalo meat may be considered a good option.

Female buffalo sent to slaughter had higher body condition scores than male buffalo, and these differences were statistically significant. In terms of hot carcass weights, carcass fat thickness, and meat pH at 24 hours, there was no significant difference between buffalo genders.The BCS may change animal feeding status and body weight(Wright and Russel, 1984).Turan et al. (2021)reported that expressed juice, drip loss, and Warner Bratzler shear force of longissimus dorsi muscles may not change depending on the gender and age of buffaloes.

The average color analysis of the buffalo meat samples examined within the scope of the study was L* value 40.88±0.97, a* value of 20.07±0.62, and b* value12.02±0.29. There was no difference in L*values of male and female buffalo of *Longissimus dorsi* thoracic muscle. However, the redness value (a*) of meat in females was found to be statistically significantly higher than in males. The differences in terms of brightness value (b*) determined from Longissimus dorsi thoracic meat samples of male and female buffaloes are not significant. Turan et al. (2021) claimed that female buffaloes had a higher redness color than male buffaloes. These results were similar to the current study data which female buffalo meat color was higher redness than males. When age advanced muscles look darker than younger buffaloes (Roy et al., 2020;Valin et al., 1984; Irurueta et al., 2008). Abdolghafour and Saghir (2014) reported dark red color of buffalo meat may be caused by less intramuscular fat or more pigmentation in meats. In buffaloes, there is less intramuscular fat (0.44%) compared to cows (3.31%). Also, beef meats had a higher marbling score than buffaloes (Roy et al., 2020) and buffaloes had despite having a lower carcass yield and the drawbacks of a reddish hue, buffalo meat outperformed beef on the parameters of yield grade, marbling score, and fat percentage.

In the current study, it was observed that the cooking loss of female animals was 40.99±0.95, whereas in male animals 40.34±01.74 Consequently no significant difference

was found between buffalo gender (male and female) in terms of cooking and thawing losses ofmeat which is due to the similarity of feeding and breeding as it was raised under identical feeding and management system as well as processing and handling of themeat.In a study conducted by Ziauddin et al. (1994) the muscles of older animals had higher percentages of cooking loss and thermal shrinkage than those of younger animals, which likely indicated the poor wellness of the older animals. Compared to meat cooked in boiling water, pressure-cooked meat had lower Warner-Bratzler shear values.Schönfeldt and Strydom (2011) reporetd that juiciness of meats decreased with increasing of age and cooking loss increased non-linearly with age. The water holding capacity is an effective factor in the appearance of the meat, chewing resistance, storage quality, and profitability of the meat due to wastage loss. The water-holding capacity of meat can be significantly affected by the type, breed, rearing conditions, age, sex, and post-slaughter storage and processing characteristics of the animal (Fhaisol et al., 2021). These researchers found in their study, that WHC was lower in the meat of properly health-controlled animals when the meat of buffaloes with and without health control was compared.

In the present experiment there were no significant differences between the genders of buffalos. In meat quality evaluation, another important criterion is loss of thawing. Thawing loss of meat refers to the weight that meat loses when thawed from a frozen state. This criterion can have a significant impact on the freshness and texture quality of meat. The amount of water that meat loses when thawed after freezing can cause loss of flavor and texture. To obtain a quality meat product, it is important to minimize thawing loss. This can be possible by using the correct freezing and thawing methods.

In the current study, no significant difference was observed in terms of fatty acid composition between genders. Fat compositions in meat can be affected by the genetics and environmental factors of the animal from which the meat is obtained(Nogoy et al., 2022;Eldahshan et al., 2020). In this study, the buffaloeswere river buffalos from the Kayseri region and since they came from the same farm, both genetic and environmental factors are thought to be very similar.

It is preferred that meat contains more unsaturated fats for the sake of consumer health (Simopoulos, 2000). In addition, the increase in the omega-3 fats, EPA and DHA contents

of meat increases the value of meat in terms of its contribution to human health. Buffalo meat has a similar fatty acid profile to beef, but it is generally lower in fat and calories. In the current experiment, the major fatty acids were myristic acid palmitic acid (C14:0), palmitic acid (C16:0), stearic acid (C18:0), oleic acid (C18:1n9), linoleic acid (C18:2n6), alpha-linolenic acid (C18:3n3). As see in fatty acid composition of buffalos in this experiment, saturated fatty acids (SFAs) are the most abundant fatty acids in buffalo meat, followed by monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs). Cifuni et al. (2014) reported that in buffalo meat fatty acids C16:0, C18:0, Linoleic acid (C18:2n6) fatty acid percentages are lower than beef meats, however, Oleic acid (C18:1n9), Alpha-linolenic acid (C18:3n3) and PUFAs/SFAs ratio higher in buffalo meat than cattle meat.

