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Determination of slaughter and carcass traits in male Turkish Anatolian buffaloes at different slaughter weights

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Abstract: Nowadays, deficits in red meat resources in Turkey are caused by the import of red meat from different countries. Anatolian buffaloes used in this research are a species that can contribute to red meat production in Turkey. This study was performed to determine the slaughter and carcass traits of Anatolian buffaloes at different slaughter weights. Twenty weaned male Anatolian buffalo calves of about 5 months old, at an average live weight of 100 kg, were used as the animal specimen in the present study. The calves were fed with 30:70 roughage (alfalfa hay = 18.07% crude protein, 2186.90 kcal kg^{-1} metabolic energy DM): concentrate feed (cattle fattening feed = 16.40% crude protein, 2696.94 kcal kg^{-1} metabolic energy DM). The calves were randomly distributed into 4 different slaughter weight (SW) groups of GI (200 kg; n = 5), GII (250 kg; n = 5), GIII (300 kg; n = 5), and GIV (350 kg; n = 5). The results showed that hot and cold carcass ratios ($P < 0.01$) and carcass chilling loss increased with increasing slaughter weights. Except for head, feet, and kidney weight, the differences in all of the other organ weights of the SW groups were not statistically significant. The differences in all of the investigated carcass measurements of the SW groups were detected to be significant ($P < 0.05$). Although total carcass conformation index values increased with increasing slaughter weights, only the differences in the carcass compactness values of the SW groups were statistically significant ($P < 0.001$). Except for chunk, short loin, sirloin, rump, and flank ratios, the differences in all of the other carcass section ratios of the SW groups were statistically significant ($P < 0.05$).

Key words: Anatolian buffalo, slaughter weight, carcass traits, carcass measurement

1. Introduction

About 30% of the Turkish population lives in rural areas of Turkey. The rapid increase in the population has brought about a need for an efficient and productive use of resources needed for human nutrition. Animal products play a key role in the nutrition of all age groups, especially of children. Therefore, for a healthy and balanced nutrition, relevant measures should be taken, welfare levels should be increased, and the quantity and quality of animal products should be improved in line with consumer demands. Together with increasing populations, consumer demands are also increasing in favor of preferred products [1]. A balanced and healthy nutrition is only possible when animal-originated proteins constitute 35%–40% of daily protein consumption [2]. Red meat consumption is increasing day by day in developing countries like Turkey. As a result, farmers and producers are moving towards alternative red meat production resources to meet such increasing demands [3].

Buffaloes raised in Turkey are called Anatolian buffaloes; they originated from Mediterranean buffaloes, a subgroup of water buffaloes [4]. According to data from 2018, the number of buffaloes in Turkey was 178,397. In the last 30 years, the buffalo population has decreased in the country. However, the number of buffalos is now continuously increasing in Turkey because of the support provided by the Ministry of Agriculture and Forestry. Annually, 1,118,695 tons of red meat is produced from important red meat production sources such as cattle, buffalo, sheep, and goats. The production sources are as follows: cattle (89.73%), sheep (9.01%), goats (1.21%), and buffalo (0.03%). In Turkey, the carcass weights of cattle, buffalo, sheep, and goats are, respectively, 296 kg, 214.9 kg, 21.6 kg, and 19.8 kg [5]. Annual red meat consumption per capita is 14.5 kg [6]. Worldwide, this quantity is 20.1 kg, and it is 50.4 kg in the USA, 34.2 kg in Canada, and 47.8 kg in Australia [7]. In other words, red meat consumption per capita in Turkey is lower than that of developed

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countries. Thus, the 12.5 kg of red meat consumption per capita in the country should be increased. Together with ever-changing lifestyles and the EU accession period, the meat quality should improve, alternative sources of red meat production should be identified, and red meat consumption per capita should increase.

In Turkey, the number of studies on slaughter and carcass traits in Anatolian buffaloes is limited. As a result, this research was designed to determine slaughter and carcass traits of Anatolian buffaloes at different slaughter weights.

