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Research Article

Effect of dental age on physico-chemical properties of meat of indigenous beef cattle

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Abstract

The objective of this study was to know the physico-chemical properties of beef in relation to dental age of the animals. This experiment was conducted with five (5) treatments (T_1, T_2, T_3, T_4 and T_5) where T_1 = 0 Permanent incisor, T_2 = 2 Permanent incisors, T_3 = 4 Permanent incisors, T_4 = 6 Permanent incisors, T_5 = 8 Permanent incisors having ten (10) replications. From the experiment it is found that colour band of a* (P=0.0008) was significantly higher in the T_5 and T_2 than others and colour band of c* (P=0.0116) was significantly higher in the T_5 than T_1, T_3 and T_4. Dental age maturity of beef cattle did not show an effect on drip-loss of beef LM having the age group of T_1 to T_5 from the post mortem day 24 hrs to 1 week with an exception of post mortem day 5 where dental maturity has a significant effect on drip loss. Cooking loss at room temperature (RT) to 100 °C at holding time of 40 minutes was significantly higher in T1 and lower in T_5. The similar trend was also observed at 100 °C in holding time of 60 minutes and 90 minutes. In both cases, cooking loss was markedly increased ($p<0.001$) in T_1 and decreased ($p<0.001$) with the advances of dental maturity. Carcass pH 2h were significantly increased gradually with the advances of age T_1, T_2, T_4 and T_5; where pH2h, was highest in T_3 and lowest in T_1. In conclusion, dental age affects colour, drip loss (post mortem day 5), cooking loss and carcass pH 2h of meat of indigenous beef cattle.

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Introduction

Livestock is an important part of Bangladesh's agricultural economy (Kamal et al., 2019; Islam et al., 2022a & 2022b). About 75% of people, particularly landless farmers, rely on livestock to some extent for their living (Rahman et al., 1997, 1998 and 1999; Tareque and Chowdhury, 2010). Nowadays, consumers are increasingly aware of the fact that beef quality is not unique, and that there are several aspects that should be taken into account in order to enhance the nutritional quality of the human diet (Akter et al., 2009; Hasan et al., 2021 and 2022). Few studies have looked at the role of beef, specifically lean beef, in the diet. Therefore, it is necessary that our indigenous beef should be characterized accurately in terms of its nutritional quality and safety according to dental age for consumption (Baset et al., 2002 and 2003; Kobir et al., 2022). Knowledge about the origin, chemical and nutritional components of beef are important tools to aware in the selection of beef in their daily diet. The present study discusses important aspects related to the nutritional and eating quality of our indigenous beef. It summarizes the ante-mortem (dental age) and post-mortem (ageing) factors, on physical, chemical parameters of beef quality. One of the major characteristics of the small-scale beef production which supplies the informal or formal market is the unavailability of records to determine the age of animals for sell. Beef cattle of unknown ages are on offer on the informal market and pricing of animal has been very difficult (Van Rooyen et al., 2007). Elsewhere, age determination of beef cattle by means of dentition has generally been done using the norms accepted for sheep and goat (Wilson and Durkin, 1984). Deciduous teeth (milk teeth) erupt first and are replaced by permanent teeth. The time of eruption or breaking through the gums by the teeth is probably the most accurate aid criterion of determining the age of animals when no other accurate records are available. There is need to know the age of animals on offer because age has been known to affect carcass yield, edible body parts and meat offal's in beef cattle (Skapetas et. al., 2006; Aduku et al., 1991). So this study was conducted to know the effect of dental age on physico-chemical properties of meat of indigenous beef cattle.

Materials and Methods

Measurement of pH

The meat sample was homogenized at 1000 rpm for 30 s using a Polytron (Brinkman instruments, New York, NY) blender. A 10 g sample of homogenized sample was weighed into a beaker, and 50 mL of distilled, deionized water was added to the sample. A stir bar was placed in the homogenized solution, and pH was measured while stirring. A bulb tip combination electrode (Orion model 9256BN, Orion Research Inc., Boston, MA) with an Orion SA 720 pH meter (Orion Research Inc.) was used in this procedure. After 2h post-mortem the ultimate carcass pH of 12th rib longissimus muscle was evaluated. Same procedure was followed for evaluating ultimate carcass pH after 24 h post-mortem chill (4°C).

