EFFECT OF AGE ON MEAT QUALITY CHARACTERISTICS AND NUTRITIONAL COMPOSITION OF TODA BUFFALO

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ABSTRACT

The study was undertaken to study the effect of age *viz.,* young (12-8 months) and adult (above 3 years) on quality characteristics and nutritional composition of meat from Toda buffalo. The *Longissimus dorsi* muscle was obtained from these animals and the physico-chemical characteristics *viz.,* pH, water holding capacity, instrumental colour, muscle fibre diameter, myofibrillar fragmentation index and nutritional composition *viz.,* proximate composition*,* amino acid, fatty acid and cholesterol content of two different age groups were studied. The results obtained in this study indicated that the meat of young buffalo had higher water holding capacity, Lightness (L*), yellowness (b*), moisture, essential amino acids, linoleic acid, linolenic acid, ecosapentaenoic acid, docosohexanoic acid, total poly unsaturated fatty acids, total unsaturated fatty acids, total P/S and lesser fat, total saturated fatty acids and cholesterol content than adult. Based on the quality and nutritional composition it was concluded that meat of young animal (12-18 months) had superior meat quality than the meat of adult animals.

Keywords: meat quality characteristics, Toda buffalo meat, *Longissimus dorsi,* nutritional composition

INTRODUCTION

Meat is an excellent source of good quality animal protein which provides all the essential amino acids and various micronutrients in proper proportion to human being (National Health and Medical Research council, 2006). It is also a valuable source of B-complex vitamins including thiamin, riboflavin, niacin, biotin, pyridoxine, pantothenic and cyanocobalamine and minerals like iron, zinc, selenium and phosphorus (Pereira and Vicente, 2013). Consumers are now more focused on the quality and nutritional characteristics of foods including meat and meat products and they are increasingly focusing on their eating habits and nutrient intake as well as food safety (Garnier *et al*., 2003).

Indian sub-continent is the home tract of world buffaloes. Buffalo is the only potential animal that can boost meat industry in India. Buffalo meat is the healthiest meat among red meats known for human consumption since it is low in calories and cholesterol (Kandeepan *et al*., 2009a). Buffalo meat has gained importance in the recent years because of its domestic usage and export potential. Buffalo meat is comparable to beef in many of its physicochemical, nutritional and functional properties and sensory attributes (Kandeepan *et al*., 2009b). Recently, attention has been focused on the meat production potential of

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buffalo and buffalo meat has been found to contain less intramuscular lipids (Valin *et al.,* 1984) and more polyunsaturated fatty acids (Sinclair *et al*., 1982) compared with beef. Buffalo convert poor quality feed into muscle growth.

An increase of buffalo meat production would make a notable contribution to human nutrition and the economy of some countries (Ziauddin *et al*., 1994). Though the buffalo meat and beef are similar in chemical composition, buffalo meat is superior that beef in certain characters (Kesava Rao and Kowale, 1986). The Toda breed of buffalo is distributed in Nilgiris, the hilly tract of Tamil Nadu. Information regarding the physico-chemical and nutritional composition buffalo meat slaughtered in local slaughter units is scanty in the available literature. Hence, the attempt has been made in this study to assess the effect of age on the physico chemical and nutritional composition of Toda buffalo meat so as to determine the optimum age for slaughter.

MATERIALS AND METHODS

Experimental design

A total number of twelve male Toda buffalos of two different age groups *viz.,* young (12 - 18 months) and adult (above 3 years) were selected based on the dentition from the native tract, Niligris of Tamil Nadu and meat from these animals were collected from the municipal slaughter houses for this study. The ante mortem inspection of animals was carried out by municipal veterinary officer. Each age group consisted of 6 animals.

Meat samples

Samples were taken from the *longissimus dorsi* muscle at the level of 13th rib (Alonso *et al*., 2009). The collected meat samples were packed in clean polyethylene bag and placed in the thermocole box with ice and immediately transported to the Department of Meat Science and Technology, Madras Veterinary College, Chennai.

