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Quality Evaluation of Meat, Skin and Wool from Garole Sheep-a Promising Breed from India

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Abstract: The aim of this study was to evaluate meat quality of Indian Garole sheep for human consumption and to provide better understanding about its skin and wool quality to stimulate its utilization and marketing. Meat production in India is much lower than the actual demand might be due to improper exploitation of animal resources particularly sheep and goat. West Bengal in India is having a unique sheep breed named as Garole with outstanding genetic potentialities. Total 60 meat, 60 skin and 200 wool samples from 12 different sources were used in this study. The meat quality parameters viz. pH, water holding capacity, refrigeration loss, muscle fiber-diameter, proximate analysis viz. moisture, protein, fat, ash and carbohydrate contents, mineral analysis for common macro and micro minerals viz. sodium, potassium, calcium, phosphorus, magnesium, iron, cupper, zinc, manganese and chloride contents were studied in this research. The study revealed that dressing percentage (55.87%) was higher than other sheep breeds and pH (5.96) water holding capacity (43.33%) and refrigeration loss (0.86%) was comparatively better than known sheep standard. The average value of moisture, protein, fat, ash and carbohydrate contents (76.02, 18.20, 3.53, 1.65 and 0.60%, respectively) is comparable to average sheep standards with lower fat content. The macro and micro minerals contents are optimum or higher than average sheep standards indicating its higher nutritive value. The skin quality parameters viz skin length (61.43 cm), skin width (53.37 cm), skin weight (wet-1.188 kg, dry-0.59 kg), total skin area (3403 cm^2) and skin weight percentage (12.02%) was good and comparable with other sheep breed. Wool parameters like fiber length (4.95 cm), fiber diameter (54.77 μm), coefficient of variation (57.48%), type of wool (carpet type), medulation (88.13%), crimp (2.21 cm), bundle strength (7.36 g t^{-1}), elongation (29.56%) and weight of wool per shearing (308 g) are almost similar to common sheep breed of India. The high genetic potential and good quality of meat, skin and wool of Garole sheep of West Bengal, India is highly encouraging and shows a great promise for improving rural economy if proper developmental efforts are made.

Key words: Garole sheep, meat, skin, wool, India

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INTRODUCTION

India is the richest country in the world in livestock wealth. However, meat production is largely a by-product of livestock production system. More than 40% of the total meat is produced from spent (culled) animals at the end of their productive economic life (Mendiratta *et al*., 2008). Sheep are also usually reared for wool and are slaughtered at the end of their productive economic life. Meat production in India is far below the level of demand from the huge population. Per capita necessity of meat consumption in India is 34 g as recommended by Indian Council of Medical Research, however, the present availability (16 g) is much below that (Mathur, 2004).

Mutton (sheep meat) or Chevon (goat meat) is highly preferred by Indian consumers due to excellent flavor and palatability. However, availability of chevon or mutton is very less and chicken is taking the major share of Indian meat market. Lower production of chevon or mutton coupled with high market price due to demand supply gap has originated from lower emphasis in production and development of sheep and goat in the country. Sheep occupy a special niche in the Indian agricultural production system and are important for the rural economy. However, the litter size of almost all Indian sheep breeds, except the Garole, is low and is thus a major constraint to sheep-meat production. The Garole is the only known prolific sheep breed in India (Pardeshi *et al*., 2005).

Garole, a precious sheep breed from West Bengal an eastern province of India, is having some outstanding genetic potentiality such as high fecundity and lambing frequency. Its prolificacy, lambing frequency, disease resistance and other extraordinary merits rarely observed in any other sheep breeds of the world (Bose, 1995). Garole is a small coarse wool sheep breed with short legs, weighing about 12-15 kg, average liter size 1.8. It has a special gene Booroola fecundity commonly named as 'FecB' gene which makes it more prolific than other breeds and world famous Booroola-Merino sheep has large litter size due to the same gene (Nimbkar *et al*., 2003). Garole sheep are able to live in wet conditions of the delta which typically lead to foot rot in other breeds, suggesting a genetic resistance to some parasitic infections (Nimbkar *et al*., 2003). As the area is coastal and saline other agricultural activity is not well adopted hence this sheep provide principal source of income during agriculturally lean period and govern socio-economic status of these sheep farmers of this region (Bose, 1995).