Cooking method

Samples were freshly cut and weighed (initial weight). The longissimus muscle cuts (50 mm thick steaks) were cooked on a water bath having a beaker with meat according to a dry heat cooking method with the beaker opening extending above the water surface. The meat was then taken from the beaker, blotted dry and weighed. Traditional cooking time was followed for the determination of cooking loss and cooking yield. In this cooking method 40 minutes were required to reach at 100°C temperature. Then cooking loss was measured in duplicate. Next at 100°C temperature meat sample was cooked for 20 minutes (total 60 minutes), surface dried and weighed. Then at 100°C temperature meat sample was cooked for 30 minutes (total 90 minutes), surface dried and weighed. Then cooking loss was measured in duplicate. Cooking loss and cooking yield were determined by expressing cooked sample (B) weight as a percentage of precooked sample (A) weight following the procedure.

Cooking loss (%): (A-B)/(A) ×100

Cooking yield (%): (B)/(A) ×100

Drip loss

Meat samples were cut from the carcass and immediately weighed. A sample weight of approximately 80-100 g was used. The samples was placed in the netting and then suspended in an inflated bag, ensuring that the sample does not make contact with the bag, or placed within the container on the supporting mesh and sealed. After a storage period (usually 24 hr) at chill temperatures, samples were again weighed. The same samples was used for further drip loss measurements up to one week of time, but in every case the initial weight was used as the reference point. At the time of measurement, samples were taken immediately from the containers, gently blotted dry and weighed (Honikel, 1998).

Drip loss (%): [(Sample weight - 24hrs after sample weight/ sample weight] × l00

Color measurement

A boneless longissimus section 12 cm thick was removed from the posterior end of the rib. Longissimus samples were individually, vacuum packaged and frozen at −20 °C. Each frozen Longissimus sample was standardized into two 2.54 cm thick steak samples (AMSA, 1995) for objective color evaluation (L, a*, b*, c* and h*). Color readings were obtained from 63 cores covering the full spectrum of discoloration in beef: from fresh samples having a bright-red color to stale samples with a green brownish tint. Readings were taken near the center of each core using a CM (Minolta Chromameter CR-300, Osaka, Japan) with a 1 cm aperture, illuminant C and a^2 viewing angle. Before data collection, the instrument was calibrated with a white calibration plate (L* = 97.06, a* = -0.14, b* = 1.93) covered in the same film wrapping the beef samples.

Statistical model and analysis

The experiment was conducted under a completely randomized design having five (5) treatments with ten (10) replications of different age group of animal. Effects of dental age on nutritional quality of meat were evaluated separately by using the analysis of variance following a general linear model in Completely Randomized Design (CRD). The Statistical model of CRD is given below: The one-way model is:

$yij = \mu + \tau i + \varepsilon ij \; i = 1,...,a; \; j = 1,...,n$

where:

yij= observation j in group or treatment i

μ = the overall mean

τi= the fixed effect of group or treatment i (different dental age groups)

εij= random error with mean 0 and variance $\sigma 2$

The independent variable τ, often called a factor, represents the effects of different treatments (different dental age groups). The factor influences the values of the dependent variable y.

The data were analyzed using the GLM procedure of SAS version 9.1, (SAS Institute, Inc.). Effects of dental maturity were tested by analysis of variance and when differences were detected, DMRT was used to compare the treatment means, with significance considered at $p<0.05$. Pearson's correlation coefficient was performed to identify significant carcass traits to predict carcass yield (SAS, 1996).

Results and Discussion

Colour

Objective analysis of meat color, an important indicator of meat quality, showed no significant differences of different teeth maturity groups for the color bands: lightness (L*) (P=0.4834), blueness (b*) (P=0.1303) and hue (h*) (P=0.0818) (Table 1). In table 1 it has been shown that the mean values of lightness (L*) was 27.78, 29.87, 27.78, 28.47 and 26.68 in the dental maturity group of T_1 (0 pi) to T_5 (8pi), respectively while the mean values of blueness (b*) was 9.28, 9.94, 8.62, 8.62 and 10.72 in the dental maturity group of T_1 (0 pi) to T_5 (8pi), respectively. It reveals from the Table 1 that the mean value of colour band redness (a*) was 6.91, 8.29, 6.51, 6.49 and 9.34 in the dental maturity group of T_1 (0 pi) to T_5 (8pi), respectively; while the mean value for colour band of chroma (c*) was 11.18, 12.99, 10.84, 10.80 and 14.25 in the dental maturity group of T_1 (0 pi) to T_5 (8pi), respectively. In case of colour band of a* (P=0.0008), the teeth maturity showed a highly significant effects ($p<0.001$) while there was a significant effects ($p<0.01$) of teeth maturity groups on the colour band of c* (p=0.0116).