Animals' serum biochemical profiles can be used to evaluate their physiological statusand health. The feeding of buffaloes is not done as carefully as it is for cattle. In the Kayseri region, Anatolian buffaloes are moved to pastures near wetlands in the spring and graze there until winter. Most of the time, additional feeding is not given to the buffaloes when they return to the pasture. According to our observations, buffaloes can fatten well in the middle of spring and summer season in Anatolian region. However, improving the care and feeding conditions of these animals will cause them to be healthier and avoid nutrient deficiency problems, and their productivity will probably increase. As it is known, genetics and environmental conditions are two important factors that determine productivity in animals. In the current study, differences in blood parameters other than total protein were not found to be different between genders. The total protein rate in the blood was found to be higher in male buffaloes than in females. There were no statistically differences in terms of serum chloride, calcium, phosphorus, and zinc in males and females. However, blood sodium and copper levels were statistically significantly higher in males than females. The blood creatinine and AST values in female buffaloes were statistically significantly lower than in male buffaloes, but, ALT values did not vary between the gender groups of buffaloes.

Blood serum components such as total protein, glucose, phosphorus, creatinine, ALT and ALP may change according to sex, age and physiological status of animals. Patel et al. (2016) reported that serum total protein, glucose, total cholesterol, and creatinine levels were higher in bulls than male calves. However, some blood parameters (calcium,

magnesium, sodium and potassium)may not show variation in male buffalo calves and bulls. Similarly, in calves, serum calcium, inorganic phosphorus, magnesium, potassium and chloride levels were not different between male and female(Patel et al., 2016).

In this study, the relationships between female buffalo body condition scores, hot carcass weights, meat fat and blood parameters were evaluated separately in male and female buffalos. In females, a significant relationship was found between BCS and hot carcass weight (HC), and subcutaneous fat thickness and HC. Also in female buffaloes, there were significant correlations meat fat content and serum triglyceride, total cholesterol, HDL and LDL. Significant positive correlations were detected between blood total cholesterol level and serum HDL and LDL levels.

In males, negative correlations were determined between BSC and MDM, MPR, and MASH, and between HC and MDM and MASH. Additionally, negative correlations were found between FT and MFAT, MPR and MASH. However, a significant negative correlation was found between FT and MDM. Also, in males, negative correlations were found between subcutaneous fat thickness and MFAT, TRG, TC, HDL and LDL in male males. Again, between MFAT and TC, HDL and LDL of male buffalos; Negative correlations were determined between serum triglyceride ratio and TC, HDL and LDL, and between TRG and HDL and LDL. However, significant positive correlations were detected between TC and HDL and LDL and between HDL and LDL.

The most striking situation in the correlations between different parameters in this study is that as the fatness of the animals increases, the fat rate in the carcass increases and the dry matter and crude protein levels decrease, which is an expected situation; Because they are proportional values, an increase in one results causes in a decrease in the other. Significant correlations have been identified between blood lipids, cholesterol HDL and LDL, which is also predicted. Blood total cholesterol level consists of the sum of HDL, LDL and VLDL, and the changes are naturally related to each other.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

According to the observations and results obtained from this study, the age of buffalo slaughtered in Turkey is earlier than those slaughtered in other countries. While in other countries animals are sent to slaughter at the end of their end of yield period, however, in Turkiye, males and female buffaloes can be sent to slaughter at young age. The feeding of buffaloes in Turkey has produced milk and meat, as in countries such as India and Pakistan, buffaloes are not used to benefit from the workforce. According to the data and observations obtained in this study, the buffaloes that are sent to slaughter are formed from buffaloes that have been fattened for a certain period under intensive conditions. Female animals constitute a significant part of the slaughtered buffaloes. Recently, for improvement genetic quality of buffaloes, live buffaloes and sperm with high milk yield have been brought from other regions of Turkey to increase milk production in buffaloes in the Kayseri region. At the same time, buffaloes from the surrounding provinces are brought to Kayseri for slaughter due to the professional slaughterhouses and production facilities in the region that process meat products.

According to the data obtained from buffaloes, the body condition scores of buffalo (3 and above) are sufficient to induce slaughter and their carcass weights are higher than some literature reports. Due to the higher age of slaughtered females compared to males, carcass weights, carcass fat, meat redness and yellowness color are higher. In females, numerically, the cooking loss of meat is slightly higher, but the freezing loss is lower. Blood serum glucose is higher, but serum protein, triglyceride, total cholesterol, LDL, and blood mineral levels (excluding Zn) are generally lower than in men. Creatine, AST, and ALT values are lower in females. (Turan et al., 2021) reported that, despite concerns about the quality of their flesh, female water buffalo might have a good potential for meat production.

As a result, the negative characteristics of the meat obtained from the buffalo slaughtered in other countries mentioned in the literature data are not similar in the buffalo slaughtered at a young age in Turkey and higher quality meat is obtained.

REFERENCES

Abdallah, O. Y., Mahallawi, M., and Latif, M. G. A., 1982. Anatomical and joint dissection studies of tissue weight distribution in buffalo bulls and cows: Part 1-Distribution of muscle and bone. **Meat Science**, **7**(2). DOI: 10.1016/0309-1740(82)90077-8

Abdolghafour, B., and Ahmad Saghir, 2014. Buffalo: a potential animal for quality meat production- A review. **Livestock Research International**, **2**(2).

