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Physico-Chemical and Functional Quality of Buffalo Head Meat and Heart Meat

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Abstract: In the present study, physico-chemical and functional properties of buffalo head meat; heart meat and buffalo skeletal meat were estimated and compared. Moisture content of buffalo heart meat (78.42%) and head meat (76.94%) was significantly ($p<0.05$) higher than buffalo skeletal meat (75.85%). Buffalo heart meat had significantly lower protein content (15.49%) than head meat (19.25%) and skeletal meat (19.84%). Fat and ash content of buffalo skeletal meat, head meat and heart meat did not differ significantly among themselves. pH of buffalo head meat (6.41) was significantly higher than skeletal meat (5.85) and heart meat (5.80). Salt extractable protein of head meat (12.02%) was significantly ($p<0.05$) higher than skeletal meat (8.25%) and heart meat (8.52%). Heart meat had significantly ($p<0.05$) lower water holding capacity than skeletal and head meat. Shear force value and emulsifying capacity of heart meat were significantly ($p<0.05$) lower than skeletal and head meat. There was a significant difference in total pigment content between head (398.82 ppm), heart (338.98 ppm) and skeletal meat (243.89 ppm).

Key words: Offal meats, head meat, heart meat, physico-chemical, functional quality

INTRODUCTION

Two terms-by-products and offals-are used to denote all materials of economic value produced from slaughter of food animals, which are not a part of the dressed carcass. They are classified into two major groups i.e., edible by-products or edible offals and inedible by-products or inedible offals depending upon their use for human food or otherwise. Edible offals are sometimes referred to as variety meats or fancy meats. The edible offals of buffaloes like head meat and heart meat are being underutilized as compared to lean meat. The efficient utilization of these by-products is essential to support an economical and viable buffalo meat production system especially in the developing countries like India (Selvan *et al*., 2007).

Use of buffalo head meat and heart meat in comminuted meat products would not only bring more returns but also improve quality and nutritive value of meat products. Generally physico-chemical properties are relevant to the processing conditions and quality of the finished products like stability of the protein matrix for binding water and fat, cooking yield and texture. It is, therefore, necessary to study the physico-chemical properties of raw offal meats like head meat and heart meat and select ideal levels of their incorporation for processing of meat products. Only a limited number of studies are available on composition and functional parameters of meat by-products. Gorska *et al*. (1988), Venegas *et al*. (1988) and Nuckles *et al*. (1990) reported the functional properties, salt soluble and stroma proteins content of selected beef and pork by-products. Mustafa (1988) reported moisture, fat

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and cholesterol content in the beef heart meat. Oliveros *et al.* (1982) reported the protein content and composition of some beef by-products. Functional properties of some selected buffalo meat by-products have also been reported by Kondaiah *et al.* (1986) and Krishnan and Sharma (1991). Rivera *et al.* (2000) have also reported functional properties and different protein fractions of meat by-products. Physico-chemical, functional and microbiological qualities of buffalo liver have been reported by Devatkal *et al.* (2004).

Keeping in view the necessity for proper understanding of qualities of buffalo head and heart meat and their use in future, the present study was designed to gather a knowledge on buffalo head meat and heart meat composition and functional qualities enabling better utilization of these offal meats in meat products formulation.

MATERIALS AND METHODS

Sample Preparation

Buffalo head meat; heart meat and skeletal meat samples were collected from retail offal market Bareilly, India within 5-6 h of slaughter. The samples were packed individually in clean low-density polyethylene bags and transported to the Laboratory under hygienic conditions. The whole experiment was conducted in the divisional laboratory of Livestock Products Technology, IVRI, Bareilly, India. For analytical works, the head meat was washed and connective tissue layers were carefully separated out and discarded. Head meat was cut into chunks of about 2×3×3 cm size. The heart was flushed in running tap water to remove the adhering blood clots. The top fatty portion of heart containing major blood vessels and fatty layer was separated out by knife and discarded. Heart was made into pieces of about 3×2×2 cm size. Similarly, buffalo skeletal meat was cut into pieces of about 3×2×2 cm size for this study.

Proximate Composition

Moisture, crude fat, protein and ash contents of buffalo skeletal, head and heart meat were determined as per the standard procedures of Association of Official Analytical Chemists (AOAC, 1995) using hot air oven, Soxhlet apparatus, Kjeldhal digestion unit and muffle furnace, respectively.