Regarding objective (instrumental) measurements of Longissimus dorsi (LD) muscle colour, there were highly significant differences ($p<0.001$) for the redness (a*) among groups (Table 1). Similarly, there was a significant effect of dental maturity ($p<0.01$) on c* (chroma) with values observed in this trial within the common range for beef (10.84 to 14.25) in Table 1. It is well matched with present findings that appearance of the meat surface to consumers depends on, among other factors, the quantity and physical state of myoglobin. Regardless of species, breed or gender muscle composition varies with increased

animal age (Lawrie, 1998). With age, cellular oxygenation capacity decreases and a larger amount of myoglobin in muscle is required for oxygen retention. Myoglobin concentration appears to increase through an abrupt initial increment, followed by a gradual phase. Thus, even with different numbers of permanent incisors, it seems that the age of the animals used in this work was not sufficient to detect differences in a* values.

Table 1. Post mortem colour composition of *longissimus dorsi* muscle of indigenous cattle for beef (n=17)

Parameter	T_1	T_2	T_3	T_4	T_5	P value	Sig. level
	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE		
L*	27.78±0.95	29.87±1.22	27.78±1.41	28.47± 1.15	26.68±.96	0.4834	NS
a*	6.19^{b}±0.62	8.29^{a}±0.84	6.51^{b}±0.39	6.49^{b}±0.40	9.34^{a}±0.66	0.0008	***
b*	9.28±0.65	9.94±0.96	8.62±0.63	8.62±0.68	10.72±0.57	0.1303	NS
c*	11.18^{b}±0.84	12.99^{ab}±1.18	10.84^{b}±0.66	10.80^{b}±0.76	14.25^{a}±0.79	0.0116	**
h*	56.58±1.67	50.23±2.34	52.64±1.87	52.53±1.46	49.15±1.60	0.0818	NS

T1 = 0 Permanent incisor, T2 = 2 Permanent incisors, T3 = 4 Permanent incisors, T4 = 6 Permanent incisors, T5 = 8 Permanent incisors; Means with different superscripts in a row differ significantly; Lightness (L*), Redness (a*), Blueness (b*), Chroma (c*) and Hue (h*): NS= Non-significant,**=p<0.01; *=p <0.05.

Drip loss, cooking properties and pH

The effects of dental age maturity on the drip loss, cooking loss and cooking yield, are summarized in Table 2.

Drip loss

Dental age maturity of beef cattle did not show an effect on drip-loss of beef LM having the age group of T_1 (0 pi) to T_5 (8pi) from the post mortem day 24 hrs to 1 week with an exception of post mortem day 5 where dental maturity has a significant effect ($p<0.05$) on drip loss (Table 2). It has been stated in the Table 2 that the drip loss measured at 24 hrs post mortem was greater (2.78%) in T_5 (8 pi) and was lower (2.38%) in T_1 (0 pi). The drip loss in other dental age maturity group was almost similar. It is also observed that the drip loss measured at 1 week post mortem was greater (8.55%) in T_3 and was lower (8.16%) in T_4. The drip loss in other dental age maturity group was almost similar. The dental maturity age group did not affect significantly ($p>0.05$) on the drip loss at 24 hrs and 1 week post mortem storage. The drip loss was increased with the increased of post mortem storage duration. At post mortem day 5 the highest (7.15%, $p<0.05$) drip loss was observed in T_3 and the lowest (5.87%, $p<0.05$) in T_1.

The ability of fresh meat to retain moisture is one of the most important quality characteristics of raw products. The majority of water in muscle is held either within the myofibrils, between the myofibrils and between the myofibrils and the cell membrane (sarcolemma), between muscle cells and between muscle bundles (groups of muscle cells). Once muscle is harvested the amount of water and location of that water in meat can change depending on numerous factors related to the tissue itself and how the product is handled. Remarkable drip loss ($p>0.05$) was not observed in the LM of beef having the dental maturity of T_1 to T_5 (Table 2). Drip loss was increased with the increase of post mortem storage of duration. It was reported that drip loss for the duration of day 2 to day 23 was markedly increased ($p<0.001$) with the increase of duration. These observations are well consistent with our finding (Table 2) (Smulders et al., 2006). Our findings also support to the observations of other workers (Zorzi, et al., 2013 and Shanks et al., 2002) where they documented that increased drip loss was associated with the increase of post mortem storage. It might be due to ages and proteins degradation and muscle loses its inherent ability to hold moisture.