Exploitation of the beneficial traits of Garole sheep will increase production of sheep to few folds and the differential demand supply ratio of red meat of the country can be decreased. Keen interest for the development of Garole sheep has been taken by government, non-government and other international development agencies (Banerjee and Banerjee, 2000). However, production potential and quality assessment of mutton, skin and wool from Indian Garole sheep are not properly studied and documented in the published literature. In this paper we report production potential and quality of Garole sheep in its native tract for mutton, skin and wool. We evaluated the basic quality of mutton, skin and wool from the Garole sheep from different sources to establish the basic data which will be useful for future research and for commercial utilization of this promising sheep breed.

MATERIALS AND METHODS

This study was done during August, 2005 to March, 2007 for a duration of 1 year 8 months

Sampling

Meat, skin and wool samples were collected from the native tract of Garole in Sunderban region and from Kolkata (about 100 km away from its native tract). All the samples were collected from randomly selected healthy Garole sheep of the age group of 8-12 months with body weight ranging between 9.09-10.67 kg from the selected sources. Sheep were reared under uniform housing, feeding and management conditions. Twelve sources were selected from three major areas for sample collection: 1. Local markets (6), 2. Kolkata markets (2) and 3. Kolkata slaughter houses (4).

Meat Quality Analysis

Total 60 meat samples (5 each from 12 different sources) were collected for this study after hygienic slaughter from the selected sources as follows: Local markets 30 samples (5 each from 6 different markets); Kolkata markets 10 samples (5 each from 2 markets) and Kolkata slaughter houses 20 samples (5 each from 4 place). About 100 g of *Longissimas dorsi* and *Semitendinosus* muscle were collected as sample in food grade plastics and transported in icebox to the laboratory. For the evaluation of carcass characteristics age at slaughter, weight at slaughter, carcass weight were recorded during slaughter of animals and dressing percentage was calculated as per standard procedure.

Meat quality parameters viz. pH, water holding capacity, muscle fiber-diameter of meat samples were done following the standard procedure. For pH about 5 g of meat sample mixed with 25 mL distilled water, homogenized at 3000 rpm for 1 min then pH was measured with the help of a digital pH meter (AOAC, 1995). For WHC Meat samples were weighed and wrapped with tissue paper, centrifuged at 1000 rpm. for 4 min. After centrifugation meat samples were taken out of tissue paper and weighed. Then samples were kept into hot air oven (70°C) for 12 h then taken weighed again. Loss of weight in the second phase was expressed as WHC in percentage. For refrigeration loss fresh meat samples were weighed and kept in refrigerator at 4°C again weighed after 17 h. The difference in pre and post refrigeration weight was expressed as the refrigeration loss in percentage (Zhang *et al*., 1995). For muscle fibre diameter 5 g raw meat from each sample was weighed, mixed with 30 mL 0.25 M chilled sucrose solution and homogenized at 5000 rpm for 1 min. A drop of this mixture was put over a clean greeze free glass slide and air dried. Now staining was done by methylene blue (0.3%) stain. After drying it was observed under microscope at 100X and 450X magnifications. The fibre-diameters were measured using oculometer on eyepiece (Davis *et al*., 1980). Proximate analysis viz. moisture, protein, fat, ash and carbohydrate contents of meat samples were estimated using modified official methods for raw meat analysis (AOAC, 1995). The samples were dried in hot air oven at 110°C for 16 h for moisture and the percent moisture was expressed as the difference in weight of the sample before and after drying. Total fat was extracted using soxhlet apparatus for 6 h with petroleum ether and the dried residue was weighed for fat content. The fat free residue was split into two portions. One was used for protein analysis by Kjeldahl method through digestion, distillation and titration. Another portion of sample was used for ash estimation by incinerating at 500°C for 12 h followed by cooling and weighing the ash residue. Carbohydrate content was calculated from the difference between fat free residue and ash plus protein. Mineral analysis for common macro and micro minerals in Garole meat viz. sodium, potassium, calcium, phosphorus, magnesium, iron, cupper, zinc, manganese and chloride contents were estimated following the standard methods (AOAC, 1995). Sodium, potassium and chloride contents were estimated by flame photometry (Systronics digital, FPM-125) methodology and other minerals (Zn, Cu, Fe, Mn, Ca, Mg and P) were estimated by using atomic absorption spectro-photometer (Parkin Elmer AAS-100) methodology based on a standard curve of known standards.

Skin Quality Analysis

A total of 60 (5 each from 12 sources) skins from the same animals were collected after the slaughter of Garole sheep at above mentioned slaughter points. Skin quality was assessed by recording different parameters like skin length, skin width, skin weight (wet and dry), total skin area, skin weight percentage and skin defect.

Skin length and skin width was measured with the help of a measuring tape and total skin area was calculated by multiplying length and width. After taking the wet weight the skins were sundried with salting and dry weights were taken using weighing balance and skin defect was noted with physical inspection. Wet Skin weight was expressed in percent over body weight at slaughter.

