ISSN 0101-2061 (Print)
ISSN 1678-457X (Online)
Food Science and Technology

DOI: https://doi.org/10.1590/fst.08918

Investigating proximate composition and fatty acid profile of *Longissimus dorsi* from Anatolian Water Buffaloes (*Bubalus bubalis*) raised in similar conditions

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Abstract

The aim of the present study was to compare the proximate analysis and fatty acid profile of water buffalo meats. Samples were taken from three different local meat suppliers in Baklalı, Orcunlu, and Nakkas villages, Istanbul Province, Turkey. Animals were males 24 months old reaching final live weights of 420-440 kg. Significant differences were observed in pH, moisture, fat, color and fatty acid profile of water buffalo meats ($p<0.05$ and $p<0.01$). The results of proximate analysis demonstrated that the pH (5.03-5.46), moisture (48.60-59.73%), fat (18.90-30.02%), ash (2.48-3.56%), protein (15.12-17.65%), 'L' lightness (24.38-33.50), 'a' redness (9.88-13.81), and 'b' yellowness (5.66-8.53) were found in the samples. C14:0, C16:0, C18:0, C16:1, C18:1 and C18:2 content of the water buffalo meats were found to be 1.53-4.15%, 19.99-26.85%, 19.48-34.50%, 2.95-5.33%, 35.37-50.62%, and 1.02-3.56%, respectively. The total SFAs, total MUFAs, total PUFAs, and total UFAs contents of the samples ranged between 40.73 and 60.28%, 38.32 and 55.15%, 1.34 and 4.46%, and 39.72 and 59.27%, respectively.

Keywords: water buffalo meat; meat quality; fatty acid profile.

Practical Application: A novel meat product can be obtained by using buffalo meat instead of cattle meat.

1 Introduction

The buffaloes raised in Turkey originate from Mediterranean buffaloes, which are a subgroup of river buffaloes, known as Anatolian Water Buffaloes. The Anatolian water buffalo is reared for several purposes in Turkey: for draft animal, meat, and milk that may be converted into many various kinds of milk products such as yoghurt, ice cream, ayran, and cheese. According to Turkish Statistical Institute data, 300 tons of meat and 51,947 tons of milk were produced from buffaloes in 2013 (Turkish Statistical Institute, 2014).

The quality and quantity of buffalo meat depend upon several factors such as breed, age, feeding intensity, management system and environmental conditions (Awan et al., 2014). Buffalo meat production in Turkey has become an alternative for the consumption of a lean, lower fat, low cholesterol and tasty product in accordance with the market regarding new trends in meat production. Anatolian Water Buffalo meat is consumed as fresh or in meat products like Turkish style fermented sucuk, sausage, pastrami and salami. In Turkish sausage, water buffalo meat decreases the fermentation duration and improve taste of product. In recent years, there has been a rise in meat production for meat only. Anatolian Water Buffalo meat is more commonly used as a determined percentage together with cattle meat. The importance of the buffalo stems from milk and meat yield resistance to many infectious diseases, low breeding costs, and being an appropriate livestock for low-income growers. In addition to this, the studies have indicated that buffalo meat is leaner and includes less saturated fat, more protein (11%), less fat (12%), more minerals (10%), less cholesterol (40%) and fewer calories (55%) compared to beef (Nanda & Nakao, 2003; Borghese, 2010; Sariozkan, 2011). Therefore, buffalo meat is reported to be a good choice of red meat for people with heart and circulatory system diseases (Kucukkebapci, 2005). Because of these characteristics, there has been increased interest in meat from this species (Irurueta et al., 2008). In particular, buffalo meat seems to be extremely suitable for patients who need dietetical foods (Calabro et al., 2014). Finally, buffalo meat is considered in Turkey as an alternative healthy product because of its good nutritional properties.

