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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Determination of Some Quality Parameters of Buffalo Meat*

Manda Etinin Bazı Kalite Parametrelerinin Belirlenmesi

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Abstract

The buffalo (*Bubalus bubalis)* is a cattle that plays an important role in the lives of millions of people in many ways such as milk, meat, cargo, transport, transportation and farm manure in India and other Asian countries. Disease resistance, adaptability to various climatic conditions, better digestible meat of low quality grass-fed, faster growth, and weight gain are essential for buffalo breeders. Buffalo meat is similar to cattle meat in terms of meat composition, quality and sensory characteristics. It has some nutritional advantages such as containing less fat and calories. As a matter of fact, studies on the meat of some other animals such as sheep, lamb and beef, which are among the sources of red meat today, have increased recently. Consumers' interest in buffalo meat is increasing day by day in terms of both the high nutritional value of meat quality and the creation of a new red meat source. In this study, the physicochemical properties of buffalo meats were determined. For this purpose, 20 different Anatolian water buffaloes (7 male and 13 female) grown in the borders of Istanbul/Catalca district were used. The samples were taken from the *Musculus longissimus dorsi (*MLD) part of the animals for the analysis of buffalo meats. Color (L*-brightness, a*-red and green, b*-yellow and blue), moisture content, protein content, fat content, ash content, pH and water activity (aw) of buffalo meat samples were determined. In addition, the fatty acid composition of buffalo meats was determined. The average ash, pH, water activity, moisture, protein and fat ratios of buffalo meats were determined as 2.64%, 5.71, 0.99, 65.60%, 22.28% and 8.65%, respectively. L*, a* and b* values were determined as 42.66, 21.66 and 19.61, respectively. The major fatty acids of buffalo meats were C18:0 (stearic acid) while C18:3 (linolenic acid) was the least abundant fatty acid. The results of this studies suggested that buffalo meat could be considered as a good source of red meat.

Keywords: Buffalo meat quality, chemical properties, fatty acid composition

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Öz

Manda (*Bubalus bubalis*), Hindistan ve diğer Asya ülkelerinde süt, et, yük, taşıma, ulaşım ve çiftlik gübresi gibi birçok yönden milyonlarca insanın hayatında önemli bir rol oynayan, büyük baş hayvandır. Hastalıklara karşı dirençli olması, çeşitli iklim koşullarına uyum sağlaması, düşük kaliteli otla daha iyi sindirilebilirlik özelliği, daha hızlı büyüme ve ağırlık kazanımı manda yetiştiricileri için oldukça önemlidir. Manda eti; etin bileşimi, kalite ve duyusal özellikleri açısından büyükbaş hayvanlara benzerdir ve daha az yağ ve kalori içermesi beslenme açısından oldukça avantajlıdır. Nitekim günümüzde kırmızı et kaynakları arasında yer alan başta koyun, kuzu ve sığır etleri olmak üzerine diğer bazı hayvanların (manda) etleri üzerine de çalışmalar son zamanlarda gittikçe yoğunlaşmaktadır. Tüketiciler açısından hem et kalitesinin besleyici değerinin yüksek olması, hem de yeni bir kırmızı et kaynağı oluşturması açısından manda etine olan ilgi gün geçtikçe artmaktadır. Bu çalışmada manda etlerinin fizikokimyasal özellikleri belirlenmiş ve bu amaçla 7'si erkek, 13'ü dişi olmak üzere İstanbul/Çatalca ilçesi sınırları içerisinde yer alan 20 farklı Anadolu mandası kullanılmıştır. Manda etlerinin analizi için hayvanların *Musculus longissimus dorsi* (MLD) bölümünden örnekler alınmıştır. Alınan manda eti örneklerinde renk (L*-parlaklık, a*-kırmızılık ve yeşillik, b*-sarı ve mavilik), rutubet miktarı, protein oranı, yağ oranı, kül oranı, pH ve su aktivitesi (a_w) analizleri yapılmıştır. Bu analizlere ilave olarak yağları ekstrakte edilen manda etlerinin yağ asitleri bileşimine de bakılmıştır. Analizler sonucunda manda etlerinin ortalama kül, pH, su aktivitesi, nem, protein ve yağ oranları sırasıyla; % 2.64, 5.71, 0.99, % 65.60, % 22.28 ve % 8.65 olarak belirlenmiştir. Etlerin renk değerleri incelendiğinde ise L* değeri 42.66, a* değeri 21.66, b* değeri de ortalama 19.61 olarak tespit edilmiştir. Manda etlerinin yağ asitleri bileşimi incelendiğinde ise hakim (majör) yağ asitinin C18:0 (stearik asit) olduğu tespit edilirken; tüm yağ asitleri arasında en az düzeyde belirlenen yağ asitinin ise C18:3 (linolenik asit) olduğu görülmüştür. Şu ana kadar yapılan çalışmalardan ve bizim yapmış olduğumuz çalışmadan elde edilen sonuçlar dikkate alındığında manda etinin iyi bir kırmızı et kaynağı olacağı belirtilebilir.