Calorific Value

Gross energy of samples was determined by Gallenkamp and Ballistic Bomb Calorimeter (Haque and Lal, 1999). Approximately 1-2 g single piece of moisture driven meat sample was taken and weighed in the pre-weighed steel crucible. This crucible was placed on the support pillar in the base of the bomb. The firing wire and the sample were connected with the help of cotton thread. The bomb was fired under an oxygen pressure of 25 atmospheres. The initial and final temperature readings on the galvanometer were noted. The deflection on the galvanometer was compared with deflection on using 1 g standard benzoic acid of known calorific value (6318 kcal g^{-1}). The calorific value of the sample was calculated and expressed as kcal 100 g^{-1} of fresh meat.

pH and Water Holding Capacity (WHC)

pH of the samples was determined by homogenizing 10 g sample with 50 mL distilled water using an Ultra-Turrax T25 tissue homogeniser (Janke and Kunkel, IKA, Germany) at 8000 rpm for 1 min. The pH of the suspension was recorded by dipping combined glass electrode of Elico digital pH meter, (Elico, Model LI 127, India).

Water holding capacity was estimated according to Wardlow *et al.* (1973). To 20 g finely minced meat sample, 30 mL of 0.6 M chilled NaCl solution was added in a centrifuge tube and was stirred for

1 min with a glass rod. After holding for 15 min at 4°C to allow the effect of salt to reach equilibrium, the meat slurry was again stirred for 1 min and then centrifuged at 5000 rpm for 15 min. The supernatant volume was measured and WHC was expressed as mL of 0.6M NaCl retained by100 g of meat.

Shear Force Value

To determine the shear force value, the frozen meat was bored at different points with the help of a borer of 1 cm diameter in the direction of muscle fiber. Meat sample was cut into 1 cm long bits. The bored pieces were sheared in the Warner-Bratzler Shear Press Apparatus (Model 81031307, USA). For each sample, 15 observations were recorded and values were expressed in kg cm^{-2}.

Salt and Water Extractable Proteins

Salt Extractable Proteins (SEP) and Water Extractable Proteins (WEP) were estimated as per the method of Kang and Rice (1970). For water extractable proteins, 4 g of accurately weighed meat sample was homogenized with 30 mL of chilled distilled water in the Ultra Turrex tissue homogenizer for 2 min in a 100 mL conical flask and kept overnight at 4°C. The slurry was centrifuged at 5000 rpm for 5 min and the supernatant was collected. The residue was re-extracted with 10 mL of chilled distilled water and centrifuged as above. Salt extractable proteins were estimated by homogenizing the residue (remaining after the extraction of water extractable proteins) with 30 mL of chilled 0.67 N NaCl for 2 min and left overnight at 4°C. The slurry was centrifuged in a refrigerated centrifuge at 5000 rpm for 5 min and the supernatant collected. Residue was re-extracted with 10 mL of 0.67 N NaCl, centrifuged and the supernatant was collected. The proteins extracted in 0.67 N sodium chloride solutions and plain distilled water was designated as salt extractable and water extractable proteins, respectively. The total proteins in these extractions were calculated by Biuret method.

Emulsifying Capacity

The emulsifying capacity was estimated by using the method derived by Swift *et al*. (1961). Twenty five gram of finely minced meat was homogenized with 100 mL cold 1 M NaCl (5°C) for 1.5 min in a laboratory blender (Remi) at high speed. To 12.5 g of the resulting slurry, 37.5 mL cold 1 M NaCl was added into a plastic bottle with a side top hole and mixed for 5 sec at 1000 rpm. To this, 50 mL of refined vegetable oil was added and subjected to high speed cutting mixing at approximately 13000 rpm in a virtis type tissue homogenizer. Immediately thereafter, refined vegetable oil was added at a rate of about 0.8 mL per second from a graduated separating funnel through tygon tubing into the stirred mixture through side top hole. An emulsion was formed, persisted and finely collapsed and the transition was being marked by a gradual increase followed by a sudden decrease in viscosity. Addition of oil was immediately terminated on observation of the abrupt collapse of emulsion. The end-point was also indicated by a change in the pitch of sound of the homogenizing bowl. The volume of oil (50 mL and the additional oil drawn from the separatory funnel) consumed by the sample of meat expressed as the emulsifying capacity of the meat and it was expressed as mL of oil emulsified by 2.5 g meat.