2. Materials and method

This study was approved by Ahi Evran University's Animal Ethic Committee with an official form date and protocol number: 12.02.2014 and 7 (1–4). The study was conducted in a private breeding farm in Tokat province. The animal material of the study was made up of 20 weaned male Anatolian buffalo calves with an average live weight of 100 kg and an age of 5 months. Buffalo calves were supplied from the city of Tokat and surrounding towns. Calves with prespecified slaughter weights were distributed randomly into different slaughter weight (SW) groups: 200 kg (GI; n = 5), 250 kg (GII; n = 5), 300 kg (GIII; n = 5), and 350 kg (GIV; n = 5). Following a week of acclimatization feeding, calves entered into a fattening period. Cattle fattening feed (16.40% crude protein, 2696.94 kcal kg^{-1} metabolic energy) was used as feed material, and alfalfa hay (18.07% crude protein, 2186.90 kcal kg^{-1} metabolic energy) was used as roughage. Calves were fed with 30:70 roughage: concentrate feed ration [8]. The calves with targeted slaughter weight were taken into individual pens. They were kept without feed for 12 h and their end of fattening live weights were determined.

From each slaughter weight group, 5 Anatolian buffaloes were slaughtered. Slaughters were performed at a licensed slaughterhouse in accordance with the slaughter procedures of the Turkish Standards Institute [9].

2.1. Slaughter and carcass traits

Following the slaughter, skin, head, feet, heart, lungs, liver, kidney, spleen, testicles, omental-mesenteric fat weights, and hot and cold carcass (following 24 h at +4 °C) weights were determined. Following carcass separation of the Anatolian buffaloes of different slaughter weights, from the inner and outer surfaces of the carcasses the carcass length, hindquarter length, hindquarter width, hindquarter circumference, and carcass width were measured [10–12]. After taking the carcass measurements, carcass conformation coefficients (carcass compactness (kg/cm) = cold carcass weight (kg)/carcass length (cm), carcass conformation = carcass width (cm)/carcass length (cm) and leg conformation = hindquarter width (cm)/hindquarter length (cm) were determined [13–15]. Following the slaughtering, the thickness of back fat surrounding the *m. longissimus dorsi thoracis* (MLT) was measured from between the 12–13th ribs with a digital caliper; the rib eye area of the MLT was measured from the same anatomic section by drawing the area over tracing paper [16,17]. Left half carcasses were separated into 10 pieces of chunk, rib, short loin, sirloin, rump, round, flank, plate, brisket, and shank in accordance with Swatland [18]; then, the weight and ratio of all of these parts were determined with a precise balance (±1 g). Experimental data were analyzed with using the GLM (general linear model) procedure in SPSS [19] statistical software was used in the study to evaluate the data of slaughter and carcass traits. Means for slaughter and carcass traits of buffalo calves at different slaughter weights were contrasted with Duncan's multiple range test [20].

3. Results

Least square means and standard errors for slaughter traits of the Anatolian buffaloes fed with 30:70 roughage: concentrate feed ration and slaughtered at different slaughter weights (200, 250, 300, and 350 kg) are provided in Table 1. The number of studies examining Anatolian buffalo slaughter and carcass characteristics in Turkey is limited. Therefore, in this research, when comparing the slaughter and carcass characteristics of buffaloes slaughtered at different weights live weight groups close to the slaughtering weights in this research were taken into consideration.

The differences in hot carcass weights of the slaughter groups were found to be significant ($P < 0.001$). Head, feet, skin, and visceral organ weights increased with increasing slaughter weights. Except for omental-mesenteric fat weight, there were significant differences in noncarcass component weights in the treatment groups ($P < 0.01$). Least square means and standard errors for slaughter and carcass traits of Anatolian buffaloes at different slaughter weights are provided in Table 2.

Both hot and cold carcass ratios increased with increasing slaughter weights ($P < 0.01$). While the differences in chilling loss, skin, lungs and trachea, lungs, liver, heart, omental-mesenteric fat, and testicle ratios of the SW groups were not statistically significant, differences in other ratios of in the SW groups were statistically significant ($P < 0.05$). Least square means and standard errors for carcass measurements and conformation coefficients of Anatolian buffaloes are shown in Table 3.