Anahtar kelimeler: Manda eti kalitesi, kimyasal özellikler, yağ asitleri kompozisyonu

1. Introduction

Animal husbandry is one of the oldest cultural activities of humankind. Long before animal husbandry, which had only been practiced culturally, people made use of animals in different ways for many years to continue their lives (Şahin, 2015; Mazoyer and Roudart, 2010). According to the records, animal husbandry has been an inseparable component of traditional agriculture for centuries. In Asia, the water buffalos (*Bubalus bubalis*) have played an important role in overall community development due to its contributions to milk, meat, leather and the workforce for agricultural activities. In fact, all of their body parts, including hair and horns, have been utilized. Buffalos have formed a part of the farmers' goods, assets and business. In addition, in some societies, they have been regarded as a reliable "living bank" and an easy "convertible source of money" in order to serve the urgent needs of the rural masses (Nanda and Nakao, 2003).

In recent years, water buffalo breeding has become a significant livestock activity in Turkey, and it is widely used in family-type breeding (Cetinkaya et al., 2011). While the number of water buffalos in our country was 146,000 in 2000, buffalos number decreased to 84,705 in 2007. However in recent years, buffalos number has increased and it reached 185,574 in 2021 (Anonymous, 2022).

The nutritional value and taste of water buffalo meat are similar to beef. Water buffalo meat is slightly darker red color than beef. Carcass fat is yellow-white in cattle, while it is milky white in buffalos (Soysal, 2006). Buffalo meat contains more protein and less cholesterol in comparison to beef. In addition, the low saturated fat content increases the preferability of water buffalo meat (Cetinkaya et al., 2011). The main appealing features of buffalo meat are red color, reduced cholesterol and fat through low intramuscular fat, low connective tissue, high protein content, water holding capacity, myofibrillar fragmentation index and emulsifying capacity (Kandeepan et al., 2013; Yılmaz, 2017).

Among all types of red meat, water buffalo meat was reported to have the lowest total lipid ratio (1.37 g/100 g). Fat content of 1.0% -3.5% was observed in the meat of two-year-old male buffalo calves (Rao and Kowale, 1991). The poor tallow in buffalo meat causes relatively low fat content. Water buffalo meat contains less saturated fat than beef. The energy value of water buffalo meat was found to be 57.22% lower than beef. Low cholesterol content and energy value of buffalo meat (6.8 Kcal/g dry matter) was also reported by Anjaneyulu et al. (2007). Palmitic, stearic, oleic and linoleic acids were reported to be the predominant fatty acids in water buffalo meat phospholipids (Rao and Kowale, 1991). It was also reported that buffalo calves had the most appropriate (n-6)/(n-3) ratio (7.00) compared to beef calves and buffalo cows (Dimov et al., 2012).