The fatty acid composition is one of the most significant determinants of the health quality of meat (Kaczor et al., 2010). In addition, muscle lipids are an important signifier of the nutritional quality of meat (Flynn et al., 1985). At the present time, especially in developed countries, there is an increasing trend in consumers to prefer lean red meat with less fat and high quality (Mushi et al., 2008; Khan & Iqbal, 2009). The fatty acid profile of buffalo fat affects the nutritional value of the meat, different aspects of meat quality, flavor content and shelf life (Lambertz et al., 2014). On the other hand, the structure of the fatty acids plays an important role in maintaining health (Williams, 2000). Moreover, the ratio between polyunsaturated and saturated fatty acids (P:S) and the ratio between omega 6 (*n*-6) and omega 3 (*n*-3) fatty acids are taken into account as two significant indices for the nutritional evaluation of fat, and these ratios are highly important for human health (Department of Health, 1994; Raes et al., 2004).

Received 26 Mar., 2018
Accepted 07 Aug., 2018
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The scientific literature concerning the description of the proximate and fatty acid profile of water buffalo meat is limited. To the best of our knowledge, no study about the fatty acid composition and omega fatty acids of water buffalo meat in Turkey has been done. For this reason, the objective of the present study was to determine some quality parameters and fatty acid composition of *longissimus dorsi* from Anatolian water buffaloes under similar conditions, harvested at 24 months of age, and from animals grown in Marmara (Thrace) region, Turkey. The results of the study could be also used as a guide for nutritionists and shoppers and to raise their information about the meat quality, omega fatty acids, and fatty acid profile of water buffalo meat.

2. Materials and methods

2.1 Materials

According to the state statistics institution, 121,826 head of water buffalo existed in Turkey in 2014. The number of buffaloes in Istanbul province is 10,853 spread around the districts of Catalca, Arnavutkoy, Eyup, Kagıthane and raised by 254 farms (Turkish Statistical Institute, 2014). Samples were taken from local meat suppliers contracted with farmers and the sampling was organized as 12 male 24 month aged individuals raised in Baklalı village (four head; Sample No:1-4) of Arnavutkoy district and Orcunlu (four head; Sample No:5-8), Nakkas village and (four head; Sample No:9-12), of Catalca district of Istanbul province in Marmara region. Environmental conditions including feeding regime and farming practices were the same. All animals were weaned at six months of age. After calving, all calves received mother's milk up to 10% of the body weight of the calf averaging 4 kg milk per day and remained to gather with the mother. After two weeks of age calves were transferred to individual pens and exercised to receive low amounts of starter feed concentrates containing 18% protein. The amount of concentrates gradually increased up to 3 kg per day until six months of age. From six months to slaughtering age, animals received 1 kg hay, 3 kg concentrates (18% protein content), 4 kg corn silage, and 1 kg of middling crushed bran or barley and were kept in closed barns. After slaughtering, the samples were received as 500 gram meat from the buttock and *longissimus dorsi* and were subjected to analysis.

2.2 Proximate analysis

Moisture, a crude fat and ash content of water buffalo meat was determined according to the guidelines of Association of Official Analytical Chemists (2005), while the protein content (as Kjeldahl nitrogen) was determined according to Association of Official Analytical Chemists (1990) official methods. The pH values of samples were determined using a pH meter according to the method of Du & Ahn (2002).

DP-900 D25-A color meter (Hunter Lab Associates, Reston, VA, USA) was used to determine the Hunter L, a, b color scales and meat color evaluation was performed according to Setser (1984). An Instron universal testing machine (Model 1140, Instron Co., Buckinghamshire, England) equipped with a blade was used to determine the firmness of water buffalo meats using a 500 kg load at 20 mm/min (Bloukas & Paneras, 1993).

2.3 Fat Extraction and Fatty Acid Methyl Esters (FAME) Analyses

5.0 ± 0.1 g taken from water buffalo (*M. longissimusdorsi*) was weighed and used for further analysis. For fat content determination, lipids were extracted from muscle tissues by the method described by Folch et al. (1957) and Association of Official Analytical Chemists (2005). Meat samples were homogenized by blender with 5 ml of chloroform: methanol (2:1, v/v) and analyzed to determine fat content. Lipid extracts were converted to fatty acid methyl esters (FAME) as described by Association of Official Analytical Chemists (1990). FAME was prepared after alkaline hydrolysis, followed by methylation in methanol plus BF3 (14% boron trifluoride). The final concentration of the FAME was approximately 7mg/mL in heptane.