Acebrón, L. B., and Dopico, D. C., 2000. The importance of intrinsic and extrinsic cues to expected and experienced quality: An empirical application for beef. **Food Quality and Preference**, **11**(3). DOI: 10.1016/S0950-3293(99)00059-2

Aksoy, Y., Şahin, A., Ulutaş, Z., and Uğurlutepe, E., 2021a. The effect of different slaughter weights on some meat quality traits of musculus longissimus dorsi thoracis of male Anatolian buffaloes. **Tropical Animal Health and Production**, **53**(1). DOI: 10.1007/s11250-021-02571-z

Aksoy, Y., Şahin, A., Ulutaş, Z., and Uğurlutepe, E., 2021b. The effect of different slaughter weights on some meat quality traits of musculus longissimus dorsi thoracis of male Anatolian buffaloes. **Tropical Animal Health and Production**, **53**(1). DOI: 10.1007/s11250-021-02571-z

de Albuquerque Borges, C. R., de Carvalho, F. F. R., Neves, M. L. M. W., Neto, J. D. P., Vieira, G. H. P., and Pessoa, R. A. S., 2022. Carcass and meat traits of bubaline finished on sugarcane-based diets supplemented with spineless cactus as a replacement for wheat bran. **Animal Bioscience**, **35**(1). DOI: 10.5713/ab.20.0825

Andrade, B. F., Castro, M. M. de, Rodrigues, L. M., Torres Filho, R. de A., Fontes, P. R., Ramos, E. M., and Ramos, A. de L. S., 2021. Rigor development and meat quality of Murrah buffalo from different production systems. **Research, Society and Development**, **10**(6), e42810615814. DOI: 10.33448/rsd-v10i6.15814

Anitha, A., Sarjan Rao, K., Suresh, J., Srinivasa Moorthy, P. R., and Kotilinga Reddy, Y., 2011. A body condition score (BCS) system in Murrah buffaloes. **Buffalo Bulletin**, **30**(1).

Anjaneyulu, A. S. R., Thomas, R., and Kondaiah, N., 2007. Technologies for value added

buffalo meat products - A review. **American Journal of Food Technology**. DOI: 10.3923/ajft.2007.104.114

AOAC, 2013. Official Methods of Analysis of AOAC International. **Association of Official Analysis Chemists International** (Vol. II, pp. 1058–1059). DOI: 10.3109/15563657608988149

Appa Rao, V., Thulasi, G., and Wilfred Ruban, S., 2009. Effect of age and sex on meat quality characteristics of south Indian non-descript buffalo. **Buffalo Bulletin**, **28**(3).

Aslam, A., Akram, A., Iqbal, U., Shamas, S., and Roshan, S., 2020. Effect of gender and body condition score on meat quality in Kundi buffalo. **Indian Journal of Animal Research**, **54**(6). DOI: 10.18805/ijar.B-1128

Aziz, A., Shah, A. H., Muhammad, H., Salman, M., and Talpur, R., 2014. Comparative Studies on Nutritional Quality of Cattle and Buffalo Meat. **International Journal of Science and Research**, **3**(7), 524–531.

Azmi, A. F. M., Amin, F. M., Ahmad, H., Nor, N. M., Meng, G. Y., Saad, M. Z., Bakar, M. Z. A., et al., 2021. Effects of bypass fat on buffalo carcass characteristics, meat nutrient contents and profitability. **Animals**, **11**(11). DOI: 10.3390/ani11113042

Banović, M., Grunert, K. G., Barreira, M. M., and Fontes, M. A., 2009. Beef quality perception at the point of purchase: A study from Portugal. **Food Quality and Preference**, **20**(4). DOI: 10.1016/j.foodqual.2009.02.009

Barile, V. L., 2005. Improving reproductive efficiency in female buffaloes. **Livestock Production Science**. DOI: 10.1016/j.livprodsci.2004.06.014

Batista, J. N., Pereira, F. B., Pereira Filho, J. M., De Lima, V., Dos Santos, V. L. F., Araújo, M. J., Moura, J. F. P., et al., 2020. Replacing corn bran and soybean meal in the diet with spineless cactus and cottonseed affects ingestive behaviour, performance, carcass characteristics and meat quality of Murrah water buffalo. **Animal Production Science**, **60**(7). DOI: 10.1071/AN19260

Bertoni, A., Napolitano, F., Mota-Rojas, D., Sabia, E., Álvarez-Macías, A., Mora-Medina, P., Morales-Canela, A., et al., 2020. Similarities and differences between river buffaloes and cattle: Health, physiological, behavioral and productivity aspects. **Journal of Buffalo Science**, **9**. DOI: 10.6000/1927-520X.2020.09.12

