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Original Article

Effects of indigenous cattle age on their beef quality

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A B S T R A C T

The experiment was conducted to examine the quality of beef from indigenous cattle at different ages. Animals were grouped into <1.6, 1.6–2 and 2–3 years, and then beef samples were collected. Live weight of <1.6 (140.93±18.82 kg), and 1.6–2 (143.87±14.95 kg) years cattle were significant (p<0.05) lower than 2–3 were years cattle (237.33±50.14 kg). Similarly, the hot carcass weight were significant (p<0.05) higher in 2–3 were years old cattle (126.77±31.80 kg) than <1.6 (68.65±13.75 kg), and 1.6–2 (72.45±9.08 kg) years old cattle, respectively. The average dressing percentages and mean pH value of meat sample were similar in all three age groups of cattle. Higher cooking loss were in 2-3 years cattle group and lower cooking loss were in 1.6-2 years cattle group after heating at 100°C for 20 and 30 minutes. Drip loss values after 1, 3, 6, 9, and 12 days in three age groups were significantly different (p<0.05) and higher drip loss were recorded in 1.6–2 years cattle group than other two age group of cattle. Among the proximate component, only crude protein (CP) and ash showed significant changes among beef cattle age group. The CP content were higher in meat from <1.6, and 1.6–2 years old cattle than 2–3 years cattle. On the other hand, ash content were significantly (p<0.05) higher in meat from <1.6 years old cattle than other age group. From this present study, it is concluded that the age of indigenous beef cattle has influenced on beef quality.

Introduction

Indigenous cattle are very important part in livelihood and well-being for the people in Bangladesh. They contribute in food, agrarian culture, agricultural power, biodiversity and heritage (FAO, 2007). The economy of Bangladesh is largely depends on agriculture. Livestock being one of the four components of agriculture (crops, livestock, fisheries and forestry) contributing 13.46% of agricultural GDP (DLS, 2019). The average per capita meat consumption is 42.1 kg/year in the world. Countries of developed and developing world consume 82.9 and 31.1 kg/year, respectively (FAO, 2009). The annual meat production in Bangladesh is 0.687 million metric ton where the beef contributes 0.191 million metric ton of the total meat production (FAOSTAT, 2019). The demand of meat in Bangladesh is 7.3 million metric tons per year (DLS, 2019).

The consumption of beef mostly depends on consumers' preference and nutritional value of beef. In Bangladesh, beef usually comes from the non-reproductive cows, unproductive aged bullocks and culled animals from our country or partly from the neighboring country, India. Beef is considered as a high source of animal protein. Chemically meat composed of water, protein, fat, ash and carbohydrate (Pearson and Gillett, 1999). The nutritional feature of meat, which provide consumer demand for protein, some vitamins and certain minerals. However, as most of the cattle in Bangladesh slaughtered at later stage of their life therefore it is important to know how age of the cattle influences the nutritive quality of beef.

Meat quality, including sensory characteristics of beef, is affected by a number of factors, such as breed (Chambaz *et al*., 2003), nutrition (Bartoň *et al*., 2010), ante-mortem treatment of animals (Jelenikova *et al*., 2008), post-mortem treatment and ageing of meat (Campo *et al*., 1999; Monson *et al*., 2005), and cooking methods (Panea *et al*., 2008). Several authors have also examined sex differences in meat quality between bulls and steers (Cross *et al*., 1984; Mandell *et al*., 1997). While only minor differences in meat quality between crossbred bulls and heifers had been observed in a study by Hoving-Bolink *et al*. (1999), significant effects

were reported by Velik *et al*. (2008). Similarly, many research works have already been carried out on the quality of different cuts of beef carcass (Savell *et al*., 2007; Gruber *et al*., 2006; Jahan, 2008), sheep carcass (Hamid *et al*., 2008) and goat carcass (Islam, 2010) in different countries including Bangladesh. There are also many research works have been done on preservation of beef in Bangladesh (Faisal *et al*., 2009; Akhter *et al*., 2009) but so far there are no work is available related to quality determination of longissimus dorsi of indigenous beef according to age in Bangladesh. So, the study was conducted to determine the physical and chemical properties of beef from different ages of indigenous cattle.