Spangero et al. (2004) reported that water buffalo meat was redder and softer than beef. Infascelli et al. (2004) indicated that buffalo meat had lower saturated and higher monounsaturated and polyunsaturated fatty acids comparing to beef. In another study, it was reported that consumption of water buffalo meat contributed to a lower cardiovascular risk profile and had a number of positive effects on health (Giordano et al., 2010). For this reason, studies on the quality features of water buffalo meat can contribute to consumer preference and price improvement of this type of meat.

On the other hand, studies not only on the water buffalo meat but also on the use of various vegetable oil sources, which are obtained by cold press technique, contain substances rich in essential fatty acids and bioactive substances, do not cause quality losses due to not adding animal fat and do not cause harmful effects on cardiovascular health, in meat products instead of using animal fat, which is stated to increase the risk of cardiovascular diseases due to the cholesterol they contain, have also been conducted to a considerable extent (Gecgel et al., 2016), and are still continuing to be conducted.

In determining the quality and quantity of buffalo meat, various factors such as the breed, age, diet, management and welfare of animals as well as environmental conditions are effective (Awan et al., 2014). Studies carried out on the subject show that water buffalo meat is leaner and contains less saturated fat, more protein (11%), less fat (12%), more minerals (10%), less cholesterol (40%) and less calories (55%) compared to beef (Nanda and Nakao, 2003; Borghese, 2010). These results show that buffalo meat is a good source of red meat for those with heart and circulatory system diseases (Kucukkebapci, 2005).

Increasing global demands are forcing the production of economically feasible, high quality and healthier meat and meat products, and forcing to search for an alternative source of meat animal to feed the growing population.

In this study, it is aimed to inform water buffalo breeders and consumers by examining the quality, chemical composition and fatty acid content of buffalo meat, which occupies an important position in the meat industry.

2. Material and Method

20 Anatolian water buffalos, of which 13 (65%) were female and 7 (35%) were male, stocked at the same age and slaughtered when necessary with a carcass weight of 214.00 to 377.40 kg constitute the material of this study. Within the scope of the study, samples were taken from the *Musculus longissimus dorsi* (MLD) muscle of 20 buffalos slaughtered in Catalca district of Istanbul province and brought to the laboratory as soon as possible under cold chain conditions in order to perform analyses. The samples were kept at -18 °C until the analyses were completed.

Analyses of moisture content (%), protein content (Kjeldahl method) (%), fat content (%), ash content (%) and pH value of buffalo meat samples were carried out according to AOAC (1990). In order to determine the Hunter L*, a*, b* colour scales, DP-900 D25-A colorimeter (Hunter Lab Associates, Reston, VA, USA) was used (Marrone et al., 2020). The a_w values of the samples were identified using a Novasina water activity measuring device (Gabriel, 2008).

For fatty acid analysis, the samples kept at -18 °C were melted at +4 °C, and oil extraction was carried out with chloroform: methanol. Afterwards, fatty acid methyl esters were formed from the obtained extract. Methyl esters were prepared according to the method in IUPAC (Anonymous, 1987). In order to determine the fatty acid composition, Shimadzu GC-2010 Plus gas chromatography and DB-23 column (60 m x 0.25 mm and 0.25 µ film thickness) (J&W) were utilized. Helium was used as the carrier gas with a flow rate of 0.1 ml/min. The split ratio was set to be 1:80 and the operating temperatures were set to 230 °C for the injection block, 190 °C for the column and 240 °C for the detector.

Statistical analyses were carried out with SPSS (Statistical Package for Social Sciences) Version 21.0 package program. Mean value, standard deviation and percentage distributions were given as descriptive statistics. Kolomogorov-Smirnov test was applied to find out whether or not the data had a normal distribution. As a result of the related test, the data was found to not have a normal distribution, and as a consequence, non-parametric statistical analysis methods were used. Mann Whitney U test was applied to determine whether there was a difference between parameters according to gender, whereas Spearman's correlation analysis was applied to see the relationship between weight and parameters. The results were evaluated at 95% ($p<0.05$) significance level (Düzgüneş et al., 1987).