2.4 GC Condition

Gas chromatography (GC) analysis was carried out using Hewlett-Packard 6890 model gas chromatograph equipped with a flame ionization detector (FID), and a split injector (Chrompack, Middleburg, The Netherlands). A fused-silica capillary column was used, CP™-Sil 88 (Chrompack), 100 m in length, 0.25 mm internal diameter, 0.2 µm in film thickness. The oven temperature was programmed to an initial temperature of 120 °C for 1 min, and then increased slowly to 230 °C (3 °C/min) and remained at 230 °C for 20 min. The injector and detector were kept at 250 °C with gas flows of 40 mL/min for hydrogen and 450 mL/min for air. Helium was used as a carrier gas at the flow rate of 1 mL/min. The GC was equipped with a split injector; a single injection volume of 1 µL was made per sample duplicate, using a split ratio of 1:100. The peaks were identified by comparing the retention times and area percentages with those of authentic standards of FAMEs obtained from Nu-Chek-Prep Inc. and on the basis of literature data (Pawlowicz & Drozdowski, 1998). Three replicate GC analyses were carried out, and the results were denoted in GC area % as a mean value.

2.5 Statistical analysis

For statistical analysis, the collected data on various parameters were subjected to statistical analysis by using completely randomized design. Duncan's multiple range test was applied to compare the difference between the means. The statistical analysis was performed using the SPSS statistical package program (SPSS Inc., 2001).

3 Results and discussion

The proximate composition of water buffalo meats is given in Table 1. Fat content of the samples was between 18.90 and 30.02%. A significant difference among buffalo meat samples was observed at the $p<0.01$ level of significance. These differences were affected by various factors such as breed, genotypes, diet, sex, and feeding system, therefore these differences were expected. The moisture content of all the buffalo meat samples was found to be 48.60-59.73%. Awan et al. (2014) noticed that usually fat and moisture in the meat were inversely related. Similarly, Lawrie (1998) reported that the moisture content of buffalo meat decreased, which was presumably connected with

Table 1. Proximate composition of water buffalo meats (Mean ± SEM).

Water buffalo meat samples	Properties							
	pH**	Moisture (%)*	Fat (%)*	Ash (%)^{ns}	Protein (%)^{ns}	Hunter		
						L**	a*	b^{ns}
1	5.13±0.028ef	59.40±1.21a	18.90±1.72c	3.56±1.17	16.58±2.84	28.12±1.14cd	11.67±1.14ab	6.67±1.11
2	5.08±0.023fg	53.69±1.62abcd	26.55±2.28abc	2.73±0.65	15.93±2.90	31.65±1.70abc	10.79±1.14ab	7.84±1.13
3	5.35±0.029b	48.60±1.10d	29.59±3.44a	3.69±1.14	17.12±2.30	29.34±1.13abcd	12.32±1.15ab	7.92±1.14
4	5.20±0.034de	50.28±2.90cd	30.02±2.90a	2.60±0.54	15.59±2.83	24.38±1.11d	10.38±1.17b	5.66±1.12
5	5.10±0.035fg	50.51±3.47cd	28.93±2.29ab	2.48±0.55	16.22±3.45	25.22±1.14d	12.82±1.13ab	6.98±1.15
6	5.03±0.017g	56.73±1.14abc	22.02±2.30abc	3.28±1.11	16.46±1.70	26.81±1.15cd	11.41±1.70ab	5.86±1.12
7	5.26±0.035cd	52.81±2.88ab	27.68±1.74ab	2.89±0.56	15.12±2.88	24.89±1.68d	14.74±1.13a	6.30±1.70
8	5.46±0.017a	59.73±1.71a	19.15±1.70c	3.32±1.17	15.80±2.28	33.50±1.70a	13.56±1.70ab	8.53±1.14
9	5.33±0.034bc	51.04±3.49bcd	26.80±3.44abc	3.01±0.57	17.65±2.29	28.40±1.13bcd	12.11±1.15ab	7.21±1.13
10	5.40±0.028ab	54.19±2.30abcd	24.40±2.28abc	3.13±1.14	16.78±2.30	33.18±1.72ab	10.40±1.11b	8.38±1.12
11	5.38±0.029ab	54.26±2.27abcd	24.20±1.70abc	3.16±1.13	16.73±1.71	28.60±2.28abcd	9.88±1.11b	6.89±1.74
12	5.05±0.028fg	58.51±2.32ab	20.75±2.86bc	3.43±1.14	15.91±2.86	33.19±1.74ab	13.81±1.12ab	8.12±1.14