Cooking loss

The effect of dental age maturity on the cooking loss of beef LM is summarized in Table 2. Percentage cooking loss was higher with increase of cooking time and temperature. Cooking loss at room temperature (RT) to 100 ^{0}C at holding time of 40 minutes was the greatest ($p<0.001$) in T_1 and the lowest ($p<0.001$) in T_5. Marked increase in cooking losses was 45.13% in T_1 and gradually decreases with the advances of dental maturity age, 28.84% in T_5. The similar trend was also observed at 100 ^{0}C in holding time of 60 minutes and 90 minutes. In both cases, cooking loss was markedly increased ($p<0.001$) in T_1 and decreased ($p<0.001$) with the advances of dental maturity. It is also interestingly observed from the Table 2 that in all cases cooking loss was significantly ($p<0.001$) increased with the increase of holding time. Marked increases in cooking losses from LM of beef at more than one week postmortem aging with holding time and temperature may have been caused by damage to cellular membranes, allowing moisture to escape out of the muscle. Present findings support to the observations of other workers (Pearson and Miller, 1950; Crouse and Koohmaraie, 1990; Hildrum et al., 1999 and Shanks et al., 2002) that cooking losses in beef increase upon freezing.

Obuz et al., 2003 well documented in his research in water bath cooking that cooking loss of longissimus steaks increases ($p<0.0001$) with the increase of temperature. They also showed that cooking loss was also increased ($p<0.0001$) with the increase of holding temperature. Cooking loss was also increased significant ($p<0.0001$) with the increase of both cooking temperature and holding time. Present findings (Table 2) support to the observations of these workers. Wheeler et al. (1990) indicated that cooking losses were greater for frozen steaks regardless of aging time (chilled 13 or 20 d vs chilled 7 or 14 d and then frozen) with the increase of holding time. Smith et al. (1969) noted that cooking losses increased significantly as a result of freezing at −34°C, but not at −23°C. However, the reason that cooking losses were not same for LM steaks at longer post-mortem aging periods in the present study is not conclusively known. It may be that as meat ages and proteins degrade, muscle loses its inherent ability to hold moisture.

Since the measurement of colour can be an easy and fast method, it is important to know the relationship between these measurements and other beef quality traits in order to predict the beef quality. In Table 4 it has been shown that the colour band L* and a* are negatively correlated (r=-0.11). It is fully consistent with the findings of Moss et al., 1994 where they revealed that L* and a* are non-significantly ($p>0.05$) and negatively correlated in meat species. The findings of Insausti et al., 2008 also support the present findings.

Table 2. Drip loss, cooking loss and cooking yield *of longissimus dorsi* muscle of indigenous cattle (n=20)

Duration *(Post mortem)*	T_1	T_2	T_3	T_4	T_5	P value	Sig. level
	Mean ± SE(%)	Mean ± SE(%)	Mean ± SE(%)	Mean ± SE(%)	Mean ± SE(%)		
24 hours	2.38±0.08	2.56±0.10	2.47±0.16	2.37±0.16	2.78±0.31	0.5181	NS
2 days	3.29±0.54	3.71±0.09	4.68±0.53	4.02±0.37	3.87±0.21	0.2072	NS
3 days	4.25±0.52	4.92±0.22	5.48±0.49	4.86±0.55	4.53±0.31	0.3806	NS
4 days	4.99±0.34	6.05±0.36	6.09±0.58	6.19±0.15	5.75±0.20	0.1643	NS
5 days	5.87^{b}±0.31	6.66^{ab}±0.36	7.15^{a}±0.31	6.92^{a}±0.26	6.22^{ab}±0.19	0.0439	*
6 days	7.59±0.44	7.84±0.69	7.79±0.45	7.69±0.22	7.65±0.25	0.9938	NS
1 week	8.35±0.49	8.33±0.66	8.55±0.17	8.16±0.20	8.17±0.24	0.9579	NS
Cooking loss (frozen more than one week)							
40 minutes (RT 38 °C to 100 °C)	45.13^{a}± 1.38	42.98^{a}±1.56	35.21^{b}±0.82	33.97^{b}±1.38	28.84^{c}±0.74	<.0001	***
60 minutes (next 20 minutes @100 °C)	47.04^{a}±1.55	47.05^{a}±1.45	42.72^{b}±0.22	39.28^{b}±1.27	34.57^{c}±0.27	<.0001	***
90 minutes (next 30 minutes @100 °C)	50.31^{a}±1.45	49.81^{a}±1.95	46.47^{ab}±0.26	42.88^{b}±1.18	38.44^{c}±0.48	<.0001	***
Cooking yield (frozen more than one week)							
40 minutes (RT 38 °C to 100°°C)	54.87^{c}±1.38	57.02^{c}±1.56	64.80^{b}±0.82	66.03^{b}±1.38	71.16^{a}±0.74	<.0001	***
60 minutes (next 20 minutes @100 °C)	52.96^{c}±1.55	52.96^{c}±1.45	57.28^{b}±0.22	60.72^{b}±1.27	65.43^{a}±0.27	<.0001	***
90 minutes (next 30 minutes @100 °C)	49.69^{c}±1.45	50.19^{c}±1.95	53.53^{bc}±0.26	57.13^{b}±1.18	61.56^{a}± 0.48	<.0001	***
pH2h	5.67^{c}±0.04	5.81^{b}±0.03	5.93^{a}±0.03	5.86^{ab}±0.02	5.91^{a}±0.01	<0.001	***
pH24h	5.48±0.07	5.45±0.02	5.45±0.06	5.31±0.02	5.43±0.04	0.1526	NS