Wool Quality Analysis

Five grams of wool samples were collected each from neck and buttock region of 100 randomly selected sheep (total 200 samples) from its native tract, Kolkata market and Kolkata slaughter points. Samples were collected in plastic packets and transferred to the laboratory at normal temperature.

Different wool characteristics like fiber length, fiber diameter, type of fiber, medullation, crimp/cm, bundle strength, elongation were assessed following standard methods (Wang *et al*., 2007). Ordinary scale was used for measuring fiber length and crimp; fiber diameter, fiber type and medullation were assessed with the help of microscope and ocular micrometer (Wang *et al*., 2007). Shearing time, duration of shearing and weight of wool per shearing were recorded as per standard animal husbandry practices and compared with normal sheep standards.

Statistical Analysis

Data obtained were analyzed to determine the mean and Standard Error (SE) for all parameters as per standard procedure (Snedecor and Cochran, 1986).

RESULTS

Garole sheep are raised in free range system in the natural pasture land without technical inputs for feeding or management. Primarily these sheep are used for meat production, though it produces wool also but it is not properly harvested. We have surveyed the marketing pattern of Garole sheep. Garole sheep is usually slaughtered at 8-12 months age in local meat shop to meet the demand of red meat among local consumers. A major population of the sheep is sent to Kolkata Market either directly or indirectly via the local wholesale market and from their sheep is sent to four major slaughter houses in the city. Acceptance of mutton is poor at village level due to their ignorance about sheep meat; therefore, it is sold as goat meat unlike in metro city Kolkata. A total of 60 meat samples, 60 skin samples and 200 wool samples from Garole sheep were evaluated on basic quality characteristics in this study. The results are presented and discussed below.

Carcass Characteristics

Average dressing percentage of Garole sheep was 55.87% and it was little higher in Kolkata slaughter houses than local or Kolkata markets. Average dressing percentage of Garole sheep was higher than other sheep breeds (48-52%) which indicates its better potentiality for meat production.

Meat Quality

The different parameters related to meat quality viz., pH, WHC (Water Holding Capacity) refrigeration loss, fiber diameter of Garole meat are shown in Table 1. Different quality parameters of Garole meat like pH (5.97), WHC (43.33%) and refrigeration loss (0.86%) was little lower than normal values for mutton.

Average value of moisture, protein, fat, ash and carbohydrate was 76.02, 18.20, 3.53, 1.65 and 0.60%, respectively (Table 2). In comparison to average sheep standards, moisture and ash percent was higher, whereas, fat and protein percent was lower in Garole meat. Fat percent in Garole meat was significantly ($p<0.01$) lower and was almost half of normal sheep standard which indicates a great advantage to the modern consumer concerned about fat eating. There was no significant difference in terms of other parameters and were close to the normal sheep standards. Minute variations were found between sources of sample of Garole meat but there was no significant difference.

Average value of different mineral content like sodium, potassium, calcium, phosphorus, magnesium, iron, cupper, zinc, manganese and chloride contents of Garole meat are shown in Table 3. In general mineral contents were comparable to their standard value for mutton or at higher side.

Skin Quality

The average value of skin length (61.43 cm), skin width (53.37 cm), skin weight (wet-1.188 kg, dry-0.59 kg), total skin area (3403 cm^2) and skin weight percentage (12.02%) was good and comparable with valuable Bengal goat skin. There was hardly any defect in skin, rarely slight perforations were seen which might be due to ectoparasitic infection (Table 4).

Table 1: Characteristics of Garole meat from different sources (Mean±SE)

Source of meat samples	Live weight at slaughter (kg)	Dressed weight (kg)	Dressing percentage	pH	WHC (%)	Refrigeration loss (%)	Fibre diameter (μm)
Local markets (30)	9.09±0.15	4.90±0.21	53.88±0.52	6.07±0.02	45.00±0.8	0.80±0.07	28.56±0.1
Kolkata markets (10)	9.89±0.25	5.43±0.13	54.87±0.55	5.80±0.03	40.00±0.6	0.99±0.06	27.36±0.1
Kolkata slaughter houses (20)	10.67±0.19	6.28±0.12	58.87±0.47	6.05±0.02	45.00±0.8	0.78±0.07	24.00±0.2
Overall (60)	9.88±0.22	5.54±0.17	55.87±0.51	5.97±0.03	43.33±0.8	0.86±0.07	26.64±0.1

Table 2: Proximate composition of Garole meat from different sources (Mean±SE)