All values are expressed as the means of three replicates; a-g: Values with different superscripts indicate significant with different water buffalo in the same column (p<0.05* and p<0.01**); ns: non-significant. L value indicates the level of dark or light, a value redness or greenness, b value yellowness or blueness.

an increase in fat content. Moisture and fat results of the current research support these statements. According to the results in Table 1, the lowest percentages of moisture (48.60 and 50.28%) versus the highest percentages of fat (29.59 and 30.02%) and the highest percentages of moisture (59.40-59.73%) versus the lowest percentages of fat (18.90 and 19.15%) were obtained. The differences in fat and moisture contents might be partly because of the higher carcass weight of the concentrate-fed animals (Lambertz et al., 2014). The protein content (%) and ash content (%) were in the ranges of 15.12-17.65, and 2.48-3.69, respectively. Awan et al. (2014) obtained similar protein results in the buffalo meat samples in different age groups. However, the protein results were lower than those reported by Juarez et al. (2010), Calabro et al. (2014), and Lambertz et al. (2014). Results for protein and ash percentage in these buffalo meat samples were found to be non-significant at the level of p>0.05. The pH at 24 h after slaughtering was comparable in the buffalo meat samples (5.03 vs. 5.46). The pH range found in the current study was similar to the findings by Spanghero et al. (2004), and Calabro et al. (2014). However, this pH value was lower than those reported by Awan et al. (2014), and Lambertz et al. (2014). pH is an outcome of post mortem biochemical changes that continue in the course of the storage period and are directly connected to storage temperature (Awan et al., 2014).

Meat color ranges from nearly white to dark red according to the species, anatomical location, pigment concentration, nutrition state, age and gender. In addition, post-mortem factors such as the rate of pH fall, oxidation processes, packaging, temperature and lighting during storage and display, and also the microbial load have a great influence on meat color (Ponce-Alquicira & Quintero-Salazar, 2009). The 'L' values of meat ranged from 24.38 to 33.50. The differences among the 'L' values of the meats were significant (p<0.05). The highest 'L' (lightness) values (33.50) were obtained from the sample eight in Table 1. Color was also greatly affected by changes in muscle pH. As the ultimate pH increases, the meat gradually became darker. Values for 'a' (redness) were also different (p<0.05) for the samples. The 'a' values of meat ranged from 9.88 to 14.74. No significant differences in 'b' (yellowness) value among the samples (p>0.05) were found.

Fatty acid profiles of water buffalo meat samples were presented in Tables 2 and 3. According to the GC analysis of fatty acid methyl esters, oleic acid (C18:1), followed by stearic acid (C18:0), palmitic acid (C16:0), palmitoleic acid (C16:1), and linoleic acid (C18:2) were the major fatty acids, which together comprised approximately 91-92% of total identified fatty acids. C18:1 content of the water buffalo meat fat varied in the range of 35.37-50.62%. It was followed by C18:0 and C16:0 in the ranges of 17.92-34.50 and 19.99-26.85%, respectively. In the present study, the contents of C14:0, C16:0, C18:0 and C18:1 were higher than those reported by Calabro et al. (2014) for Italian young male buffaloes. Giuffrida-Mendoza et al. (2015), showed similar proportions of C14:0 and C16:0 fatty acids, and lower proportions of C18:0 and C18:1 fatty acids than our findings. It has been reported that fatty acid contents of *longissimus thoracis* from water buffalo meat of 1.84, 20.71, 13.24, and 31.56% for C14:0, C16:0, C18:0, and C18:1 were observed, respectively. The differences in fatty acid composition might be resulted from diet, age of animal, and muscle structure.