Camcı, S., and Erdem, H., 2022. Samsun İlinde Özel Bir Kesimhanede Kesilen Anadolu Mandalarının Bazı Karkas Kalite Özellikleri. **Turkish Journal of Agriculture - Food Science and Technology**, **10**(9). DOI: 10.24925/turjaf.v10i9.1646-1653.5294

Canozzi, M. E. A., Sphor, L. Á., Pimentel, C. M. M. M., Barcellos, J. O. J., Poli, C. H. E. C., Bergmann, G. P., and Kindlein, L., 2016. Sensory evaluation of beef and buffalo extensively reared and its relationship to sociodemographic characteristics of consumers. **Semina:Ciencias Agrarias**, **37**(3). DOI: 10.5433/1679-0359.2016v37n3p1617

Charles, D. D., 1982. Meat tenderness and palatability of Swamp buffalo and four breeds of cattle. **Animal Production**, **34**(1). DOI: 10.1017/S0003356100000507

Cifuni, G. F. rancesc., Contò, M., Amici, A., and Failla, S., 2014. Physical and nutritional properties of buffalo meat finished on hay or maize silage-based diets. **Animal science journal = Nihon chikusan Gakkaihō**, **85**(4). DOI: 10.1111/asj.12152

Contò, M., Cifuni, G. F., Iacurto, M., and Failla, S., 2022. Effect of pasture and intensive feeding systems on the carcass and meat quality of buffalo. **Animal Bioscience**, **35**(1). DOI: 10.5713/ab.21.0141

Cruz-Monterrosa, R., Mota-Rojas, D., Ramirez-Bribiesca, E., Mora-Medina, P., and Guerrero-Legarreta, I., 2020. Scientific findings on the quality of river buffalo meat and prospects for future studies. **Journal of Buffalo Science**, **9**, 170–180. DOI: 10.6000/1927-520X.2020.09.18

El Debaky, H. A., Kutchy, N. A., Ul-Husna, A., Indriastuti, R., Akhter, S., Purwantara, B., and Memili, E., 2019. REVIEW: Potential of water buffalo in world agriculture: Challenges and opportunities. **Applied Animal Science**. DOI: 10.15232/aas.2018-01810

Duru, S., and Sak, H., 2017. Türkiye'de Besiye Alınan Simmental, Aberdeen Angus, Hereford, Limousin ve Charolais Irkı Sığırların Besi Performansı ve Karkas Özellikleri. **Türk Tarım - Gıda Bilim ve Teknoloji Dergisi**, **5**(11), 1383–1388.

Eguienta, Y., Martin, C., and Lecomte, P., 2002. Crop-livestock interactions in northern Viet Nam : Issues , diversity of farmers ' responses , and alternatives for sustainable integration of animals in upland agricultural systems. **International Rice Research Institute (IRRI)**, (2002).

Ekiz, B., Yilmaz, A., Yalcintan, H., Yakan, A., Yilmaz, I., and Soysal, I., 2018a. Carcass and meat quality of male and female water buffaloes finished under an intensive production system, **18**(2), 557–574. DOI: 10.1515/aoas-2017-0036

Ekiz, B., Yilmaz, A., Yalcintan, H., Yakan, A., Yilmaz, I., and Soysal, I., 2018b. Carcass and Meat Quality of Male and Female Water Buffaloes Finished under an Intensive Production System. **Annals of Animal Science**, **18**(2). DOI: 10.1515/aoas-2017-0036

Eldahshan, E., Saddick, E., and Selim, S., 2020. Lactation Performance, Milk Fatty Acid Composition, and Blood Lipid Profile of Lactating Buffaloes in Response to Dietary Soybean and Linseed Oils. **Tropical Animal Science Journal**, **43**(3). DOI: 10.5398/tasj.2020.43.3.254

FAOStat, 2019. Food and Agricultural Organization. Animal Production Data. **http://www.fao.org/faostat/en/#data/QL Access:15.02.2021**.

Fhaisol, M. A., Rosly, S., Nasyatul, E. M. H., Lokman, I., Hasliza, A. H., Zamri, M. S., and Zuki, A. B., 2021. Water holding capacity of Swamp Buffalo muscles raised with and without proper herd health. **BIO Web of Conferences**, **33**. DOI: 10.1051/bioconf/20213304004

Franzolin, R., and Dehority, B. A., 1999. Comparison of protozoal populations and digestion rates between water buffalo and cattle fed an all forage diet1. **Journal of Applied Animal Research**, **16**(1). DOI: 10.1080/09712119.1999.9706260

Gecgel, U., Yilmaz, I., Soysal, M. I., Gurcan, E. K., and Kok, S., 2019. Investigating proximate composition and fatty acid profile of longissimus dorsi from anatolian water buffaloes (Bubalus bubalis) raised in similar conditions. **Food Science and Technology**, **39**(4), 830–836. Sociedade Brasileira de Ciencia e Tecnologia de Alimentos, SBCTA. DOI: 10.1590/fst.08918