Analytical procedures

The pH was measured using a digital pH meter (Digisun electronic system, model: 2001) as per the method outlined by Troutt *et al.* (1992b) and the Water holding capacity was assessed by adopting the filter paper press method with certain modifications (Grau and Hamm, 1957). Muscle fibre diameter was measured according to the method outlined by Jeremiah and Martin (1982). Myofibrillar fragmentation index (MFI) was determined by ‘‘Virtis homogeniser 45” (Virtis Company, Gardinar, New York, USA) with slight modifications (Davis *et al*., 1980). Colour of the sample was tested using Hunter lab Mini scan XE plus Spectro colorimeter (Model No. 45/O-L, Reston Virgenia, USA) with geometry of diffuse/80 (sphere - 8mm view) and an illuminant of D_{65} and 10^{o} observer (Bindu *et al*., 2007). Proximate composition *viz.,* moisture, protein, fat and total ash content of meat samples were analyzed by following the standard procedure (AOAC, 1995). Amino acid and fatty acid content of meat was estimated by Chromatography (Bruckner *et al*., 1991) and by Standard hydrolysis procedure (Fountoulakis and Lahm, 1998; Palmquist and Jenkins, 2003) with slight modifications respectively. Cholesterol content was determined using cholesterol test kit (Recombigen Pvt ltd., India) except that instead of blood serum, lipid extract was prepared (Folch *et al*., 1957) and the cholesterol content was estimated as per the method described by Wybenga *et al.* (1970).

Statistical analysis

The data obtained in the present study on young and adult age groups of Toda buffalo meat was analysed by unpaired t-test using IBM® statistical package for social sciences 20.0 for MS-Windows®.

RESULTS AND DISCUSSION

Meat quality characteristics

The meat quality characteristics of young and adult Toda buffalo (Table 1) revealed that there was a highly significant difference (P<0.01) in pH, muscle fibre diameter, myofibrillar fragmentation index, redness and yellowness and significant difference (P<0.05) in lightness of meat between two age groups of Toda buffalo. It was observed that with the increase in the age, the mean pH value also increased, which was in concurrence with results of Marichal *et al.* (2003) in goats, Appa Rao *et al*. (2009) in buffaloes and Boni *et al.* (2010) in quail. However, contrary to the findings of this study a non-significant decrease in pH with increase body weight in Kanniadu goat has been reported (Sivakumar, 2003).

Water holding capacity of meat samples decreased non significantly (P>0.05) with the increase in the age of the animals suggesting that animals slaughtered at 12-18 months of age have better juiciness compared to older animals since water holding capacity of meat is closely related to tenderness and juiciness (Lawrie, 1985). Similarly a decrease in water holding capacity with increase in age has been reported in buffaloes (Kandeepan *et al*., 2009a; Appa Rao, 2001) and goat (Sivakumar, 2003). There was a highly significant (P<0.01) difference in fibre diameter between two age groups of buffaloes. The higher fibre diameter was observed in adult buffaloes than young and it could be due to increased age and maturity, which is similar to the findings of Kandeepan *et al.* (2009a) and Ragab *et al.* (1966) in buffaloes.

Myofibrillar fragmentation index (MFI) is an accurate index for tenderness and is a useful indicator of the extent of proteolysis (Olson *et al*., 1976). The results revealed that there was a highly significant (P<0.01) increase in myofibrillar fragmentation index with higher values in adult buffalo meat as compared to young buffalo meat. Similar results were observed in carabeef (Kandeepan *et al.,* 2009a) and chevon (Ilavarasan *et al*., 2015). The animal age had more influence on tenderness attributes than sex (Huff and Parrish, 1993).

The meat of adult buffalo had significantly lower lightness (L*) value (P<0.05) and yellowness (b*) value (P<0.01) and higher redness (a*) value (P<0.01) than young. This phenomenon indicates that buffalo meat, just like other red meats, becomes darker and redder with increase in age, which is mainly due increase in concentration of myoglobin pigment with age (Lawrie, 1991). Similar to the findings of this study an inverse correlation was observed in lightness and myoglobin content with increasing age in the meat of goats (Dhanda *et al*., 1999b) and sheep (Gardner *et al*., 2007). The muscle pH and meat colour are correlated, higher the muscle pH darker the meat whereas lower muscle pH values are associated with lighter color of meat. (Richardson and Mead, 1999) and the results obtained in this study also indicated higher pH and redness (a*) in adult buffalo meat.