3. Results and Discussion

3.1. Physicochemical properties of water buffalo meat

The results of the physicochemical properties of the meat samples are presented in *Table 1*. Accordingly, the average moisture content, aw value, pH, ash content, and protein and fat ratio of buffalo meat samples were found as 65.60%, 0.9973, 5.71, 2.64%, 22.28% and 8.65%, respectively.

3.2. Colour, aw and pH values of water buffalo meat

The average L* value (brightness) of the water buffalo meat samples was found to be 42.66 whereas a* (redness and greenness) and b* value (yellow and blueness) were 21.66 and 19.61, respectively. These values were found to be higher than those reported by Geçgel et al. (2019). The different results were more likely to the diet differences, welfare, and management of the animals, as well as the slaughtering conditions.

The water activity (a_w) values of water buffalo meat samples were between 0.9919 and 0.9999, and the average water activity value was found to be 0.9973 (*Table 1*). The pH values of the buffalo meat samples were between 5.34 and 5.97, and the average pH was found to be 5.71 (*Table 1*). Faustman et al. (2010) reported that the average pH value of water buffalo meat was 5.56 and the average pH value of beef was 5.47. Consequently, the pH values were higher than those (5.03 to 5.46) obtained by Geçgel et al. (2019) in their study on water buffalo meat.

3.3. Moisture, ash, protein and fat values of water buffalo meat sample

The moisture content of water buffalo meat samples were varied between 57.57 and 70.05% (*Table 1*). The results of the variance analysis are presented in *Table 1*. Uğurlutepe (2017) reported that the moisture contents of

Anatolian water buffalo meat samples with low, medium, and high weight were found to be 75.23%, 74.30%, and 74.02%, respectively. The values obtained in this study are lower than the values obtained by Uğurlutepe (2017) whereas they are similar with the values obtained by Geçgel et al. (2019).

The protein ratio of water buffalo meat samples varied between 19.48 and 24.56% and the average protein ratio was found to be 22.58% (*Table 1*). In a study conducted by Infascelli et al. (2005) on water buffalos and Marchigian bulls, the protein ratio of water buffalo meat was reported to be 21.40%, while it was reported to be 22% in Marchigian bull meat. Fonseca et al. (2005) found the protein ratio as 20.52% in their study conducted on Murrah female buffalos. In another study, Malek et al. (2009) reported that the protein ratio of buffalo meat in Bangladesh was 20.90%. Faustman et al. (2010) found the protein ratio of buffalo meat to be 20.39% in their study. In another study conducted on water buffalo meat, the protein ratio was reported to be ranged between 15.12% and 17.65% (Geçgel et al., 2019).

The fat content values of water buffalo meat samples varied between 3.94 and 15.68%, and its average value was found to be 8.65%. The fattiness of water buffalo meat varies based on the diet, breed, and regions where the meat is obtained. The results of variance analysis are presented in *Table 1*.