T_1 = 0 Permanent incisor, T_2 = 2 Permanent incisors, T_3 = 4 Permanent incisors, T_4 = 6 Permanent incisors, T_5 = 8 Permanent incisors; Means with different superscripts in a row differ significantly; NS= Non significant, *=p <0.05; ***=p<0.001.

pH

There was a highly significant effect (p<0.001) of dental maturity on the carcass pH2h (Table 2), with a mean value (5.84). It appears in the Table 2 that the pH2h were increased gradually with the advances of age T_1, T_2, T_4 and T_5; where pH2h, 5.93 of T_3 was the highest in number and T_1 (pH 2h, 5.67) was the lowest in number. There were no differences (p>0.05) for the final pH values (24 h) among the five teeth maturity groups. The average final pH24h was 5.31–5.48. In experiments of this kind, samples with the highest ultimate pH24h (5.48) was observed in T_1 teeth maturity group while the lowest ultimate pH24h (5.31) was in the teeth maturity group of T_4. The rate of pH decline and ultimate pH of the meat are variable 24h post-mortem. Highly significant effect (p<0.001) of dental maturity was observed on the beef carcass pH2h (Table 2), with a mean value (5.84), values typically observed in beef carcasses (5.5-5.9). However, according to Felício (1997), when cattle are exposed to stress before harvest, muscle glycogen reserves of these animals may be partially or totally exhausted. As a result, the establishment of rigor mortis occurs in the first hour post mortem since the reserve of energy is not sufficient to support anaerobic metabolism and to produce lactic acid capable of lowering the pH to 5.5. This change in carcass ultimate pH causes great losses to the beef industry, since the meat with high values of pH (>5.8), has a darker color and therefore less consumer appeal. Swatland (2004) reported that meat with a low pHu is generally paler than meat with higher pH due to lighter scattering.

In unstressed animals with large reserves of muscle glycogen, pH normally decreases from an initial 7.0–7.2 post-mortem to final values of 5.4–5.8, 48 h post-mortem (Young et al., 2004). The final pH values of Longissimus and Semitendinosus muscle observed in this trial are within the standards of the beef industry, which recommends a final pH lower than 5.8 as ideal to prevent meat quality from being compromised. A decline in post-mortem pH due to the formation of lactic acid is responsible for a decreased water-holding capacity of meat by causing the denaturation and loss of solubility of muscle proteins (Roça, 2011 and Frylinck et al., 2013). The present findings (Table 2) support to the observations of these workers. In addition, several studies have shown that meat tenderness decreases as ultimate pH rises from 5.5 to 6.0 (Purchas et al., 1999 and Wulf et al., 2002), and most frequent problems related to tougher beef usually coincide with ultimate pH values near 5.8–6.0 (Wulf et al., 2002). For that reason the Brazilian beef industry only exports beef with a pH below 5.8, measured directly in the Longissimus dorsi muscle 24h post-mortem (Roça, 2000).