Nutritional composition

The proximate composition of young and adult age groups of Toda buffalo meat (Table 2) revealed that the meat of adult buffalo had

Table 1. Physico-chemical properties of young and adult age groups of Toda buffalo meat (Mean±SE)

Parameters	Young	Adult	t- value
pH	6.62±0.01	6.72±0.01	5.31**
Water holding capacity (cm^2)	2.33±0.11	2.50±0.06	1.39^{NS}
Muscle fibre diameter (µm)	79.59±0.78	99.01±0.47	21.27**
Myofibrillar fragmentation index	866.50±1.73	965.83±3.42	25.93**
Instrumental colour			
Lightness (L*)	35.74±0.86	30.02±1.68	3.02*
Redness (a*)	11.37±0.50	17.16±0.83	5.98**
Yellowness (b*)	9.27±0.09	7.91±0.15	7.65**

n = 6, means bearing different superscripts differ significantly.

* = significant (P<0.05), ** = highly significant (P<0.01), ^{NS} = Non - significant (P>0.05).

Table 2. Proximate composition (%) of young and adult age groups of Toda buffalo meat (Mean±SE).

Parameters	Young	Adult	t - value
Moisture	75.57±0.30	73.30±0.14	6.79**
Protein	20.69±0.22	22.55±0.13	7.24**
Fat	2.70±0.09	3.04±0.04	3.47**
Total Ash	1.05±0.01	1.12±0.03	2.46*

n = 6, means bearing different superscripts differ significantly.

** = highly significant (P<0.01).

significantly (P<0.01) lower moisture and higher protein, fat and total ash (P<0.05) content than young. The moisture content of buffalo meat decreased with increase in the age of the animal, which is probably associated with an increase in fat content (Lawrie, 1998) and the fat was the last tissue to mature in the older animals tending to be fatter (Warriss, 2000). Similar results were obtained in buffalo (Kandeepan *et al*., 2009a) and goat meat (Sivakumar, 2003). On the other hand Ziauddin *et al.* (1994) observed lower protein and fat in old buffaloes than young (P>0.05). The fat content of meat was highly variable and was influenced by factors such as age, sex, nutrition, body weight, growth rate, physiological condition and physical activity of animal (Owen *et al*., 1978; Kirton, 1988).

The amino acid content of young and adult age groups of Toda buffalo meat (Table 3) revealed a significant difference (P<0.05) in arginine, isoleucine and phenylalanine and highly significant difference (P<0.01) in histidine, lysine, threonine, valine, alanine, aspartic acid, glutamic acid and glycine content of young and adult Toda buffalo meat. The glutamic acid was found to be higher followed by lysine and aspartic acid. Similar results were recorded by Ziauddin *et al.* (1994), whereas Madhavi *et al.* (1982) observed that glysine was

Table 3. Amino acid content (g/100 g of meat) of two age groups of Toda buffalo meat (Wet basis) Mean±SE).

Amino acid (g/100 g of meat)	Young	Adult	t- value
Essential amino acids			
Arginine	0.71±0.02	0.78±0.01	2.97*
Histidine	0.35±0.03	0.51±0.03	3.64**
Isoleucine	0.50±0.02	0.56±0.02	2.59*
Leucine	0.87±0.03	0.88±0.03	0.3^{NS}
Lysine	0.84±0.02	1.07±0.06	3.57**
Methionine	0.16±0.01	0.20±0.03	1.16^{NS}
Phenylalanine	0.42±0.02	0.52±0.03	2.95*
Threonine	0.10±0.01	0.35±0.03	8.95**
Valine	0.57±0.02	0.67±0.02	3.91**
Non-essential amino acids			
Alanine	0.62±0.01	0.73±0.03	3.36**
Aspartic acid	0.89±0.03	1.05±0.02	3.96**
Glutamic acid	1.80±0.05	2.22±0.05	5.66**
Glycine	0.53±0.02	0.67±0.02	5.35**
Serine	0.50±0.03	0.51±0.03	0.50^{NS}
Tyrosine	0.43±0.02	0.48±0.02	8.95^{NS}

n = 6, means bearing different superscripts differ significantly.

* = significant (P<0.05), ** = highly significant (P<0.01), ^{NS} = Non - significant (P>0.05).

the major amino acid in buffaloes. The results of this study revealed that Toda buffalo meat is a rich source of all essential and non-essential amino acids.