Materials and methods

Experimental samples

The experiment was conducted in Animal Science Laboratory, Bangladesh Agricultural University. Nine samples of longissimus dorsi muscle of nine indigenous beef cattle were obtained from <1.6, 1.6–2 and 2–3 years age beef cattle (age evaluated through dentition stage) with three replication of each age group. The meat samples were used to examine physical and chemical properties. Live weight, hot carcass weight, dressing percentage, pH, cooking loss and drip loss were examined as physical properties. Similarly, moister, crude protein, ether extract and ash were examined as chemical properties.

Physical properties

The live weight (kg) of indigenous beef cattle were taken directly using a weighing balance. Hot carcass weight was determined by removing head, skin, thoracic cavity contents, abdominal cavity contents, pleural cavity contents, fore and hind canons from slaughtered cattle. Dressing percentage was calculated on the basis of hot carcass weight.

Meat samples (5 g) were homogenized using a grinder and diluted in 10 ml of distilled water and the pH was measured using a pH meter (Coring model 250). To examine cooking loss, 80-100 g of meat sample was heated at 100°C in hot water bath for 20 min and 30 min, respectively. The final weight was deducted from the initial weight to determine cooking loss. The individually weighing steaks were suspending in inflated polythene bags to determine the drip (enough care were taken so that samples did not touch the sides of the polythene bags) for 24 hrs at ± 4°C. After 24 hrs, samples were removed, blotted dry and weighed; this process was continued until 14 days. Then the final weight was deducted from the initial weight and drip loss was calculated as the percentage.

Chemical properties

Proximate analysis (moisture, protein, ether extract and ash) were carried for determining chemical properties of meat samples (AOAC, 1995). Moisture content was determined by the placing 5 gm of sample in a pre-weighed porcelain crucible and then transferred in an electric oven for 24 hours at 105°C to get constant weight of sample. The loss of moisture was calculated as percentage.

Micro-Kjeldahl method were used to calculate the crude protein content of meat samples. Total nitrogen content of each sample (1 g) was determined in triplicate by using Kjeldahl apparatus. In this case total nitrogen was determined by digesting the samples with 20 ml concentrated sulphuric acid (H_2SO_4) in presence of 100 g potassium suphate (K_2SO_4), 10 g copper sulphate (Cu_2SO_4) and 1 g selenium iodide followed by distillation of ammonia liberated by alkali (NaOH) into boric acid (H_3BO_4) and titrated with standard HCl (0.1 N). The nitrogen values thus obtained were converted to total crude protein by multiplying with a factor of 6.25.

Meat samples were taken in porcelain crucibles and pre-ashes at 100°C in an electric oven. The crucibles were then placed in a muffle furnace and heated at 550°C for 6 hours. The crucibles were then cooled in desiccators. The average weight in percentage of each sample of the remaining material was taken as ash.

Ether extract was determined by Soxhlet Apparatus using acetone. Meat sample (2 g) was taken in pre-weighed thimbles and were dipped in pre-weighed aluminum cups with 80 ml ether. First boiling then rinsing and finally extraction were done at 40-45°C which took about 7 hours. After extraction the aluminum cups were taken out and dried in oven for 30 min at 100°C. The cup containing ether extract was cooled in a desiccators and weighed. The calculated value for lipid content was obtained as percent of the sample.

Statistical analysis

All data from the experiments were subjected to one-way ANOVA followed by Duncan's test (IBM SPSS Statistics 22). Values of $P < 0.05$ were considered significant.

Results and discussion

Physical properties

In this study we have found that the live weight of cattle increased with addition of age (Table 1). The highest live weight (237.33±50.14 kg) was found in 2-3 years cattle. On the other hand, the live weight of <1.6 and 1.6-2 years indigenous cattle were similar. Hot carcass weight at different ages of cattle are shown in Table 1. The result represented that the hot carcass weight (126.77±31.80 kg) was significantly higher in 2-3 years cattle than 1.6-2 (72.45±9.08 kg) and <1.6 (68.65±13.75 kg) years cattle. However, there were no significant difference between the hot carcass weight of 1.6-2 and <1.6 years indigenous cattle. The dressing percentage values at different ages of indigenous beef cattle are also shown in Table 1. There were no significant changes to dressing percentage values in different ages of indigenous beef cattle. The maximum body weight of native bull in Bangladesh usually 442 kg (Koirala *et al*., 2011). The body weight of native cattle increased with the increase of age and higher weight was 237.33±50.14 kg in 2-3 years cattle which indicate that the cattle of this study did not reach the mature body weight yet. There is a positive correlation between live weight of cattle and hot carcass weight (Lardy, 1998). As the body weight of 2-3 years cattle were higher therefore the hot carcass weight were also higher in that group of cattle. The carcass dressing percentage was relatively constant. A similar result has been reported that increasing slaughter age from 18-30 months could increase live and carcass weights but not the dressing percentage of beef steers finished on natural pastures (Du Plessis and Hoffman, 2007). Similarly, Priyanto *et al*. (2019) reported that the dressing percentage of cattle is not correlated with neither the age nor the body weight of animals.