SFA content of samples was found between 40.73 and 60.28% (p<0.01). Similar results were found in the previous work by Juarez et al. (2010), and Calabro et al. (2014) who reported the values as 54.6%, and 52.5% in *Longissimus thoracis* muscle from buffalo meat, respectively. The fat composition of red meat was not recommended as being unhealty for consumers due to the high SFA content (Yousefi et al., 2012). However, it has been emphasized that controlling other diet components (i.e. fructose) is far more significant than SFA intake (Lustig et al., 2012). Therefore, reducing SFAs content in animal products is important for improving the quality of animal products (Rana et al., 2012).

The main SFAs found were C18:0, followed by C16:0 and myristic acid (C14:0), which represented about 98-99% of the total SFAs in the *Longissimus dorsi* of water buffalo meats

Table 2. Saturated fatty acid composition of water buffalo meats (Mean ± SEM).

Fatty acids (%)	Water buffalo meat samples											
	1	2	3	4	5	6	7	8	9	10	11	12
C8:0	nd	nd	nd	nd	nd	nd	0.01±0.001c	0.03±0.005a	0.02±0.003b	nd	nd	nd
C10:0	0.02±0.003d	0.02±0.001d	0.0±0.0011de	nd	0.02±0.003d	0.04±0.01c	0.02±0.003d	0.09±0.005b	0.11±0.01a	0.02±0.003d	nd	0.04±0.005c
C12:0	0.03±0.01def	0.03±0.005def	0.03±0.01def	0.02±0.003de	0.06±0.01bc	0.08±0.005ab	0.03±0.003def	0.05cd±0.01	0.04±0.005cde	0.03±0.01def	0.01±0.001f	0.10±0.01a
C14:0	2.00±0.02h	2.05±0.01g	1.88±0.01i	1.94±0.01ı	3.17±0.01c	3.96±0.02b	2.58±0.01e	4.15±0.01a	2.33±0.01f	2.36±0.02f	1.53±0.01j	2.93±0.01d
C16:0	21.14±0.02g	21.16±0.01g	20.79±0.02h	26.85±0.02a	22.85±0.02d	24.26±0.02c	21.92±0.02e	25.43±0.01b	19.99±0.01i	20.12±0.02ı	24.24±0.02c	21.55±0.02f
C17:0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
C18:0	19.48±0.02i	20.34±0.02ı	17.92±0.01j	27.72±0.01e	27.41±0.02f	25.18±0.02g	20.37±0.02ı	23.89±0.01h	32.38±0.03c	33.30±0.02b	34.50±0.02a	28.62±0.02d
C20:0	0.12±0.01def	0.11±0.01ef	0.10±0.01f	0.10±0.005f	0.19±0.01c	0.14±0.01de	0.15±0.005d	2.11±0.017a	0.25±0.005b	nd	nd	0.19±0.011c
C22:0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
∑SFA	42.79±0.02ı	43.71±0.028h	40.73±0.03i	56.63±0.017b	53.70±0.02e	53.66±0.03e	45.08±0.037g	55.75±0.02c	55.12±0.028d	55.83±0.017c	60.28±0.023a	53.43±0.01f

All values are expressed as the means of three replicates; a-j: Values with different superscripts indicate significant with different water buffalo in the same row ($p<0.01$); SFA: saturated fatty acids; nd: non-detected.

Table 3. *Trans* and unsaturated fatty acid composition of water buffalo meats (Mean ± SEM).