The fatty acid content of young and adult age groups of Toda buffalo meat (Table 4) revealed highly significant difference (P<0.01) in palmitic acid, arachidic acid, behenic acid and linoleic acid content between them. Palmitic acid was the predominant saturated fatty acid followed by stearic acid (Madruga *et al*., 2001) and Oleic acid and linoleic acid were the predominant monounsaturated and poly unsaturated fatty acids as reported by Sharma *et al.* (1986) in water buffaloes and Padre *et al.* (2006) in buffalo bulls. The polyunsaturated fatty acids such as the linoleic, linolenic, ecosapentaenoic and docosohexanoic acid were all higher in younger age groups. The mean total saturated (P<0.01) and mono unsaturated fatty acids content increased whereas the total poly unsaturated fatty acids and total P/S ratio content significantly (P<0.01) decreased as age at slaughter increased. Saturated fatty acids (except stearic acid) have a tendency to increase total cholesterol levels (Bananome and Grundy, 1988). The recommended poly unsaturated to saturated (P/S) ratio in the human food is 0.45-0.65 (Department of Health, 1984). The P/S value in our study was

Table 4. Fatty acid analysis (%) and cholesterol content (mg/100 g) of young and adult age groups of Toda buffalo meat (Mean±SE).

Fatty acid type	Fatty acid (Percent)	Young	Adult	t - value
(SFA)	Myristic Acid (C14:0)	1.91±0.08	2.04±0.12	0.94^{NS}
	Palmitic Acid (C16:0)	22.95±0.12	24.77±0.39	4.46**
	Stearic Acid (C18:0)	21.71±0.55	22.37±0.69	0.75^{NS}
	Arachidic Acid (C20:0)	0.18±0.01	0.62±0.05	9.15**
	Behenic Acid (C22:0)	1.29±0.11	2.9±0.12	9.87**
(MUFA)	Palmitoleic Acid (C16:1)	1.72±0.10	1.94±0.05	2.00^{NS}
	Oleic Acid (C18:1)	38.56±1.20	39.15±0.51	0.46^{NS}
(PUFA)	Linoleic Acid (C18:2)	5.59±0.22	3.60±0.21	6.49**
	Linolenic Acid (C18:3)	1.00±0.10	0.95±0.08	0.42^{NS}
	Ecosapentaenoic Acid (C20:5)	0.82±0.10	0.49±0.07	2.75*
	Docosohexanoic Acid (C22:6)	0.82±0.08	0.63±0.11	1.39^{NS}
Total saturated fatty acids (SFA)		48.03±0.55	52.72±0.59	5.81**
Total mono unsaturated fatty acids (MUFA)		40.27±1.28	41.09±0.54	0.59^{NS}
Total poly unsaturated fatty acids (PUFA)		8.23±0.32	5.66±0.35	5.40**
Total unsaturated fatty acids (UFA)		48.50±1.23	46.75±0.51	1.31^{NS}
Total P/S		0.13±0.01	0.10±0.01	3.95**
Cholesterol (mg/100 g)		56.91±0.31	60.65±0.42	7.17**

n = 6, means bearing different superscripts differ significantly.

** = highly significant (P<0.01), ^{NS} = Non - significant (P>0.05).

lower than recommended value and it could be due to the rumen hydrogenates unsaturated fat from the diet and the ratio of n-6: n-3 PUFA was beneficially lower in ruminant meats (Enser *et al*., 1998). The young buffalo had significantly (P<0.01) lower cholesterol content than adult and the cholesterol content increased with advance in slaughter age and higher the fat content, the higher will be the cholesterol content (Madruga, 2001; Dorado *et al*., 1999). The variations in the nutritional composition may be attributed to climate, soil content, water composition and breeding policies of the various regions, which affects the nutrient content of the animal feed and thus the nutrient content its meat (Greenfield and Southgate, 2003; Okeudo and Moss, 2005).

CONCLUSION

Based on the meat quality characters and nutritional composition it was observed that Toda buffalo slaughtered at 12-18 months of age had better meat quality as well as balanced nutritional

composition as compared to animals slaughtered at 3 years of age.

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