Giuffrida-Mendoza, M., de Moreno, L. A., Huerta-Leidenz, N., Uzcátegui-Bracho, S., Valero-Leal, K., Romero, S., and Rodas-González, A., 2015. Cholesterol and fatty acid composition of longissimus thoracis from water buffalo (Bubalus bubalis) and Brahman-influenced cattle raised under savannah conditions. **Meat Science**, **106**. DOI: 10.1016/j.meatsci.2015.03.024

Gómez, I., Janardhanan, R., Ibañez, F. C., and Beriain, M. J., 2020. The effects of

processing and preservation technologies on meat quality: Sensory and nutritional aspects. **Foods**. DOI: 10.3390/foods9101416

Guerrero-legarreta, I., Napolitano, F., Cruz-monterrosa, R., Mota-, D., Mora-medina, P., Ramírez-bribiesca, E., Bertoni, A., et al., 2020. River Buffalo Meat Production and Quality : Productivity , Nutritional and Sensory Properties, 159–169.

Guerrero-Legarreta, I., Napolitano, F., Cruz-Monterrosa, R., Mota-Rojas, D., Mora-Medina, P., Ramírez-Bribiesca, E., Bertoni, A., et al., 2020. River Buffalo Meat Production and Quality: Sustainability, Productivity, Nutritional Information, and Sensory Properties. **Journal of Buffalo Science**, **9**. DOI: 10.6000/1927-520x.2019.08.03.17

Hassan, M. A., Abdel-Naeem, H. H. S., Mohamed, H. M. H., and Yassien, N. A., 2018. Comparing the physico-chemical characteristics and sensory attributes of imported Brazilian beef meat and imported Indian buffalo meat. **Journal of Microbiology, Biotechnology and Food Sciences**, **8**(1). DOI: 10.15414/jmbfs.2018.8.1.672-677

Hegde, N. G., and Abdullah-Al-Zabir,), 2019. Buffalo Husbandry for Sustainable Development of Small Farmers in India and other Developing Countries. **Asian Journal of Research in Animal and Veterinary Sciences**, **3**(1).

Holló, G., Barna, B., and Nuernberg, K., 2014. Characterisation of carcass composition and meat quality of male suckling buffalo calves kept on natural grassland. **Archives Animal Breeding**, **56**(1). DOI: 10.7482/0003-9438-56-107

Honikel, K. O., 1998. Reference methods for the assessment of physical characteristics of meat. **Meat Science**, **49**(4), 447–457. DOI: 10.1016/S0309-1740(98)00034-5

Ilavarasan, R., Abraham, R. J. J., Appa Rao, V., Wilfred Ruban, S., and Ramani, R., 2016. Effect of age on meat quality characteristics and nutritional composition of Toda buffalo. **Buffalo Bulletin**, **35**(2).

Iommelli, P., Infascelli, F., Musco, N., Grossi, M., Ferrara, M., Sarubbi, F., D'aniello, B., et al., 2021. Stearoyl-coa desaturase activity and gene expression in the adipose tissue of buffalo bulls was unaffected by diets with different fat content and fatty acid profile. **Agriculture (Switzerland)**, **11**(12). DOI: 10.3390/agriculture11121209

Irurueta, M., Cadoppi, A., Langman, L., Grigioni, G., and Carduza, F., 2008. Effect of aging on the characteristics of meat from water buffalo grown in the Delta del Paraná region of Argentina. **Meat Science**, **79**(3). DOI: 10.1016/j.meatsci.2007.12.010

Jaspal, M. H., Badar, I. H., Amjad, O. Bin, Yar, M. K., Ijaz, M., Manzoor, A., Nasir, J., et al., 2021. Effect of wet aging on color stability, tenderness, and sensory attributes of longissimus lumborum and gluteus medius muscles from water buffalo bulls. **Animals**, **11**(8). DOI: 10.3390/ani11082248

Joele, M. R. S. P., Lourenço, L. F. H., Lourenço Júnior, J. B., Araújo, G. S., Budel, J. C. C., and Garcia, A. R., 2017. Meat quality of buffaloes finished in traditional or silvopastoral system in the Brazilian Eastern Amazon. **Journal of the Science of Food and Agriculture**, **97**(6). DOI: 10.1002/jsfa.7922

Joksimovic, J., and Ognjanovic, A., 1977. Comparison of carcase yield, carcase composition and quality characteristics of buffalo meat and beef. **Meat Science**, **1**(2). DOI: 10.1016/0309-1740(77)90011-0

Juárez, M., López-Campos, Ó., Prieto, N., Roberts, J., Galbraith, J., Failla, S., and Aalhus, J. L., 2019. Carcass Characteristics and Meat Quality of Bison, Buffalo, and Yak. **More than Beef, Pork and Chicken – The Production, Processing, and Quality Traits of Other Sources of Meat for Human Diet**. DOI: 10.1007/978-3-030-05484-7_5