There were significant differences in the carcass measurements of the GII and GIII SW groups ($P < 0.01$). Although the differences between GI, GII, GIII, and GIV were statistically significant in SW groups in terms of carcass length ($P < 0.01$), the differences observed between GIII and GIV were not significant ($P > 0.05$). The carcass compactness values of the SW groups were calculated as

Table 1. Means and standard errors for slaughter traits of Anatolian buffaloes at different slaughter weights.

Traits	Slaughter weight groups (SW) (kg)				P- value
	GI (n = 5)	GII (n = 5)	GIII (n = 5)	GIV (n = 5)	
SW	200.21 ± 0.71	249.85 ± 1.82	299.96 ± 3.48	353.78 ± 2.80	0.000***
HCW	98.60 ± 2.52^{d}	122.15 ± 2.52^{c}	157.00 ± 2.52^{b}	189.52 ± 2.25^{a}	0.000***
CCW	96.45 ± 2.57^{d}	119.23 ± 2.57^{c}	153.55 ± 2.57^{b}	185.33 ± 2.30^{a}	0.000***
Noncarcass components weight					
Head	14.27 ± 0.51^{c}	16.49 ± 0.51^{b}	17.99 ± 0.51^{b}	20.50 ± 0.45^{a}	0.000***
Feet	6.00 ± 0.32^{c}	7.29 ± 0.32^{b}	7.62 ± 0.32^{b}	9.35 ± 0.29^{a}	0.000***
Skin	23.72 ± 1.78^{d}	29.25 ± 1.78^{c}	35.02 ± 1.78^{b}	41.81 ± 1.59^{a}	0.000***
Lungs + Trachea	1.73 ± 0.07^{d}	1.98 ± 0.07^{c}	2.51 ± 0.07^{b}	2.77 ± 0.06^{a}	0.000***
Lungs	1.38 ± 0.05^{d}	1.64 ± 0.05^{c}	1.96 ± 0.05^{b}	2.29 ± 0.04^{a}	0.000***
Liver	2.80 ± 0.18^{c}	3.63 ± 0.18^{b}	4.28 ± 0.18^{a}	4.57 ± 0.16^{a}	0.000***
Spleen	0.46 ± 0.05^{c}	0.61 ± 0.05^{bc}	0.66 ± 0.05^{b}	0.90 ± 0.04^{a}	0.000***
Heart	0.94 ± 0.05^{c}	1.27 ± 0.05^{b}	1.41 ± 0.05^{ab}	1.54 ± 0.04^{a}	0.000***
Testicles	0.17 ± 0.02^{b}	0.23 ± 0.02^{ab}	0.29 ± 0.02^{a}	0.29 ± 0.02^{a}	0.008**
Omental-mesenteric fat	1.41 ± 0.24	1.45 ± 0.24	1.93 ± 0.24	2.08 ± 0.22	0.158^{NS}
Kidney	0.52 ± 0.03^{b}	0.62 ± 0.03^{b}	0.64 ± 0.03^{b}	0.80 ± 0.03^{a}	0.001**

HCW: hot carcass weight; CCW: cold carcass weight.
GI: 200 kg slaughter weight; GII: 250 kg slaughter weight; GIII: 300 kg slaughter weight; GIV: 350 kg slaughter weight.
NS: nonsignificant; **: P < 0.01; ***: P < 0.001.
a, b, c, d: means indicated with different letters in the same row were significantly different (P < 0.05).

0.99, 1.13, 1.34, and 1.60 kg/cm, respectively. Although increasing index values were observed with increasing slaughter weights, the differences in carcass conformation and leg conformation of the SW groups were not statistically significant. The differences in the back fat thickness of the SW groups were statistically significant (P < 0.01). In terms of SW, the difference between GI and GII and the difference between GIII and GIV groups is statistically insignificant (P > 0.05), while the difference between GI, GIII, and GIV and the difference between GII and GIV were statistically significant (P < 0.01). The rib eye area of the MLT of the SW groups was calculated as 52.33, 56.81, 68.99, and 69.61 cm^2, respectively. The differences in the rib eye area of the MLT of the GI and GII SW groups and the GIII and GIV SW groups were not statistically significant. However, the differences between GI and GII and GIII and GIV were statistically significant (P < 0.01). The effects of slaughter weights on ratio and weight of different carcass sections are provided in Table 4.