Table 1. Physicochemical analysis results of buffalo meat

Sample	(Colour)			Water activity(aw)	pH	Moisture(%)	Protein(%)	Fat(%)	Ash(%)
	L*	a*	b*						
1	47.00^{a}	13.66^{d}	18.43^{b}	0.9956	5.86	63.55^{c}	21.51^{a}	12.60^{b}	2.27^{b}
2	32.27^{d}	25.6^{a}	18.68^{b}	0.9931	5.66	62.61^{c}	23.77^{a}	9.66^{c}	3.49^{a}
3	42.04^{b}	24.11^{a}	21.38^{a}	0.9995	5.61	62.59^{c}	22.87^{a}	12.07^{b}	2.25^{b}
4	42.91^{b}	22.13^{a}	21.03^{a}	0.9996	5.65	66.5^{b}	24.59^{a}	4.38^{e}	3.01^{a}
5	40.36^{b}	22.83^{a}	18.62^{b}	0.9948	5.79	68.45^{b}	21.92^{a}	7.22^{d}	3.03^{a}
6	40.86^{b}	19.03^{b}	17.93^{c}	0.9980	5.87	65.77^{c}	19.48^{b}	9.69^{c}	2.60^{b}
7	42.94^{b}	22.53^{a}	20.21^{a}	0.9950	5.62	67.76^{b}	22.28^{a}	5.24^{e}	3.07^{a}
8	47.08^{a}	20.92^{b}	20.31^{a}	0.9927	5.75	61.59^{c}	21.15^{a}	11.93^{b}	2.54^{b}
9	48.86^{a}	23.27^{a}	21.90^{a}	0.9919	5.58	57.57^{d}	24.23^{a}	14.26^{a}	2.26^{b}
10	44.89^{b}	21.04^{a}	20.32^{a}	0.9980	5.70	68.13^{b}	21.23^{a}	8.53^{c}	2.85^{b}
11	43.83^{b}	17.76^{c}	17.39^{c}	0.9999	5.79	61.45^{c}	19.6^{b}	15.68^{a}	2.41^{b}
12	45.1^{a}	20.47^{b}	20.09^{a}	0.9988	5.64	70.06^{a}	21.83^{a}	3.94^{e}	3.18^{a}
13	40.94^{b}	17.65^{c}	17.66^{c}	0.9977	5.34	67.36^{b}	22.15^{a}	4.96^{e}	2.70^{b}
14	42.44^{b}	23.03^{a}	20.43^{a}	0.9999	5.79	64.77^{c}	21.92^{a}	9.16^{c}	2.46^{b}
15	37.35^{c}	26.47^{a}	19.26^{a}	0.9999	5.79	67.63^{b}	21.67^{a}	5.04^{e}	2.87^{b}
16	42.19^{b}	25.14^{a}	20.92^{a}	0.9985	5.97	62.14^{c}	23.38^{a}	8.87^{c}	2.35^{b}
17	46.91^{a}	20.93^{b}	19.81^{a}	0.9972	5.69	66.73^{b}	23.36^{a}	4.99^{e}	2.65^{b}
18	48.21^{a}	20.84^{b}	20.72^{a}	0.9968	5.76	66.26^{b}	23.41^{a}	5.88^{e}	2.59^{b}
19	38.96^{c}	22.31^{a}	18.50^{b}	0.9989	5.68	65.84^{c}	20.89^{b}	11.72^{b}	1.47^{c}
20	38.13^{c}	23.57^{a}	18.67^{b}	0.9999	5.75	64.29^{c}	24.56^{a}	7.29^{d}	2.91^{b}

Means within the same column with different superscripts are significantly different ($p<0.05$)

3.4. Fatty acid components (%) of water buffalo meat

Average fatty acid ratios in water buffalo meat are shown in *Table 2*. Accordingly, the highest ratio is stearic acid (C18:0) (30.31%) while the lowest ratio is alpha-linolenic acid (C18:3-n3) (0.01%). The fatty acids in red

meat are usually medium and long chain, and consist of approximately 40% saturated, 40% mono-unsaturated, and 2 to 25% poly-unsaturated fatty acids. They are mostly expressed by the length of the carbon chains and the number of double bonds. Oleic acid (C18:1 cis-9), which is the major fatty acid in all types of meat has a ratio of more than 30% among total fatty acids (Chow, 2007).