Junior, V. L. L., Pereira, F. B., Batista, J. N., Bezerra, L. R., Santos, V. L. F., da Silva Filho, F. F., Menezes, M. dos S., et al., 2017. 526 Meat quality of feedlot buffalo fed with forage palm+cottonseed replacing high concentrate diet. **Journal of Animal Science**, **95**(suppl_4). DOI: 10.2527/asasann.2017.526

Kandeepan, G., Anjaneyulu, A. S. R., Kondaiah, N., Mendiratta, S. K., and Lakshmanan, V., 2009. Effect of age and gender on the processing characteristics of buffalo meat. **Meat Science**, **83**(1), 10–14. Elsevier Ltd. DOI: 10.1016/j.meatsci.2009.03.003

Kandeepan, Gurunathan, Anjaneyulu, A. S. R., Kondaiah, N., Mendiratta, S. K., and Suresh, R., 2009. Comparison of quality and shelf life of buffalo meat patties stored at refrigeration temperature. **International Journal of Food Science and Technology**, **44**(11). DOI: 10.1111/j.1365-2621.2009.02057.x

Kandeepan, G., Mendiratta, S. K., Shukla, V., and Vishnuraj, M. R., 2013. Processing

characteristics of buffalo meat-a review. **Journal of Meat Science and Technology**, **1**(1).

Kennedy, P. M., 1995. Intake and digestion in swamp buffaloes and cattle. 3. comparisons with four forage diets, and with rice straw supplemented with energy and protein. **The Journal of Agricultural Science**, **124**(2). DOI: 10.1017/S0021859600072932

Khan, S., Rahman, S. M. B., Roy, B. K., Huda, N., Habib, M. A., and Sarkar, M., 2021. Meat quality assessment of local cattle and buffalo through nutritive and physiochemical evaluation of blood and meat. **Buffalo Bulletin**, **40**(3).

Kiran, M., Naveena, B. M., Reddy, K. S., Shahikumar, M., Reddy, V. R., Kulkarni, V. V., Rapole, S., et al., 2016. Understanding tenderness variability and ageing changes in buffalo meat: Biochemical, ultrastructural and proteome characterization. **Animal**, **10**(6). DOI: 10.1017/S1751731115002931

Lapitan, R. M., Del Barrio, A. N., Katsube, O., Ban-Tokuda, T., Orden, E. A., Robles, A. Y., Cruz, L. C., et al., 2008. Comparison of carcass and meat characteristics of Brahman grade cattle (Bos indicus) and crossbred water buffalo (Bubalus bubalis) fed on high roughage diet. **Animal Science Journal**, **79**(2). DOI: 10.1111/j.1740-0929.2008.00519.x

Li, Q., Wang, Y., Tan, L., Leng, J., Lu, Q., Tian, S., Shao, S., et al., 2018. Effects of age on slaughter performance and meat quality of Binlangjang male buffalo. **Saudi Journal of Biological Sciences**, **25**(2), 248–252. King Saud University. DOI: 10.1016/j.sjbs.2017.10.001

Mello, J. L. M., Rodrigues, A. B. B., Giampietro-Ganeco, A., Ferrari, F. B., Souza, R. A., Souza, P. A., and Borba, H., 2018. Characteristics of carcasses and meat from feedlot-finished buffalo and Bos indicus (Nellore) bulls. **Animal Production Science**, **58**(7). DOI: 10.1071/AN16556

Melo, S. A. F., Magalhães, A. L. R., Neves, M. L. M. W., DE Carvalho, F. F. R., Melo, A. A. S., Vieira, G. H. P., Lima, D. O., et al., 2023. Performance, carcass yield, and meat quality of buffalo (Bubalus bubalis) fed on diets with different levels of concentrate. **South African Journal of Animal Science**, **53**(1). DOI: 10.4314/sajas.v53i1.15

Minervino, A. H. H., Zava, M., Vecchio, D., and Borghese, A., 2020. Bubalus bubalis: A

Short Story. **Frontiers in Veterinary Science**. DOI: 10.3389/fvets.2020.570413

Nanda, A. S., and Nakao, T., 2003. *Role of buffalo in the socioeconomic development of rural Asia: Current status and future prospectus*. **Animal Science Journal** (Vol. 74, pp. 443–455). DOI: 10.1046/j.1344-3941.2003.00138.x

Naveena, B. M., and Kiran, M., 2014a. Buffalo meat quality, composition, and processing characteristics: Contribution to the global economy and nutritional security. **Animal Frontiers**, **4**(4), 18–24. DOI: 10.2527/af.2014-0029

Naveena, B. M., and Kiran, M., 2014b. Buffalo meat quality, composition, and processing characteristics: Contribution to the global economy and nutritional security. **Animal Frontiers**, **4**(4), 18–24. Oxford University Press. DOI: 10.2527/af.2014-0029

Neath, K. E., Del Barrio, A. N., Lapitan, R. M., Herrera, J. R. V., Cruz, L. C., Fujihara, T., Muroya, S., et al., 2007. Difference in tenderness and pH decline between water buffalo meat and beef during postmortem aging. **Meat Science**, **75**(3), 499–505. DOI: 10.1016/j.meatsci.2006.08.016