The differences between the rib, round, plate, brisket, and shank ratios of the SW groups were not statistically significant. In general, carcass rib, rump, plate, and brisket ratios increased, and flank and shank ratios decreased with increasing slaughter weights.

4. Discussion

Carcass ratio is the most important factor in designating carcass quality [21,22]. In this study, hot and cold carcass ratios increased with increasing slaughter weights. Lapitan et al. [23] conducted a study with crossbred buffaloes slaughtered at 468.7 kg live weight and reported hot and cold carcass weights as 257.32 kg and 250.97 kg, respectively, and hot and cold carcass ratios as 54.99 and 53.65%, respectively. The cold carcass ratio noted by Lapitan et al. [23] for local buffaloes slaughtered at about 250 kg was greater than the present values for all of the slaughter weights of Anatolian buffaloes.

Aksoy [24] conducted a study with local buffaloes and reported the end of fattening weights as 311, 307, and 317 kg; cold carcass weights as 162, 161, and 168 kg; and cold carcass ratios as 52.80%, 53.00%, and 53.60%. This author indicated that differences between the groups were not statistically significant. The present cold carcass ratio for the 300 kg slaughter weight was similar to the one reported by Aksoy [24].

In another study conducted with local buffaloes slaughtered at 397 and 484 kg slaughter weights, Akdağ [25] reported hot carcass weights as 216.71 and 249.41 kg, respectively, and cold carcass weights as 205.22 and 235.66

Table 2. Means and standard errors for the slaughter and carcass traits of Anatolian buffaloes at different slaughter weights.

Traits	Slaughter weight groups (SW) (kg)				P-value
	GI (n = 5)	GII (n = 5)	GIII (n = 5)	GIV (n = 5)	
HCP[1]	49.25 ± 0.83[b]	48.87 ± 0.83[b]	52.37 ± 0.83[a]	53.56 ± 0.74[a]	0.002**
CCP[1]	48.17 ± 0.86[b]	47.70 ± 0.86[b]	51.30 ± 0.86[a]	52.38 ± 0.77[a]	0.003**
CLP	2.18 ± 0.14	2.45 ± 0.12	2.21 ± 0.14	2.20 ± 0.12	0.443[NS]
Noncarcass components (as % of slaughter weight)					
Head	7.12 ± 0.195[a]	6.60 ± 0.195[a]	6.00 ± 0.195[b]	5.79 ± 0.174[b]	0.001**
Feet	3.00 ± 0.11[a]	2.91 ± 0.11[ab]	2.53 ± 0.11[c]	2.64 ± 0.09[bc]	0.030*
Skin	11.85 ± 0.55	11.72 ± 0.55	11.65 ± 0.55	11.82 ± 0.49	0.993[NS]
Lungs	0.69 ± 0.01	0.66 ± 0.01	0.66 ± 0.01	0.65 ± 0.01	0.219[NS]
Liver	1.40 ± 0.07	1.45 ± 0.07	1.42 ± 0.07	1.29 ± 0.06	0.387[NS]
Heart	0.47 ± 0.02	0.51 ± 0.02	0.47 ± 0.02	0.43 ± 0.01	0.098[NS]
Spleen	0.23 ± 0.01	0.24 ± 0.01	0.21 ± 0.01	0.25 ± 0.01	0.377[NS]
Kidney	0.26 ± 0.01[a]	0.25 ± 0.01[ab]	0.21 ± 0.01[b]	0.22 ± 0.01[b]	0.039*
Omental-mesenteric fat	0.70 ± 0.09	0.58 ± 0.09	0.64 ± 0.09	0.59 ± 0.08	0.766[NS]
Testicles	0.08 ± 0.01	0.09 ± 0.01	0.10 ± 0.01	0.08 ± 0.01	0.350[NS]