The fatty acid composition has a significant role in defining meat quality and is often associated with meat flavour as well as nutritional values (Yarali et al., 2014). Examining the fatty acid profile in water buffalo meat samples, palmitic acid (C16:0) is the most abundant saturated fatty acid, followed by stearic acid (C18:0) and myristic acid (C14:0) (*Table 2*). The ratio between n-6 and n-3, which are polyunsaturated (PUFA) fatty acids, is an index mostly used to identify the nutritional value of fats (Santos-Silva et al., 2002). The Health Organization Department recommended that the n-6/n-3 ratio should not exceed 4.0 (Anonymous, 1994). The ratio between n-6 and n-3 PUFA was found to be 15 in water buffalo meat. PUFA:SFA (P:S) ratio is another index used in terms of nutrition and its recommended value in diet is between 0.40 and 0.45 (Anonymous, 1994). Whereas the ratio found in this study is 0.77, which is significantly higher than the recommended level.

Table 2: Fatty acid composition of buffalo meat (%)

Sample	**C:14:0**	**C:16:0**	**C:16:1**	**C:17:0**	**C:17:1**	**C:18:0**	**C:18*t***	**C:18:1*c***	**C:18:2**	**C:18:3**
1	2.03	27.72	0.49	1.16	-	32.3	1.88	32.29	2.13	-
2	1.40	22.06	1.32	1.29	0.32	30.03	2.00	39.53	2.05	-
3	1.73	23.62	1.75	1.12	0.63	22.95	-	45.81	1.90	0.49
4	1.51	20.76	1.66	1.27	0.37	29.58	1.66	41.28	1.91	-
5	1.99	24.36	1.71	1.31	0.37	25.97	1.74	40.86	1.69	-
6	2.39	20.4	5.35	1.52	1.32	31.90	2.27	32.54	2.31	-
7	2.63	24.78	2.18	1.20	-	28.62	1.98	35.00	2.51	1.10
8	1.95	24.45	1.59	1.28	-	32.25	1.35	35.53	1.60	-
9	2.21	29.09	1.62	0.87	-	22.20	0.51	42.96	-	-
10	1.91	24.01	2.27	1.16	0.37	25.09	1.21	42.38	1.60	-
11	1.56	22.45	1.38	1.24	-	29.67	0.60	41.24	1.86	-
12	2.09	25.08	1.02	1.23	-	33.81	-	34.82	1.95	-
13	1.92	24.22	0.80	1.41	-	33.04	-	35.85	1.91	0.88
14	2.15	29.17	0.82	1.14	-	32.58	0.61	32.20	1.33	-
15	-	29.25	-	-	-	22.64	-	48.11	-	-
16	-	27.45	-	-	-	35.38	-	33.85	3.32	-
17	-	28.76	-	-	-	35.34	-	35.90	-	-
18	1.48	22.97	2.61	1.30	-	26.87	0.93	41.41	2.43	-
19	1.44	22.86	0.74	1.48	-	40.48	2.27	28.76	1.97	-
20	-	24.93	-	-	-	35.61	-	35.98	3.48	-
X_{ort}	1.52	23.94	2.37	0.12	0.17	30.32	0.95	37.81	1.80	0.12
Ss (±)	0.84282	6.10400	5.46716	0.53012	0.33183	4.90992	0.87	5.06	0.93412	0.30746

The main fatty acids are found as oleic acid (C18:1) followed by stearic acid (C18:0), palmitic acid (C16:0), palmitoleic acid (C16:1), and linoleic acid (C18: 2), respectively. These fatty acids constitute approximately 95 to 96% of the total fatty acids. C18:1 C18:0 and C16:0 were found as 32.20-48.11%, 22.95-40.48%, and 20.40-29.17%, respectively. Our findings are similar to the values reported by Giuffrida-Mendoza et al. (2015) and Geçgel et al. (2019). The differences in fatty acid composition may vary according to the differences in diet, age and muscle structure of the animals. When the fatty acid composition of the butter made using water buffalo milk was examined by Eser and Inanc (2022), the fatty acids of C16:0 (36.07%), C18:1 (24.19%), C18:0 (9.30%), C14:0

(8.98%) and C4:0 (3.80%) were detected to be at high rates while other fatty acids were found to be at quite low rates.