Neath, K E, Barrio, A. N. Del, Lapitan, R. M., Herrera, J. R. V, and Cruz, L. C., 2007. MEAT Difference in tenderness and pH decline between water buffalo meat and beef during postmortem aging, **75**, 499–505. DOI: 10.1016/j.meatsci.2006.08.016

Nogoy, K. M. C., Sun, B., Shin, S., Lee, Y., Li, X. Z., Choi, S. H., and Park, S., 2022. Fatty Acid Composition of Grain- And Grass-Fed Beef and Their Nutritional Value and Health Implication. **Food Science of Animal Resources**. DOI: 10.5851/kosfa.2021.e73

O'Quinn, T. G., Legako, J. F., Brooks, J. C., and Miller, M. F., 2018. Evaluation of the contribution of tenderness, juiciness, and flavor to the overall consumer beef eating experience. **Translational Animal Science**, **2**(1). DOI: 10.1093/tas/txx008

Oswin Perera, B. M., 1999. Reproduction in water buffalo: comparative aspects and implications for management. **Journal of reproduction and fertility. Supplement**. DOI: 10.1530/biosciprocs.4.012

Patel, M. D., Lateef, A., Das, H., Prajapati, M. V, and Kakati, P., 2016. Estimation of blood biochemical parameters of Banni buffalo (Bubalus bubalis) at different age , sex and physiological stages. **Journal of Livestock Science**, **7**.

Ramírez Toro, E. J., Mesa R, J. A., Agudelo Gomez, D. A., Bolivar Vergara, D. M., and Cerón-Muñoz, M. F., 2011. Meat-type buffaloes: Age at slaughter by survival analysis. **Livestock Research for Rural Development**, **23**(4).

Ranjhan, S. K., 2013. Latest concepts in rearing buffaloes for meat production. **Buffalo Bulletin**, **32**(SPEC. ISSUE 1).

Rashad, A. M. A., EL-Hedainy, D. K., Mahdy, A. E., Badran, A. E., and El-Barbary, A. S. A., 2019. Utilization of live body weight, measurements, and eye muscle components to predict carcass performance of fattened Egyptian male buffalo calves. **Tropical Animal Health and Production**, **51**(8). DOI: 10.1007/s11250-019-01950-x

Rébak, G. I., Obregón, G. R., Obregón, J. B., Gómez, D. M., and Pino, M. S., 2021. Chemical characteristics of buffalo meat in a self-consumption feeding system in Corrientes, Argentina. **Revista Veterinaria**, **32**(1). DOI: 10.30972/VET.3215635

Robertson, J., Ratcliff, D., Bouton, P. E., Harris, P. V., and Shorthose, W. R., 1986. A Comparison of Some Properties of Meat from Young Buffalo (Bubalus bubalis and Cattle. **Journal of Food Science**, **51**(1), 47–50. DOI: 10.1111/j.1365-2621.1986.tb10832.x

Rodas-González, A., Huerta-Leidenz, N., Vidal, A., Colina, O., Lopez, J., and Rodriguez, R., 2015. Comparison of water buffalo (Bubalus bubalis) with crossbred and purebred Brahman cattle for growth performance on savannah and slaughter traits at four ages in Venezuela. **Animal Production Science**, **55**(8). DOI: 10.1071/AN13352

Roy, B. K., Huda, N., Huque, K. S., Sultana, N., and Sarker, N. R., 2020. Yield Grade and Quality Assessment of Native Buffalo Meat and Beef at Different Ages. **Tropical Animal Science Journal**, **43**(4). DOI: 10.5398/tasj.2020.43.4.360

Saleem, M. U., Ali, M. M., Nazir, M. M., Durrani, A. Z., Naseer, O., and Asghar, B., 2021. Variations in growth performance, meat quality and consumer preferences influenced by difference of breed in buffalo bulls (Bubalus bubalis). **Animal Production Science**, **61**(16). DOI: 10.1071/AN20293

Schönfeldt, H. C., and Strydom, P. E., 2011. Effect of age and cut on cooking loss, juiciness and flavour of South African beef. **Meat Science**, **87**(3). DOI:

10.1016/j.meatsci.2010.10.007

Simopoulos, A. P., 2000. Human Requirement for N-3 Polyunsaturated Fatty Acids. **Poultry Science**, **79**(7), 961–970. Oxford University Press. DOI: 10.1093/ps/79.7.961

Soysal, M. I., 2014. Anatolian water buffalo husbandry in Turkey. **Proceedings of the International Symposium on Animal Science 2014, September 2014, Belgrade-Zemun**, **1991**(September), 491–501.