HCP: hot carcass percentage; CCP: cold carcass percentage; CLP: chilling loss percentage.
[1]: calculated based on preslaughter live weight.
GI: 200 kg slaughter weight; GII: 250 kg slaughter weight; GIII: 300 kg slaughter weight; GIV: 350 kg slaughter weight.
NS: nonsignificant; *: $P < 0.05$; **: $P < 0.01$.
a, b, c: means indicated with different letters in the same row were significantly different ($P < 0.05$).

Table 3. Effects of slaughter weights on carcass measurements and conformation indices.

Traits	Slaughter weight groups (SW) (kg)				P-value
	GI (n = 5)	GII (n = 5)	GIII (n = 5)	GIV (n = 5)	
Carcass measurements (cm)					
Carcass length	96.67 ± 2.28[c]	104.95 ± 2.28[b]	114.37 ± 2.28[a]	115.16 ± 2.04[a]	0.000***
Carcass width	53.02 ± 1.968[c]	58.15 ± 1.968[bc]	63.93 ± 1.96[ab]	65.62 ± 1.76[a]	0.002**
Hindquarter length	68.47 ± 1.16[c]	72.28 ± 1.16[b]	72.63 ±1.164[b]	76.88 ± 1.041[a]	0.001**
Hindquarter width	18.20 ± 1.10[b]	21.38 ± 1.10[ab]	22.38 ± 1.10[a]	24.04 ± 0.98[a]	0.013*
Hindquarter circumference	82.50 ± 1.47[c]	86.28 ± 1.47[bc]	89.50 ± 1.47[b]	96.22 ± 1.32[a]	0.000*
Carcass conformation indices					
Carcass compactness (kg / cm)	0.99 ± 0.02[d]	1.13 ± 0.02[c]	1.34 ± 0.02[b]	1.60 ± 0.01[a]	0.000***
Carcass conformation	0.54 ± 0.02	0.55 ± 0.02	0.56 ± 0.02	0.57 ± 0.01	0.880[NS]
Leg conformation	0.26 ± 0.01	0.29 ± 0.01	0.31 ± 0.01	0.31 ± 0.01	0.250[NS]
Back fat thickness (mm)	2.65 ± 0.54[c]	4.09 ± 0.48[bc]	5.16 ± 0.54[ab]	6.41 ± 0.48[a]	0.001**
Rib eye area of MLT (cm^2)	52.33 ± 1.76[b]	56.81 ± 3.78[b]	68.99 ± 4.61[a]	69.61 ± 3.67[a]	0.01**

GI: 200 kg slaughter weight; GII: 250 kg slaughter weight; GIII: 300 kg slaughter weight; GIV: 350 kg slaughter weight.
NS: nonsignificant, $P > 0.05$; *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$.
a, b, c, d: means indicated with different letters in the same row were significantly different ($P < 0.05$).
MLT: *m. longissimus dorsi thoracis*.

Table 4. Carcass section weight (kg) and ratios (%) at different slaughter weights.