3.5. Comparison of physicochemical properties of water buffalos based on gender and weight

It was observed that moisture content (%), protein ratio (%), pH value as well as L* and a* values of the male buffalo meat samples were slightly higher than the female buffalos whereas the b* value was lower. There was no significant gender-related difference in terms of related parameters ($p>0.05$) (*Table 3*). Kandeepan et al. (2009) reported that normal values for pH in water buffalo meat ranged from 5.4 to 5.6. In this study, it is possible to state that the pH values of male and female Anatolian water buffalos are at acceptable rates.

The water activity (a_w) value of the buffalo meat samples was found to be between 0.9919 and 0.9999 with an average of 0.9973. The average value of the a_w was very close to each other in terms of both genders. While the ash content of the male buffalo meat samples was lower than that of female buffalo meat samples, the difference between the groups was not significant ($p>0.05$).

It was found that C14:0 and C16:1 ratios of the female buffalo meat samples were significantly higher than the male buffalo meat samples while C18:0 and C18:2n6c ratios were significantly lower ($p<0.05$) (*Table 3*). Most of the previous studies compared carcass fattiness of male and female cattle slaughtered at similar ages (Węglarz, 2010; Daza et al., 2014) reported that females have higher carcas fattiness than males. In a study, it is reported that gender does not have a significant effect on fatty acids (Ekiz et al., 2018). As in this study, Zhang et al. (2010) detected higher rates of myristic acid in male Qinchuan cattle than in females. In many studies, it is found that males have lower intramuscular fat content and higher polyunsaturated fatty acids (PUFA) than females slaughtered at similar age. Hoffman et al. (2005) identified higher rates in males compared to females in terms of PUFA. Hollo et al. (2001) reported that PUFAs were found in higher ratios in male animals than in females except for C20:3 n-6. and the amount of individual saturated fatty acids (SFA) was similar in both genders.

Table 3. Comparison of physicochemical properties of buffalo meats by gender

Characteristics	***Gender***		**p**
	Female	***Male***	
L*	43.04±3.01	41.95±5.86	.721
a*	21.63±2.52	21.72±4.01	.663
b*	19.73±1.44	19.39±1.08	.606
a_w	0.997±0.01	0.997±0.01	.691
pH	5.68±0.13	5.76±0.11	.301
Moisture (%)	65.35±3.58	66.05±3.70	.843
Protein (%)	21.91±1.47	22.98±1.29	.191
Fat (%)	8.62±3.931	8.71±2.85	.956
Ash (%)	2.71±0.31	2.53±0.62	.501
C:14:0	1.85±0.63	0.90±0.87	.009
C:16:0	23.22±7.33	25.25±2.72	.905
C:16:1	3.24±6.66	0.73±0.96	.039
C:17:0	1.13±0.37	0.74±0.70	.578
C:17:1	0.23±0.39	0.04±0.12	.187
C:18:0	28.48±4.24	33.71±4.41	.019
C:18n9t	0.79±0.83	1.42±0.94	.143
C:18:1n9c	39.12±5.11	35.39±4.28	.296
C:18:2n6c	1.58±0.76	2.19±1.14	.035
C:18:3n6	0.17±0.37	0.00±0.00	.181
C:18:3n3	0.01±0.06	0.00±0.00	.463
C:22:1n9	0.04±0.14	0.00±0.00	.463

No significant relationship was observed between the weight of buffalos and the average L*, a* and b* values ($p>0.05$) (*Table 4*). In other words, the weight of the buffalos was not found to be an effective factor on the colour values. In addition, a negative relationship was observed between the weight of buffalos and the moisture content.

However, this relationship was not significant (p>0.05). In addition, as a result of the statistical analysis, no significant relationship was observed between the weight of water buffalos and a_w, and between the weight of water buffalos and the pH value of buffalo meat (p>0.05).

