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Physico-chemical and structural attributes of meat from young and spent buffaloes*

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Abstract

The current study was carried out to determine the physico-chemical and structural attributes of buffalo muscles from two anatomical locations obtained from animals belonging to two different age groups. Six each of young (2-4 years) and spent (8-10 years) buffaloes were procured from University Buffalo Farm, Mannuthy and were slaughtered scientifically at Meat Technology Unit, Mannuthy. Each carcass was electrically stimulated. The longissimus dorsi (LNG) and Biceps femoris (BIF) muscles were harvested, connective tissue and fat removed, aged for 72 hours at 4±1°C and analysed for the parameters. The ultimate pH values did not differ significantly between the muscles as well as the age groups. Hunter L and a* values were significantly different between the muscles. Hunter L* and b* values had significant difference between the age groups. Myofibrillar fragmentation index and Warner bratzler shear force of LNG and BIF were significantly different between age groups as well as between muscles. With respect to structural characteristics, no significant variation was noticed in sarcomere length between the muscles and the age groups. Between two age groups, muscle fibre diameter of samples from spent animal group showed significantly higher values. Thus, the results indicate important differences in the quality attributes of buffalo meat of two different age groups, which may be reflected in their palatability and processing properties.*

Key words: *Physico chemical attributes, meat, spent buffaloes*

Buffalo meat has gained importance in the recent years because of expanding domestic market and export potential. Buffalo meat is comparable to beef in many of its physicochemical,

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nutritional and functional properties and sensory attributes. Furthermore, its use in meat processing is increasing because of its higher content of lean meat and lower fat. Most of the buffalo meat production in India is from animals which are spent and unproductive. However, buffalo male calf rearing for meat production has been mooted as a sustainable way of salvaging these otherwise neglected source of meat animals. Hence, it is pertinent to analyse and evaluate the physico-chemical and structural attributes of the meat obtained from young and spent buffaloes. The current study was thus carried out to compare the physico-chemical and structural characteristics of meat from young and spent buffaloes.

Materials and methods

Twelve buffaloes from the University Buffalo farm, Kerala Veterinary Animal Sciences University, Mannuthy were utilized in this study. The animals belonged to two age groups *viz.* 2-4 years (n=6) and 8-10 years (n=6). They were reared intensively under similar management practices with occasional periods of grazing. The animals were slaughtered at the multi-species abattoir of the Meat Technology Unit, Kerala Veterinary and Animal Sciences University, Mannuthy after 24 hours of fasting as per scientific slaughter procedures. Ante-mortem and post-mortem inspections were conducted for each animal. The carcasses were electrically stimulated (100-110V, 1.5 to 2 min) and *Longissimus dorsi* (LNG) and *Biceps femoris* (BIF) muscles were immediately harvested from each carcass by hot deboning. After removal of separable fat and the connective tissue, each muscle was packed in High Density Poly Ethylene (HDPE) pouches and aged for 72 h at 4±1°C (Samsung Digital Inverter Technology, India). After ageing, each muscle was portioned for analysis of physico-chemical and structural attributes. The muscles were further packed in LDPE pouches and stored at -18±2ºC until subsequent analysis which took place within one week of freezer storage. Meat was thawed at 4±1ºC for 12 h before assessment of the following parameters: Ultimate pH (O'Halloran *et al.*, 1997), colour (Hunter L*, a*, b* values), myofibrillar fragmentation index (Davis *et al.,* 1980), Warner-Bratzler shear force (Wheeler *et al.,* 1997), sarcomere length (Hostetler *et al.,* 1972) and muscle fibre diameter (Jeremiah and Martin, 1977).

Results and Discussion

Ultimate pH

The mean ultimate pH of LNG and BIF muscles from both the age groups is shown in Table 1. Among the two muscle samples from both the age groups, LNG from spent buffaloes had the highest ultimate pH (5.96±0.27). LNG and BIF muscles had no significant difference with respect to ultimate pH values between two age groups. There was no significant difference in ultimate pH between LNG and BIF within the same age group which is in agreement with the findings of Kandeepan *et al.* (2009). Higher pH of buffalo meat from both the age groups obtained in the current study when compared to some of the previous reports could be due to the slower decline of pH as reported by Neath *et al.* (2007).