Table 1. Effect of age on live weight, carcass weight and dressing percentage

Parameters	Age of beef cattle		
	< 1.6 years	1.6-2 years	2-3 years
Live weight (kg)	140.93±18.82[b]	143.87±14.95[b]	237.33±50.14[a]
Hot carcass weight (kg)	68.65±13.75[b]	72.45±9.08[b]	126.77±31.80[a]
DP (%)	51.60±3.65	49.71±1.72	46.82±4.25

DP: Dressing percentage. Values with different superscripts (a-b) at the same row differed ($P < 0.05$).

The pH values of meat from different ages of indigenous beef cattle shown in Table 2. There were no significant differences in pH values measured 2 hours and 24 hours after slaughter of cattle from different age group. Muscle pH value is greatly affected by pre-slaughter live weight. Muscle pH, which directly reflects the strength of glycogenolysis, is closely related to other meat quality indicators as one of the important indicators to determine muscle quality (Komariah, 1999). There were no significant differences in meat pH measured 2 hours and 24 hours after slaughter of cattle from different age group. A similar result has been reported that buffalo slaughtered at 0-3, 4-6, 12-18 and 24-36 months of age exhibited similar meat pH (Li *et al*., 2018).

Table 2. Effect of age of indigenous beef cattle on meat pH

Time after slaughter	Age of beef cattle		
	< 1.6 years	1.6-2 years	2-3 years
After 2 hours	5.79±0.07	5.75±0.05	5.92±0.07
After 24 hours	5.67±0.10	5.45±0.06	5.47±0.07

Values with different superscripts (a-b) at the same row differed ($P < 0.05$).

The cooking loss of 2-3 year age cattle was increased (50.17±0.21%) significantly ($P<0.05$) than 1.6-2 (43.98±0.13%) and <1.6 (47.28±0.42%) years cattle after 20 minutes of cooking at 100°C (Table 3). The cooking loss of 1.6-2 year age cattle was also significantly ($P<0.05$) higher than <1.6 year cattle. Similar trend was observed after 30 minutes of cooking at 100°C. Schönfeldt and Strydom (2011) reported that cooking losses increased nonlinearly with age, irrespective of the muscle which is similar to present study.

Table 3. Effect of age on cooking loss (%) of meat

Cooking at 100°C	Age of beef cattle		
	< 1.6 years	1.6-2 years	2-3 years
20 minutes	47.28±0.42[b]	43.98±0.13[c]	50.17±0.21[a]
30 minutes	48.77±0.31[b]	46.11±0.13[c]	50.60±0.23[a]

Values with different superscripts (a-c) at the same row differed ($P < 0.05$).

The trend of drip loss with different ages of indigenous beef cattle are shown in Table 4. After 1 day the drip loss was found the highest at 1.6-2 years cattle compared to <1.6 and 2-3 years cattle. Similar trend was observed after 3, 6, 9 and 12 days. Sargentini *et al.* (2010) reported that the drip loss of beef increased with advancing age of bulls. The present findings suggested that the drip loss was highest in 1.6-2 years compared to <1.6 and 2-3 years indigenous cattle. It may be due to temperature, duration of time and method of drip loss determination in the present study.

Table 4. Time course changes in drip loss (%) of meat sample from different ages of indigenous beef cattle

Time after slaughter	Age of beef cattle		
	< 1.6 years	1.6-2 years	2-3 years
1 day	2.17±0.11[c]	9.31±1.20[a]	5.87±1.00[b]
3 day	3.57±0.45[c]	14.55±1.23[a]	10.60±0.36[b]
6 day	6.84±0.11[c]	17.33±1.42[a]	13.17±0.41[b]
9 day	9.00±0.04[c]	19.05±1.52[a]	14.60±0.15[b]
12 day	10.32±0.05[c]	20.35±1.66[a]	15.61±0.07[b]

Values with different superscripts (a-c) at the same row differed ($P < 0.05$).