Spanghero, M., Gracco, L., Valusso, R., and Piasentier, E., 2004. In vivo performance, slaughtering traits and meat quality of bovine (Italian Simmental) and buffalo (Italian Mediterranean) bulls. **Livestock Production Science**, **91**(1–2). DOI: 10.1016/j.livprodsci.2004.07.013

Di Stasio, L., and Brugiapaglia, A., 2021. Current knowledge on river buffalo meat: A critical analysis. **Animals**, **11**(7). DOI: 10.3390/ani11072111

Stasio, L. Di, and Brugiapaglia, A., 2021. Current Knowledge on River Buffalo Meat : A Critical Analysis.

Tateo, A., De Palo, P., Quaglia, N. C., and Centoducati, P., 2007. Some qualitative and chromatic aspects of thawed buffalo (Bubalus bubalis) meat. **Meat Science**, **76**(2). DOI: 10.1016/j.meatsci.2006.12.003

Turan, A., Yalcintan, H., Orman, A., and Ekiz, B., 2021. Effects of gender and slaughter age on meat quality of Anatolian water buffaloes. **Tropical Animal Health and Production**, **53**(4). DOI: 10.1007/s11250-021-02835-8

Uriyapongson, S., 2013. Buffalo and buffalo meat in Thailand. **Buffalo Bulletin**, **32**(SPEC. ISSUE 1).

Uzca, S., and Rinco, G., 2007. MEAT Mineral content of longissimus dorsi thoracis from water buffalo and Zebu-influenced cattle at four comparative ages, **75**, 487–493. DOI: 10.1016/j.meatsci.2006.08.011

Valin, C., Pinkas, A., Dragnev, H., Boikovski, S., and Polikronov, D., 1984. Comparative study of buffalo meat and beef. **Meat Science**, **10**(1), 69–84. DOI: 10.1016/0309-1740(84)90032-9

Wanapat, M., and Kang, S., 2013. World buffalo production: Challenges in meat and milk

production, and mitigation of methane emission. **Buffalo Bulletin**, **32**(SPEC. ISSUE 1).

Wright, I. A., and Russel, A. J. F., 1984. Partition of fat, body composition and body condition score in mature cows. **Animal Production**, **38**(1). DOI: 10.1017/S0003356100041313

Yilmaz Adkinson, A., and Konca, Y., 2021a. Sütçü Manda Irklarının Performans ve Verimliliğini Etkileyen Faktörler ve Türkiye'deki Geleceği. **European Journal of Science and Technology**, **25**, 498–508. DOI: 10.31590/ejosat.896113

Yilmaz Adkinson, A., and Konca, Y., 2021b. Manda Eti Üretimi ve Kalite Özellikleri. **European Journal of Science and Technology**. DOI: 10.31590/ejosat.1003259

Zardari, M. S., 2017. Effect of breed on carcass traits of Kundhi and Nili Ravi buffalo. **Pure and Applied Biology**, **6**(1), 267–271. DOI: 10.19045/bspab.2017.60023

Zhong, H., Zhou, J., Abdelrahman, M., Xu, H., Wu, Z., Cui, L., Ma, Z., et al., 2021. The effect of lignin composition on ruminal fiber fractions degradation from different roughage sources in water buffalo (Bubalus bubalis). **Agriculture (Switzerland)**, **11**(10). DOI: 10.3390/agriculture11101015

Ziauddin, K. S., Mahendrakar, N. S., Rao, D. N., Ramesh, B. S., and Amla, B. L., 1994. Observations on S o m e Chemical and Physical Characteristics of Buffalo Meat *, **37**, 103–113.

CURRICULUM VITAE (CV)

1. Personal details:

Full Name : Aisha Ali Ahmed Yousuf

Nationality : Somali

2. Academic Background:

A) Formal education

2020:Bachelor of Science (honors) in Veterinary Medicine, Sudan University of Science and Technology, Khartoum, Sudan.

2014:Secondary School Certificate, ImaamShafie Secondary School, Mogadishu, Somalia.

B) Courses and skillful

Food Safety Management system and HACCP, 2019. Sudan University of Science and Technology, Khartoum, Sudan

Farm Management, 2019 SFARI Institute for Reproductive Technology,Khartoum, Sudan

Poultry Production, 2017 Animal production Research Center Khartoum, Sudan

Clinical Nutrition, 2016 University of Khartoum, Sudan

Fundamental Epidemiology, 2016 Tanweer Training and Development Center Khartoum, Sudan

Medical Laboratory science, 2016 Scars Training Center Khartoum, Sudan

English Communication, 2018 American Discussion Club. Khartoum, Sudan

C) Professional training

Full practical training in all departments of the Animal Production Research Center - Ministry of Animal Resources and Fisheries, Khartoum, Sudan.

Practical training in different parts of the Veterinary Hospital - Elkadaro Veterinary Teaching Hospital- University of Bahri, Khartoum, Sudan.

D. Transferable skills

a) Computer skills and knowledge: Microsoft Office, SPSS.

b) Leadership Skills: Worked as the Academic Affairs Coordinator of Somali Veterinary Medicine Students Association in Sudan, 2018.