Total Pigments

The method used by Hornsey (1956) was adopted for measurement of total pigments. The meat was trimmed of the excess fat tissue, cut with scissors and then minced thoroughly using a pestle and mortar. Ten gram of minced sample was made to a smooth paste with approximately 10 mL of acetone-water-acid mixture containing 40 mL acetone, 2 mL distilled water and 1 mL concentrated hydrochloric acid. The remainder of the acetone solution (33 mL) was then added and solution was

mixed. After 1 h solution was filtered through Whatman No.1 filter paper and the OD was recorded at 640 nm against a blank using Beckman Spectrophotometer (Model DU 640). The OD values were multiplied by 680 to get values of total meat pigments as ppm of haematin.

Statistical Analysis

Each experiment was replicated seven times and the data collected were analyzed using standard statistical procedure (Snedecor and Cochran, 1994). Analysis of variance (ANOVA) was used to determine significant differences ($p<0.05$) among means for the different meat samples.

RESULTS AND DISCUSSION

Proximate Composition

Moisture content of buffalo heart meat was significantly ($p<0.05$) higher than moisture content of skeletal meat (Table 1). However, there was no significant difference between the moisture content of buffalo heart and head meat. Moisture content of buffalo skeletal meat in the present study was in agreement with the moisture values reported by Naveena *et al.* (2004) and Yadav and Singh (1974). Moisture content of buffalo head meat and heart meat were in close agreement with the moisture values reported by Kondaiah *et al.* (1986) as 76.44 and 79.83%, respectively. Almost similar moisture values (79.85%) were reported by Krishnan (1988) for buffalo heart meat and Mustafa (1988) for beef.

The protein content in buffalo heart meat was significantly ($p<0.05$) lower than the protein content of head and skeletal meat. However, protein content of buffalo head meat and skeletal meat did not differ significantly. Similar findings were also reported by Kondaiah *et al.* (1986) for buffalo skeletal meat and Wiley *et al.* (1979) for beef (19.5 to 20.76%). Protein content of buffalo heart meat of this study was in accordance with value reported by Nuckles *et al.* (1990) in beef heart (15.4%).

There were no significant differences in the fat and ash content of skeletal, head and heart meat. Fat percentage of buffalo skeletal meat recorded in the present study was higher than the value (0.91%) reported by Kondaiah *et al.* (1986) and lower than the value (1.60%) reported by Krishnan (1988). Kondaiah *et al.* (1986) reported similar findings in case of ash percentage. These contrasting results of fat content may be due to the differences in age, plane of nutrition and might be due to removal of the top portion of heart, which contains higher deposition of fat. The calorific value of buffalo skeletal meat, head meat was significantly ($p<0.05$) higher than heart meat. Lower calorific value in heart meat might be due to lower fat content in heart meat than skeletal and head meat.

Emulsifying Capacity and Total Pigment

Emulsifying capacity of skeletal and head meats was significantly ($p<0.05$) higher than heart meat. However, values did not differ significantly between skeletal and head meat (Table 2). Emulsifying capacity of heart meat in the present study was much higher than the value reported by Kondaiah *et al.* (1986). Total pigment in head meat was significantly ($p<0.05$) higher than the values of heart meat and skeletal meat and again heart meat had significantly ($p<0.05$) higher total pigment than skeletal meat. Higher content of total pigment in head and heart meat than skeletal meat

Table 1: Proximate composition of buffalo skeletal meat, head meat and heart meat

Parameters	Skeletal meat	Head meat	Heart meat
Moisture (%)	75.85±0.51^{b}	76.94±0.80^{ab}	78.42±0.50^{a}
Protein (%)	19.84±0.82^{a}	19.25±0.47^{a}	15.49±0.89^{b}
Fat (%)	1.35±0.10	1.39±0.33	1.14±0.14
Ash (%)	1.00±0.04	0.95±0.04	0.92±0.08
Calorific value (kcal/100 g)	95.37±1.12^{a}	94.52±1.29^{a}	86.52±0.95^{b}

n = 12: Mean values bearing same superscripts row-wise do not differ significantly ($p<0.05$)