Correlation matrix of selected physical and nutritional properties of beef

The results of Pearson's correlation coefficients correlation analysis among selected physical and nutritional properties of beef are presented in Table 3. A significant (p<0.05) association was found between hot carcass weight and fat% (r= 0.59). There was also highly significant (p<0.001) associations between moisture% and ash% (r=68, positively); ash% and pH after 2 hrs (r=80, negatively); and pH after 24 hrs and drip loss% after 1 week (p<0.01, r=63, positively). In the above stated variables in Table 3, positive associations were observed non-significantly (p>0.05) between hot carcass weight, pH after 2 hrs and Drip loss% after 24 hrs. In turn, negative associations were detected between hot carcass weight, moisture%, ash%, pH after 24 hrs and Drip loss% after 24 hrs.

Table 3. Pearson correlation coefficients among selected physical and nutritional properties of beef (n=15)

Parameters	Mean±SD	1	2	3	4	5	6	7
1. Hot carcass wt., kg	112.46±41.18							
2. Moisture %	72.86±1.32	-0.43^{NS}						
3. Fat%	3.60±0.32	0.59*	0.06^{NS}					
4. Ash%	3.71±0.76	-0.39^{NS}	0.68***	-0.27^{NS}				
5. pH after 2 hrs	5.86±0.10	0.35^{NS}	-0.46^{NS}	0.27^{NS}	-0.80***			
6. pH after 24 hrs	5.41±0.19	-0.23^{NS}	0.35^{NS}	0.35^{NS}	0.15^{NS}	-0.05^{NS}		
7. Drip loss% after 24 hrs	2.54±0.42	0.03^{NS}	-0.12^{NS}	0.51^{NS}	-0.35^{NS}	0.13^{NS}	0.08^{NS}	
8. Drip loss% after 1 week	8.50±0.60	-0.44^{NS}	0.17^{NS}	0.04^{NS}	-0.05^{NS}	-0.13^{NS}	0.63**	0.31^{NS}

NS= Non-significant; *p<0.05. **p<0.010 and ***p<.001.

Correlation matrix of selected beef quality properties

Correlations among colour physical variables and other beef quality traits are presented in Table 4. Table 4 shows that hot carcass weight, b*, and c* were positively associated with pH after 2 hrs, Drip loss% after 24 hrs. Hot carcass weight was positively associated with a* (r=.54, p<0.05); a* and b* (r=0.80, p<0.001); a* and c* (r=0.95, p<0.001); a* and h* (r=-0.69, p<0.001); a* and Drip loss% after 24 hrs (r=0.62, p<0.05); b* and c* (r=0.95, p<0.001); b* and Drip loss% after 24 hrs (r=0.59, p<0.05); Drip loss% after 24 hrs (r=0.64, p<0.01); h* and pH after 2 hrs (r=-0.53, p<0.05); In other cases, the above stated variables in Table 4 were non-significantly (p>0.05) and positively or negatively correlated.

Table 4. Pearson correlation coefficients among selected beef quality properties (n=15)

Parameters	Mean±SD	1	2	3	4	5	6	7	8
1. Hot carcass wt., kg	112.46±41.18								
2. L*	28.00±2.44	-0.41^{NS}							
3. a*	7.38±1.59	0.54*	-0.11^{NS}						
4. b*	9.40±1.32	0.20^{NS}	0.02^{NS}	0.80***					
5. c*	12.00±1.92	0.38^{NS}	-0.05^{NS}	0.95***	0.95***				
6. h*	52.04±3.57	-0.68**	0.14^{NS}	-0.69***	-0.13^{NS}	-0.43^{NS}			
7. pH after 2 hrs	5.86±0.10	0.36^{NS}	0.37^{NS}	0.37^{NS}	0.09^{NS}	0.23^{NS}	-0.53*		
8. pH after 24 hrs	5.41±0.19	-0.23^{NS}	-0.02^{NS}	0.05^{NS}	-0.13^{NS}	-0.04^{NS}	-0.11^{NS}	-0.05^{NS}	
9. Drip loss% after 24 hrs	2.54±0.42	0.03^{NS}	0.05^{NS}	0.62*	0.59*	0.64**	-0.32^{NS}	0.14^{NS}	0.09^{NS}

Lightness (L*), Redness (a*), Blueness (b*), Chroma (c*) and Hue (h*); NS= Non-significant; *p<0.05; **p<0.010 and ***p<.001.

Conclusions

From this study it can be concluded that dental age maturity had a significant effect on physico-chemical properties of meat of indigenous beef cattle.

Conflicts of Interest

The authors declare no potential conflict of interest.

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