Warner Bratzler Shear Force (WBSF)

Mean WBSF values (Newton) of LNG and BIF muscles from both age groups are shown in Table 1. Mean WBSF values of LNG and BIF muscles from young and spent buffaloes were 40.13±1.08N, 66.81±4.86, 56.90±1.10N and 89.34±5.89N, respectively. There was a significant ($p<0.01$) difference in WBSF values between the muscles in both the age groups, with BIF exhibiting significantly higher values. Similar results were found by Prajwal *et al.* (2007) who reported the highest

Table 1. Ultimate pH, Warner-Bratzler shear force (WBSF) and myofibril fragmentation index (MFI) of young and spent buffalo meat (Mean±S.E.)

Attributes	Muscles	Animal group		F-value (p-value)		
		Young	Spent	Between age groups	Between muscles	Age* muscle
pH	LNG	5.79±0.05	5.96±0.27	0.27^{ns} (0.61)	0.01^{ns} (0.94)	0.34^{ns} (0.57)
	BIF	5.86±0.051	5.868±0.13			
WBSF (N)	LNG	40.13±1.08^{ax}	56.90±1.10^{bx}	32.03** (0.00)	124.13** (0.00)	2.65^{ns} (0.13)
	BIF	66.81±4.86^{ay}	89.34±5.89^{by}			
MFI	LNG	662.47±10.24^{ax}	723.17±6.92^{bx}	39.72** (0.00)	12.701** (0.01)	0.12^{ns} (0.73)
	BIF	772.98±12.57^{ay}	822.8±26.93^{by}			

Means having different small letters as superscripts differ significantly: ab- across column, xy- across rows. *Significantly different at 5% level, ns- non-significant. LNG-*Longissimus dorsi,* BIF-*Biceps femoris*

Table 2. Hunter L* a* and b* values of young and spent buffalo meat (Mean±S.E.)

Attributes	Muscles	Animal group		F-value (p-value)		
		Young	Spent	Between age groups	Between muscles	Age* muscle
*L**	LNG	32.62±1.2^{ax}	28.83±2.06^{bx}	6.807* (0.02)	5.136* (0.047)	1.11^{ns} (0.316)
	BIF	31.37±1.78^{ay}	25.39±0.66^{by}			
*a**	LNG	14.814±0.617^{x}	14.079±0.898^{x}	0.329^{ns} (0.579)	13.99* (0.04)	0.224^{ns} (0.646)
	BIF	11.94±0.745^{y}	11.849±0.467^{y}			
*b**	LNG	13.63±1.00^{a}	12.10±0.8^{b}	5.622* (0.039)	1.532^{ns} (0.244)	0.191^{ns} (0.671)
	BIF	13.08±0.51^{a}	10.94±0.49^{b}			

Means having different small letters as superscripts differ significantly: ab- across column, xy- across rows. *Significantly different at 5% level, ns- non-significant. LNG-*Longissimus dorsi,* BIF-*Biceps femoris*

Table 3. Sarcomere length (SL) and muscle fibre diameter (MFD) (µm) of young and spent buffalo meat (Mean±S.E.)

Attributes	Muscles	Animal age		F-value (p-value)		
		Young	Spent	Between age groups	Between muscles	Age* muscle
SL	LNG	1.74±0.35	1.67±0.02	1.462^{ns} (0.254)	0.004^{ns} (0.954)	0.126^{ns} (0.730)
	BIF	1.76±0.06	1.65±0.11			
MFD	LNG	54.57±0.86^{a}	70.26±2.18^{b}	17.608** (0.002)	1.299^{ns} (0.281)	7.349^{ns} (0.022)
	BIF	58.50±3.26^{a}	60.63±2.32^{b}			

WBSF value for BIF among ten buffalo muscles studied. Significantly higher WBSF for BIF than LNG could be due to a more stable connective tissue. Between the two age groups also, WBSF of both the muscles differed significantly ($p<0.01$), with samples from the spent age group showing significantly higher values. Significant increase in WBSF in LNG of older buffaloes has been previously reported by Rao *et al.* (2009), which is due to the fact that collagen with in the muscle tissue develops more stable cross links as it matures with its obvious adverse effect on subjective and objective tenderness values (Weston *et al.* 2002).

Myofibrillar Fragmentation Index (MFI)

Mean MFI values of LNG and BIF muscles from both age groups are shown in Table 1. Mean MFI values of LNG and BIF muscles from young and spent buffaloes were 662.47±10.24, 772.98±12.57, 723.17±6.92N and 822.8±26.93 respectively. There was a significant ($p<0.01$) difference in MFI values between the muscles in both the age groups, with BIF exhibiting significantly higher values. Similar observations were reported by Prajwal *et al.* (2017). Between the two age groups also, MFI of both the muscles differed significantly ($p<0.01$), with samples from spent buffaloes showing significantly higher values. Ilavarasan *et al.* (2016) reported similar significantly different MFI values for LNG from Toda buffaloes of young and adult age groups. Kandeepan *et al.* (2009) also reported lower MFI values (expressed as percentage) for meat from old (>10 years) than young (18 months) buffaloes.