Table 2: pH, WHC, shear force value, extractable proteins, emulsifying capacity and total pigments of buffalo skeletal meat, head meat and heart meat

Parameters	Skeletal meat	Head meat	Heart meat
pH	5.85±0.51[b]	6.41±0.16[a]	5.80±0.07[b]
Shear force value (kg cm^{-2})*	3.69±0.31[a]	3.85±0.28[a]	1.64±0.06[b]
WHC (mL/100 g of meat)	27.58±1.87[b]	37.05±3.00[a]	12.69±1.47[c]
WEP (%)	6.13±0.48	5.98±0.44	6.62±0.64
SEP (%)	8.25±0.65[b]	12.02±1.31[a]	8.52±0.45[b]
EC (mL oil 2.5 g meat)	136.86±1.42[a]	138.57±1.23[a]	133.29±0.84[b]
Total pigments (ppm)	243.89±8.38[c]	398.82±10.95[a]	338.98±4.30[b]

Mean values bearing same superscripts row-wise do not differ significantly ($p<0.05$), n = 12; *: n = 45. WHC = Water Holding Capacity, WEP = Water Extractable Protein, SEP = Salt Extractable Protein, EC = Emulsifying Capacity

might be due to higher percentage of red fibers in these offal meats (Lawrie, 1998) and higher activity of cardiac muscle (Pearson and Gillett, 1997). The *Masseter* muscles of head meat display higher muscular activity during mastication and it might be the reason for higher content of total pigment in head meat.

pH, Water Holding Capacity (WHC), Shear Force Value and Extractable Proteins

Buffalo head meat had significantly ($p<0.05$) higher pH value than buffalo skeletal meat and heart meat. However, there was no significant difference between the pH values of skeletal meat and heart meat (Table 2). Significantly higher pH in head meat could be due to greater quantity of respiratory enzymes in the red fibers of head meat (Lawrie, 1998). pH of fresh buffalo skeletal meat recorded in the present study was in agreement with the pH range of 5.1 to 6.2 for beef reported by Nickerson and Sinsikey (1977). The high pH value recorded in skeletal meat might be due to the estimation of pH of meat before completion of rigor mortis. The pH of buffalo head meat and heart meat was in agreement with the findings of Kondaiah *et al.* (1986). The pH of heart meat (5.82) reported by Krishnan (1988) is very close to present study.

Significant ($p<0.05$) differences were observed in the WHC of skeletal meat, head meat and heart meat of buffaloes. WHC of head meat was significantly ($p<0.05$) higher than that of skeletal meat and heart meat. Similarly, WHC of buffalo skeletal meat was significantly ($p<0.05$) higher than the WHC of heart meat. WHC of buffalo head meat recorded was slightly higher than the value (33.60) reported by Kondaiah *et al.* (1986). The shear force values of buffalo skeletal meat and head meat were significantly ($p<0.05$) higher than heart meat. Higher shear force value of buffalo head meat and skeletal meat might be due to higher connective tissue content and larger fiber size. There were no significant differences in the values for WEP of buffalo skeletal meat, head meat and heart meat. Rao *et al.* (1985) reported similar results. However, Kondaiah *et al.* (1986) reported comparatively lower WEP content in these meats. SEP content of buffalo head meat was significantly ($p<0.05$) higher than SEP content of skeletal meat and heart meat of buffaloes. However, there was no significant difference between SEP content of buffalo skeletal meat and heart meat. Salt extractable proteins content of buffalo skeletal meat was comparable with the values reported by Rao *et al.* (1985) as 8.68% and Anjaneyulu (1988) as 7.87%. However, SEP content of buffalo head meat and heart meat of the present study were higher than the values reported by Kondaiah *et al.* (1986) as 5.11 and 4.53%, respectively.

CONCLUSION

From these results, it is concluded that the moisture content in heart meat is higher than buffalo head meat and skeletal meat. However, protein content in heart meat is significantly lower than head meat and skeletal meat. Physico-chemical and functional properties such as WHC and total pigment of head meat, heart meat and skeletal meat differ significantly. There is no significant difference

in SEP, pH of heart meat and skeletal meat, but these values are lower than the values of buffalo head meat. The EC and shear force value of buffalo head meat and skeletal meat were higher than heart meat.

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