Fatty acids (%)	Water buffalo meat samples											
	1	2	3	4	5	6	7	8	9	10	11	12
C16:1	4.08±0.02e	4.03±0.017e	3.93±0.02fg	4.00±0.03ef	4.47±0.023d	4.69±0.04c	5.33±0.01a	5.06±0.034b	3.87±0.01gh	3.85±0.02gh	2.95±0.028ı	3.81±0.01h
C17:1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
C18:1	48.40±0.02c	48.69±0.04b	50.62±0.02a	35.81±0.028j	38.96±0.03e	37.37±0.04g	46.12±0.02d	37.06±0.03h	36.49±0.028ı	36.15±0.02i	35.37±0.017k	38.59±0.03f
C20:1	nd	nd	nd	0.56±0.01a	nd	nd	nd	0.51±0.017b	0.43±0.01c	0.45±0.017c	nd	nd
C22:1	0.27±0.01cd	nd	0.60±0.02b	nd	nd	0.24±0.011de	0.68±0.017a	0.28±0.01c	0.20±0.01f	0.21±0.017ef	nd	nd
∑MUFA	52.75±0.028b	52.72±0.03b	55.15±0.02a	40.37±0.017i	43.43±0.01d	42.30±0.02g	52.13±0.03c	42.91±0.02e	40.99±0.03h	40.66±0.034ı	38.32±0.028j	42.40±0.02f
C18:1*trans*	nd	nd	nd	nd	nd	nd	nd	nd	0.72±0.011a	0.71±0.005a	nd	0.30±0.011b
C18:2*trans*	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
C18:2	3.56±0.01a	2.86±0.011d	3.37±0.02c	2.28±0.03h	2.18±0.01ı	3.44±0.011b	2.47±0.01g	1.08±0.011i	2.72±0.01e	2.54±0.017f	1.02±0.01j	2.90±0.017
C18:3	0.90±0.017b	0.71±0.017cd	0.75±0.011c	0.72±0.011cd	0.69±0.01d	0.60±0.011e	0.32±0.01h	0.26±0.011ı	0.45±0.01f	0.26±0.011ı	0.38±0.028g	0.97±0.01a
∑PUFA	4.46±0.017a	3.57±0.011e	4.12±0.01b	3.00±0.017g	2.87±0.01h	4.04±0.01c	2.79±0.017ı	1.34±0.01j	3.17±0.017f	2.80±0.01ı	1.40±0.011i	3.87±0.017d
∑UFA	57.21±0.02b	56.29±0.028c	59.27±0.01a	43.37±0.02ı	46.30±0.028e	46.34±0.023e	54.92±0.02d	44.25±0.028f	44.16±0.023g	43.46±0.02h	39.72±0.017i	46.27±0.02e
P/S	0.10±0.011a	0.08±0.011ab	0.10±0.005a	0.05±0.01cd	0.05±0.005cd	0.07±0.011abc	0.06±0.01bc	0.02±0.005de	0.06±0.011bc	0.05±0.01cd	0.02±0.003de	0.07±0.011abc
n-3	0.90±0.01b	0.71±0.01cd	0.75±0.01c	0.72±0.011cd	0.69±0.011d	0.60±0.017e	0.32±0.011h	0.26±0.01ı	0.45±0.01f	0.26±0.01ı	0.38±0.028g	0.97±0.011a
n-6	3.56±0.017a	2.86±0.011d	3.37±0.023c	2.28±0.034h	2.18±0.017ı	3.44±0.011b	2.47±0.017g	1.08±0.01i	2.72±0.01±e	2.54±0.017f	1.02±0.011j	2.90±0.017d
n-9	48.40±0.028c	48.69±0.04b	50.62±0.02a	35.81±0.02±j	38.96±0.034e	37.37±0.04g	46.12±0.02d	37.06±0.03h	36.49±0.02ı	36.15±0.028i	35.37±0.017k	38.59±0.034f
n-6/*n*-3	3.95±0.018h	4.03±0.03g	4.49±0.041e	3.16±0.01ı	3.16±3.16ı	5.73±0.041d	7.72±0.045b	4.15±0.034f	6.04±0.056c	9.77±0.055a	2.68±0.011j	2.99±0.012i

All values are expressed as the means of three replicates; a-k: Values with different superscripts indicate significant with different water buffalo in the same row ($p<0.01$); MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids; UFA, unsaturated fatty acids; P/S: total polyunsaturated fatty acids / total saturated fatty acids; nd: non-detected.