Table 4. The relationship between the weight of buffalo and the characteristics of buffalo meat

Characteristics		**Weight**
L	r	-.114
	p	.631
a	r	.230
	p	.329
b	r	-.104
	p	.663
Moisture	r	-.215
	p	.363
aw	r	.106
	p	.657
pH	r	.316
	p	.175
Ash	r	-.343
	p	.139
Protein	r	.217
	p	.359
Fat	r	.183
	p	.439
C:14:0	r	-.616**
	p	.004
C:16:0	r	.176
	p	.458
C:16:1	r	-.557*
	p	.011
C:17:0	r	-.285
	p	.223
C:17:1	r	-.416
	p	.068
C:18:0	r	.353
	p	.126
C:18:1n9t	r	.170
	p	.474
C:18:1n9c	r	-.211
	p	.372
C:18:2n6c	r	.218
	p	.355
C:18:3n6	r	-.184
	p	.438
C:18:3n3	r	-.020
	p	.934
C:22:1n9	r	-.139
	p	.558

A negative but insignificant relationship was observed between the weight of buffalos and the ash content of buffalo meat (p>0.05) (*Table 4*). In addition, as a result of the statistical analysis, no significant relationship was found between the weight of buffalos and the protein ratio of buffalo meat (p>0.05) (*Table 4*). In a study conducted by Infascelli et al. (2005) on water buffalos and Marchigian bulls, the protein ratio of water buffalo meat was

reported to be 21.40% while it was reported to be 22% in Marchigian bull meat. Fonseca et al. (2005) found the protein ratio as 20.52% in their study conducted on Murrah female buffalos. In another study carried out by Malek et al. (2009) in Bangladesh, it was reported that the protein ratio of buffalo meat was 20.90%. Faustman et al. (2010) found the protein ratio of buffalo meat to be 20.39% in their study. In a study conducted by Uğurlutepe (2017), it was reported that the protein ratio in meat increased as the increase in the weight of buffalos. However, this increase was not significant. Ito et al. (2010) found the protein ratio in Puruna bulls, which were slaughtered at 465.1 kg and 469 kg live weight, to be 22.7% and 22.7%, respectively. In a study conducted by Dimov et al. (2012), it was reported that the protein ratio of young buffalo calves slaughtered at 450 kg live weight was lower than of buffalos slaughtered at 580 to 600 kg live weight.

It was found that a statistically significant ($p<0.05$) negative but highly strong ($r = -.616$) relationship was observed between water buffalo weight and C16:1 while negative but moderately strong ($r = -.557$) relationship was observed between water buffalo weight and C14:0 (*Table4*). In other words, as the weight of water buffalos increases, the ratios of C14:0 and C16:1 decrease significantly. In a study conducted by Uğurlutepe (2017), it was reported that C16:0 and C18:0 fatty acids among the saturated fatty acids were at the highest level in buffalos with low, medium, and high carcass weight.

4. Conclusion

In terms of protein, fat and fatty acids, it was found that the buffalo meat samples had important components for human nutrition. It was observed that gender was important in terms of C14:0, C16:1, C18:0 and C18:2 (n6) fatty acids in the buffalo meat samples examined while live weight was effective on the fatty acids of C14:0 and C16:1. Gender and live weight were not found to be effective in terms of other examined values.

The rapid increase occurring in the world population leads consumers to different protein sources. We are rapidly advancing towards a period in which cultivated animals bred in the traditional style will be much more important in the future. In this sense, the analyzed buffalo meat samples components in a sufficient and balanced, which are important for consumer’s way. Depending on the improvements in people's living standards and education levels, some changes also occur in their consumption habits. Nowadays, humans who have become more conscious about balanced and healthy diets are making efforts in this direction. Considering the results obtained from the studies, it is seen that buffalo meat is very beneficial in terms of nutrition. Taking the findings obtained from previous studies and our study into consideration, it can be said that water buffalo meat is a good source of red meat.

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