Traits	Slaughter weight groups (SW) (kg)				P-value
	GI (n = 5)	GII (n = 5)	GIII (n = 5)	GIV (n = 5)	
Chuck					
Weight	19.72 ± 1.15^{c}	26.42 ± 1.15^{b}	33.65 ± 1.15^{a}	36.96 ± 1.03^{a}	0.000***
Ratio	20.51 ± 0.72	22.08 ± 0.72	21.91 ± 0.72	19.98 ± 0.64	0.132 ^{NS}
Rib					
Weight	11.11 ± 0.51^{d}	13.16 ± 0.51^{c}	18.14 ± 0.51^{b}	22.10 ± 0.45^{a}	0.000***
Ratio	11.54 ± 0.18^{ab}	11.01 ± 0.18^{b}	11.80 ± 0.18^{a}	11.94 ± 0.16^{a}	0.012*
Short loin					
Weight	5.10 ± 0.54^{c}	7.28 ± 0.54^{b}	7.93 ± 0.54^{b}	10.56 ± 0.48^{a}	0.000***
Ratio	5.31 ± 0.35	6.10 ± 0.35	5.18 ± 0.35	5.70 ± 0.32	0.301 ^{NS}
Sirloin					
Weight	6.33 ± 0.54^{c}	8.66 ± 0.54^{b}	9.90 ± 0.54^{b}	12.91 ± 0.49^{a}	0.000***
Ratio	6.58 ± 0.40	7.27 ± 0.40	6.46 ± 0.40	6.98 ± 0.36	0.494 ^{NS}
Rump					
Weight	10.17 ± 1.08^{c}	10.96 ± 1.08^{c}	15.10 ± 1.08^{b}	18.37 ± 0.97^{a}	0.000***
Ratio	10.58 ± 0.59	9.18 ± 0.59	9.80 ± 0.59	9.91 ± 0.53	0.454 ^{NS}
Round					
Weight	21.89 ± 0.70^{d}	25.47 ± 0.70^{c}	30.49 ± 0.70^{b}	37.76 ± 0.63^{a}	0.000***
Ratio	22.72 ± 0.58^{a}	21.32 ± 0.58^{ab}	19.89 ± 0.58^{c}	20.42 ± 0.51^{c}	0.020*
Flank					
Weight	2.93 ± 0.41	2.99 ± 0.41	3.55 ± 0.41	4.02 ± 0.37	0.213 ^{NS}
Ratio	3.04 ± 0.29	2.52 ± 0.29	2.31 ± 0.29	2.18 ± 0.29	0.190 ^{NS}
Plate					
Weight	7.07 ± 0.51^{d}	9.51 ± 0.51^{c}	13.40 ± 0.51^{b}	16.60 ± 0.45^{a}	0.000***
Ratio	7.34 ± 0.29^{c}	7.99 ± 0.29^{bc}	8.73 ± 0.29^{ab}	8.97 ± 0.29^{a}	0.005**
Brisket					
Weight	9.20 ± 0.754^{d}	11.91 ± 0.754^{c}	17.83 ± 0.754^{b}	21.63 ± 0.675^{a}	0.000***
Ratio	9.56 ± 0.456^{b}	9.99 ± 0.456^{b}	11.59 ± 0.456^{a}	11.68 ± 0.408^{a}	0.008**
Shank					
Weight	2.66 ± 0.178^{c}	2.99 ± 0.178^{bc}	3.50 ± 0.178^{b}	4.04 ± 0.159^{a}	0.000***
Ratio	2.80 ± 0.036^{a}	2.26 ± 0.036^{b}	1.76 ± 0.036^{c}	1.46 ± 0.032^{d}	0.000***

GI: 200 kg slaughter weight; GII: 250 kg slaughter weight; GIII: 300 kg slaughter weight; GIV: 350 kg slaughter weight.

NS: nonsignificant, P > 0.05; *: P < 0.05; **: P < 0.01; ***: P < 0.001.

a, b, c, d: means indicated with different letters in the same row were significantly different (P < 0.05).

kg, respectively. Similar to the present study, Akdağ [25] also indicated that slaughter weights had significant effects on cold carcass weights. In the same study, hot carcass ratio, cold carcass ratio, and chilling loss for the 397 kg slaughter weight were reported respectively as 54.87%, 51.96%, and 5.28%. The same values for the 484 kg slaughter weight were reported as 51.65%, 48.81%, and 5.47%, respectively. The chilling loss value reported by Akdağ [25] was about 3% lower than the present values for all slaughter weights. In this research, hot and cold carcass ratios were measured as 52.37% and 51.30% for GIII and 53.56% and 52.38% for GIV, respectively. The present research detected hot and cold carcass weights for SW groups that were lower than the hot and cold values previously reported for Turkish

buffaloes [26,27]. Present hot and cold carcass ratios were similar with the values of Tahir et al. [28] (47.4%, 46.9%, 51.8%, and 50.5%), lower than the value of Afifi et al. [29] (57.3%) and the values of Romita et al. [30,31] (58.25% and 59.61%). In a study carried out on swamp buffaloes [32], the carcass ratio for the 250 kg slaughter weight was reported as 52.1%.