(Figure 1). Similar results were reported previously for the SFAs composition of Italian male buffaloes (Juarez et al., 2010). Caneque et al. (2001) reported that C16:0 tended to increase blood cholesterol, while C18:0 did not affect cholesterol levels. Additionally, C18:0 is an unusual SFA, which does not elevate blood cholesterol levels to the same extent as other fatty acids. This disparity can be explained by chain length, inefficient absorption, metabolism kinetics, and hepatic desaturation of stearic into oleic acid (Steinberg et al., 2003). On the other hand, Bonanome & Grundy (1988) indicated that SFAs lauric acid (C12:0) and C14:0 can be considered as hyperlipidemias as they act to reduce cholesterol owing to their rapid conversion to oleic acid (*n*-9, C18:1) and thereby, an increase in the activity of the enzyme Δ^9-desaturase, which synthesizes C18:1 from C18:0 (Velasco et al., 2001).

A higher proportion of MUFAs and lower percentage of SFAs and PUFAs are demonstrated in Figure 2. Similarly, Spanghero et al. (2004), reported high levels of MUFAs in buffalo muscle. C18:1 content is responsible for pretty much 90% of the MUFAs in all the buffalo meat samples. C18:1 has the beneficial effect of decreasing plasma cholesterol and LDL levels (Tejeda et al., 2008) and may slow the progression of atherosclerosis (Parthasarathy et al., 1990). Therefore, buffalo meat should be taken into account because of high oleic acid contents. The content of C16:1 in buffalo meats varied from 2.95% to 5.33% ($p<0.01$). Minor MUFAs in the buffalo meat samples were gadoleic acid (C20:1), and erucic acid (C22:1); their contents were less than 1% of the total fatty acids. Additionally, heptadeceonic acid (C17:1) could not be determined in buffalo meats. Linoleic acid (C18:2, *n*-6) preponderates among the PUFAs, but linolenic acid (C18:3, *n*-3) is the leading minor fatty acid within PUFAs ($p<0.01$). SFAs, MUFAs, PUFAs and the contribution of specific fatty acids have health importance, and each of these dietary lipids elements has been demonstrated to affect the development of cardiovascular diseases (Garcia et al., 2008). As shown in Tables 2 and 3, the lower SFAs and the higher UFAs proportions were in numbers 1, 2, 3, and 7 of water buffalo meat samples.

The P/S and *n*-6/*n*-3 are generally used to evaluate the nutritional value and potential effects on consumer health of dietary fat (Giuffrida-Mendoza et al., 2015). The World Health Organization (WHO) has recommended that *n*-6/*n*-3 ratio should not exceed 4.0 (Department of Health, 1994). For most of the water buffalo meat samples (1, 2, 4, 5, 8, 11, and 12), the value obtained for *n*-6/*n*-3 FA is below the recommended level. These results are in accordance with those of Giuffrida-Mendoza et al. (2015). On the other hand, the ratio of *n*-6/*n*-3 in other samples exceeds the value of 4.0 as described in Figure 3. Likewise, Juarez et al. (2010), and Calabro et al. (2014) cited that *n*-6/*n*-3 ratio was higher than those reported by WHO. The differences in the *n*-6/*n*-3 fatty acids ratio may be linked to buffaloes' diet. Finally, Lambertz et al. (2014) showed that a lower *n*-6/*n*-3 ratio was observed in grass-fed compared to concentrate-supplemented animals. In addition to diet, these differences are affected by various factors such as sex, age, and breed; however, these differences were expected (Yarali et al., 2014). On the whole, the optimal nutritional value of the *n*-6/*n*-3 ratio has still not been entirely evaluated for humans or animals (Calabro et al., 2014).