Colour (Hunter L*, a* and b* values)

Hunter L* values

The Hunter L* values of LNG and BIF muscles from both age groups are shown in Table 2. Between the age groups, LNG (25.39±0.66) and BIF (28.83±2.06) from spent buffaloes had significantly ($p<0.05$) lower Hunter L* values compared to LNG (32.62±1.15) and BIF (31.37±1.78) from young buffaloes. Between the muscles, BIF from both the age groups had significantly ($p<0.05$) higher Hunter L* values than the LNG from both age groups. Being a locomotor muscle, BIF might have endured higher physical activity in the live buffaloes as compared to less physical activity of LNG resulting in lower myoglobin content (Dikeman and Devine, 2014).

Hunter a* values

The Hunter a* values of LNG and BIF muscles from both age groups are shown in Table 2. Hunter a* values for LNG and BIF from young and spent buffaloes were 14.81±0.62, 11.94±0.76, 14.08±0.90 and 11.85±0.47, respectively. Between muscles, a* value was significantly ($p<0.05$) higher for LNG than BIF in both the age groups. This is in agreement with the observation of Prajwal (2016). Between age groups, a* values of both LNG and BIF did not differ significantly because young buffaloes utilized in the current study were adult animals of 2-4 years with possible higher myoglobin content, which could have resulted in lack of any significant difference as compared to a* values of meat from spent animals.

Hunter b* values

The Hunter b* values of LNG and BIF muscles from both age groups are shown in Table 2. Hunter b* values for LNG and BIF from spent and young buffaloes were 12.10±0.80, 10.94±0.50, 13.63±1.01 and 13.08±0.51, respectively. Between muscles, Hunter b* values did not differ significantly in both the age groups. This observation differed from that of Prajwal (2016) who reported significantly different b* values between buffalo LNG and BIF from 4-6 years old buffaloes. This different observation in the current study when compared to above mentioned study could be due to different age groups of animals selected for evaluation. However, between age groups, both LNG and BIF from young buffaloes had significantly ($p<0.05$) lower b* values. This finding is in accordance with Rao *et al.* (2009) who also reported lower values for chroma (intensity of colour) for buffalo LNG muscles in 2-4 years old non-descript buffaloes when compared to samples that were obtained from animals aged between 6 months and 2 years.

Structural Characteristics

Sarcomere length

The mean sarcomere length (µm) of LNG and BIF muscles from both age groups are shown in Table 3. Mean sarcomere lengths of LNG and BIF muscles from young and spent buffaloes were 1.74±0.35, 1.76±0.06, 1.67±0.02 and 1.65±0.11, respectively. There was no significant difference in sarcomere length between the muscles in both the age groups. Between two age groups also, sarcomere length values of both the muscles did not differ significantly with samples from younger age group showing slightly higher values. Ffoulkes(1992) reported a decrease in sarcomere length of buffalo muscle fibres with advancing age.

Muscle fibre diameter

Mean muscle fibre diameter (μm) of LNG and BIF muscles from both age groups are shown in Table 3. Mean muscle fibre diameter of LNG and BIF muscles from young and spent buffaloes were 54.57±0.86, 58.50±3.26, 70.26±2.18 and 60.63±2.32, respectively. There was no significant difference in muscle fibre diameter values between the muscles in both the age groups. Prajwal (2016) also observed no significant difference in muscle fibre diameter between buffalo LNG and BIF muscles. But between the two age groups, muscle fibre diameter of both the muscles differed significantly ($p<0.01$), with samples from spent buffaloes showing higher values. Similar observations were recorded by Kandeepan *et al.* (2009) and Ragab *et al.* (1966).

Means having different small letters as superscripts differ significantly: ab- across column, xy- across rows. *Significantly different at 5% level, ns- non-significant. LNG-*Longissimus dorsi,* BIF-*Biceps femoris*

Conclusions

The study was carried out to evaluate and compare physico-chemical and structural attributes of meat from young and spent buffaloes. The ultimate pH and Hunter L* and b* values had significant difference between the age groups. Myofibrillar fragmentation index and WBSF of LNG and BIF had significant difference between age groups as well as between muscles. With respect to structural characteristics, muscle fibre diameter of samples from spent animal group showed significantly higher values. Thus, the results indicate important differences in the quality attribute of buffalo meat of two different age groups, which may be reflected in their palatability and processing properties.

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