Increasing head, feet, skin, lungs and trachea, lungs, liver, spleen, heart, testicles, omental-mesenteric fat, and kidney weights were observed with increasing slaughter weights (Table 1). Only the differences in the omental-mesenteric fat weights of the treatment groups were found to be significant. Organ weights also increased with increasing slaughter weights (Table 1). In a previous study from the Afyon Buffalo Research Institute, increasing carcass weights of local buffaloes were reported with increasing animal age, and varying increases were reported for organ weights [27,33]. In this study, the liver, lungs, kidney, and mesenteric fat weights of the SW groups were lower than the values of Akdağ [25]. While feet, skin, and heart weights from the 200, 250, and 300 kg SW groups were lower than the values found by Akdağ [25], feet, skin, and heart weights from the 350 kg SW group were similar with Akdağ's reported findings [25].

The head weights of the 250 and 300 kg SW groups were similar to the values reported for local buffaloes slaughtered at 397–484 kg slaughter weights, but the head weight of 350 kg SW group was lower than the value reported for those local buffaloes [25].

While the differences in the head, feet, and kidney ratios of the SW groups were found to be significant ($P < 0.01$), the differences in the other organ ratios were not found to be significant (Table 2). The head and feet ratios of the present study's SW groups were greater than the values that Akdağ [25] reported for local buffaloes, but the mesenteric fat, kidney, and liver ratios of the present study's SW groups were similar to the values of Akdağ [25].

Girth is the last body section to develop during animal growth. Thus, back fat thickness and rib eye area constitute significant parameters for carcass growth and fattening [17,34,35]. Both the back fat thickness and rib eye area values of Anatolian buffaloes increased with increasing slaughter weights. Similar to the present findings, Özavcı and Eyigör [36] and Aksoy and Ulutaş [22] reported increasing back fat thickness and rib eye area values with increasing carcass and slaughter weights.

Carcass measurements increased with increasing slaughter weights, and the differences in the carcass measurements of the SW groups were statistically significant. Lambertz et al. [37] reported carcass lengths of river buffaloes slaughtered at 367, 373, 394, and 402 kg slaughter weights as 142, 143, 144 and 143 cm, respectively. The present study's hindquarter lengths for all slaughter weight groups were lower than the values of Akdağ [25], but hindquarter circumference values were greater than the values determined for local buffaloes (44 and 46 cm) [25].

The hindquarter lengths found in this study for the 200, 250, and 300 kg SW groups were similar with the values (67.87 and 72.62 cm) reported by Yılmaz et al. [38]. However, the carcass lengths and hindquarter widths of all slaughter weight groups were lower than the findings of Yılmaz et al. (28.99 and 29.96 cm) [38]. The differences in carcass measurements of different researchers were mostly attributed to the age of the buffaloes.

5. Conclusion

Studies have reported that there is a positive relationship between carcass yield and carcass measurements in terms of quality and quantity of the meat in the carcass [25, 26]. Therefore, cold carcass yield is a significant parameter for meat production and carcass quality. In this study, with an increase in the slaughter weight and in the cold carcass yield, all of the carcass measurements and carcass compactness increased; in addition, the ratio of edible noncarcass components such as head, liver, heart, and kidney ratios decreased in Anatolian buffaloes. Depending on the increase in slaughter weight for the Anatolian buffalo, the flank and shank ratio decreased, and the plate and brisket ratio increased.

In conclusion, based on the present data, cold carcass yield and compactness increased with slaughter weight; therefore, Anatolian buffaloes must not be slaughtered before they reach a live weight of 350 kg.

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Contribution of authors

EU, YA, and AŞ received data; YA, AŞ, and ZU planned and wrote the study.

Conflict of interest

All of the authors declare that they have no conflict of interest.

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