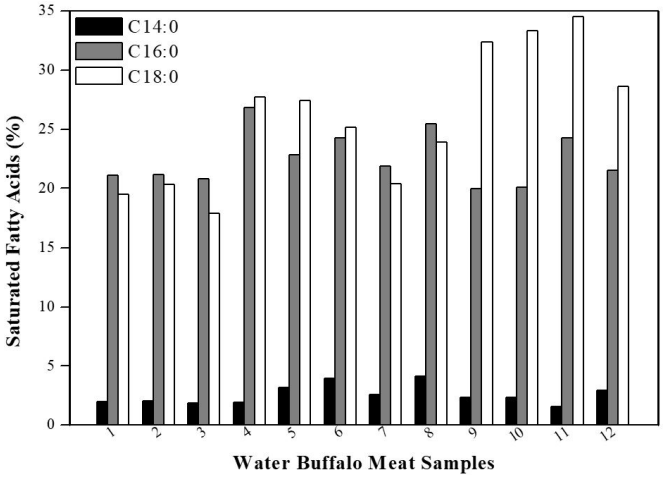

Figure 1. C14:0, C16:0, C18:0 percentage of water buffalo meats.

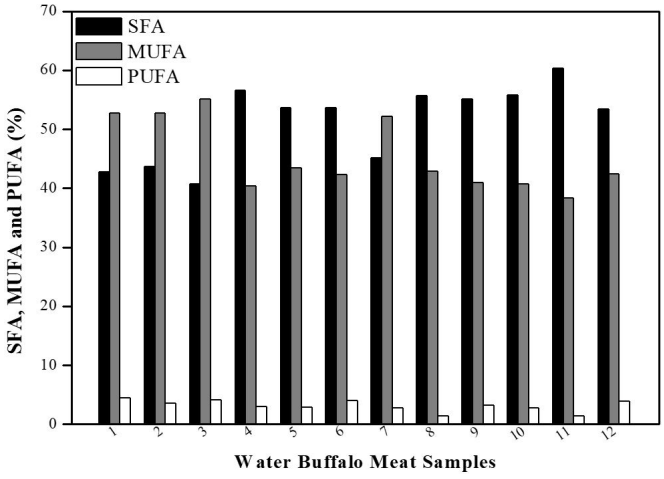

Figure 2. SFA, MUFA and PUFA percentage of water buffalo meats.

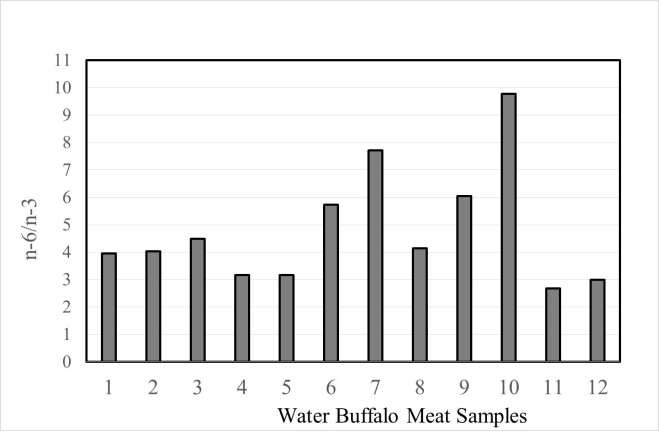

Figure 3. n-6/n-3 percentage of water buffalo meats.

4. Conclusion

The present study revealed the differences in the proximate composition and fatty acid profile of the meat among water buffaloes that were raised in similar conditions and slaughtered at the same age. According to the research results, fat content of the samples was between 18.90 and 30.02%. The fatty acid profile of water buffalo meat is composed of five major fatty acids; C18:1 was the highest fatty acid followed by C18:0, C16:0, C16.1, and C18:2. MUFAs were present in higher proportions than SFAs and PUFAs. Water buffalo meat may be taken into account in the diet for the prevention of heart disease owing to high MUFAs content. On the other hand, it is considered that *n*-6 and *n*-3 PUFAs are exceptionally significant in human nutrition and have a useful nutrient composition. In addition, the value obtained for *n*-6/*n*-3 FA was below the recommended level. Results of this study can be useful for water buffalo meat breeders, suppliers, and consumers.

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