Chemical properties

The moisture content of meat from different age group of indigenous beef cattle are shown in Table 5. There were no significant difference on moisture content in meat from different age group of cattle. Buffalo meat moisture decreased gradually with age with an insignificant difference (Li *et al*, 2018). Ito *et al*. (2010) found that the moisture content of the Longissimus muscle of Puruna bulls was 73.27%, which is similar to the present study and indicate that the moisture content of meat is not influenced by age of the animals.

There were significant differences in crude protein content of meat from different ages of indigenous cattle (Table 5). The highest value of crude protein (85.49±0.46%) was found in meat from <1.6 years old cattle which was significantly difference from 2-3 years old cattle. Although there was no significant difference in crude protein content of meat between 1.6-2 years cattle (81.37±2.32%) and <1.6 years indigenous cattle. The lowest crude protein content (69.15±0.73%) was observed in 2-3 years cattle. Ito *et al.* (2010) reported Puruna bulls contain crude 22.56% protein content.

Table 5. Effect of indigenous cattle age on proximate composition of meat

Proximate component	Age of beef cattle		
	< 1.6 years	1.6-2 years	2-3 years
Moisture (%)	74.00±0.96	72.62±1.59	75.89±0.54
CP (%)	85.49±0.46[a]	81.37±2.32[a]	69.15±0.73[b]
Ash (%)	4.27±.010[a]	3.29±0.02[b]	3.40±0.02[b]
EE (%)	3.36±0.02	3.32±0.06	3.38±0.02

CP: Crude protein (Dry matter basis). EE: Ether extract. Values with different superscripts (a-b) at the same row differed ($P < 0.05$).

The ash content of meat from <1.6 years indigenous cattle (4.27±.010%) was significantly higher than 1.6-2 years (3.29±0.02%) and 2-3 years (3.40±0.02%) indigenous cattle. On the other hand, the ash content of 1.6-2 years and 2-3 years indigenous cattle were similar and statistically identical. Kamble *et al. (*1989) reported that ash content decreased with increase in age which is agreement the present study. Ash content accurately reflects the mineral content, but does not differentiate between minerals. The fatty tissues contain relatively low minerals, and the fat level also directly influences the mineral or ash content of meat

and meat products (Pearson and Gillett, 1999). In the present study it is thought that with the increase of animal age fat deposition increase thus the minerals content of meat decrease and subsequently the ash content of meat sample decrease.

The ether extracts values at different ages of indigenous beef cattle shown in table 5. The ether extract values at different ages of indigenous beef cattle were statistically non-significant. So, there was no effect of age of indigenous beef cattle on ether extract content of meat sample. Nellore young bulls in the age of 18 months fed corn silage (CS), sugar cane (SC) and sugar cane bagasse (CB), after 85 days of feeding the ether extract value of meat samples were 2.75, 2.33 and 2.53 in corn silage (CS), sugar cane (SC) and sugar cane bagasse (CB) fed cattle group, respectively (Machado *et al*. 2015). The effects of slaughter age on meat quality properties of Eastern Anatolian Red (EAR) bulls were investigated by Kopuzlu *et al*. (2018). Forty-six EAR bulls were slaughtered at 15, 17, 19, 25 and 27 months and found that the ether extracts values at different ages of EAR bulls were statistically non-significant which is similar to the present study and indicate that the ether extract content of meat is not influenced by age of the animals.

Conclusion

Age of animal at slaughter have a large impact on beef quality and also consumer acceptance. As maturity or age, increases beyond 30 months, an increase in marbling is required in order to maintain quality grade levels. Most countries require beef animals be less than 30 months of age at slaughter, while Japan has a more stringent requirement of less than 21 months of age. In our contrary age of indigenous cattle plays a significant role in acceptance of meat. Meat quality depends genetic factors like species, breed, sex, age and non-genetic factors like environment and nutritional inclusion to the diets. More specifically, fat deposition is one of the major contributors against meat quality. Therefore, it is concluded that the age of indigenous beef cattle has influenced on beef quality.

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