Source of meat samples	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)
Local markets (30)	76.04±0.2	18.81±0.05	2.93±0.2	1.77±0.02	0.45±0.002
Kolkata markets (10)	76.01±0.2	18.09±0.08	3.82±0.1	1.19±0.02	0.89±0.001
Kolkata slaughter houses (20)	76.00±0.2	17.70±0.07	3.85±0.1	1.99±0.02	0.46±0.002
Overall (60)	76.02±0.2	18.20±0.06	3.53±0.1	1.65±0.02	0.60±0.002
Known mutton*	73.30±0.1	19.20±0.05	6.00±0.2	1.50±0.02	0.60±0.002

Table 3: Mineral content of mutton from Garole sheep of different sources (Mean±SE)

Source of Garole mutton	Sodium	Potassium	Calcium	Phosphors	Magnesium
	---------- (mg/100 g) ----------				
Local markets (30)	85.50±4.87	380±0.12	9.78±0.47	170±6.61	20.10±1.02
Kolkata markets (10)	84.75±4.21	338±21.11	5.44±0.51	170±6.28	19.80±1.22
Kolkata slaughter houses (20)	84.00±4.17	255±19.27	5.65±0.43	176±6.11	19.80±1.23
Overall (60)	84.75±4.42	324±20.35	6.96±0.42	172±5.89	19.90±1.32
Source of Garole mutton	Iron	Cupper	Zinc	Manganeze	Chloride
	---------- (mg/100 g) ----------				
Local markets (30)	3.76±0.29	0.24±0.07	1.01±0.09	0.13±0.02	99.50±5.19
Kolkata markets (10)	2.59±0.27	0.30±0.09	1.03±0.19	0.15±0.02	80.00±5.21
Kolkata slaughter houses (20)	3.41±0.26	0.32±0.08	1.24±0.12	0.10±0.06	71.00±5.22
Overall (60)	3.25±0.25	0.29±0.06	1.13±0.11	0.13±0.01	83.50±5.20

Table 4: Skin quality of Garole sheep from different sources (Mean±SE)

Source of meat	Skin length (cm)	Skin width (cm)	Total skin area (cm^2)	Skin weight		Skin weight (wet) %
				Wet (kg)	Dry (kg)	
Local markets (30)	60.00±7.03	53.80±9.2	3228±78.1	1.123±0.3	0.57±0.1	12.35±2.8
Kolkata markets (10)	63.50±7.90	57.30±8.1	3638±75.2	1.265±0.1	0.61±0.1	12.79±2.3
Kolkata slaughter houses (20)	60.80±8.01	55.00±8.8	3344±74.7	1.175±0.2	0.59±0.1	11.01±2.5
Overall (60)	61.43±7.28	53.37±8.7	3403±73.8	1.188±0.2	0.59±0.1	12.02±2.4

Table 5: Wool quality of Garole sheep from different sources (Mean±SE)

Parameters	Native and local markets (140)	Kolkata markets (20)	Kolkata slaughter houses (40)	Overall (200)
Fibre length (cm)	4.87±0.18	4.98±0.16	5.01±0.15	4.95±0.16
Fibre diameter (μm)	52.81±1.52	53.22±1.31	58.28±1.28	54.77±1.74
CV* %	55.28±1.89	58.13±1.79	59.04±1.31	57.48±1.81
Type of fibre	Carpet	Carpet	Carpet	Carpet
Hairy (%)	60±1.80	58±2.30	59±1.90	59±2.00
Hetero (%)	10±0.91	12±0.87	16±0.76	13±0.88
Pure (%)	30±1.01	30±1.07	23±1.83	28±1.12
Weight of wool/shearing (g)	220±34.27	343±20.15	361±22.31	308±25.58
Medulation %	78.3±2.42	87.5±2.17	98.6±2.26	88.13±2.38
Crimp/cm	1.90±0.09	2.34±0.06	2.41±0.02	2.21±0.04
Bundle strength (g t^{-1})	7.01±0.25	7.22±0.23	7.84±0.19	7.36±0.22
Elongation (%)	26.89±2.06	30.26±1.54	31.54±1.31	29.56±.88

*Coefficient of variation

Wool Quality

The value of different parameters determining wool quality is expressed as average of wool collected from buttock and neck region of each Garole sheep (Table 5). Overall average of different qualities of Garole sheep wool like fiber length (4.95 cm), fiber diameter (54.77 μm) with coefficient of variation of 57.48%, type of wool (carpet type), medullation (88.13%), (crimp/cm (2.21)), bundle strength (7.36 g t^{-1}), elongation (29.56%) and weight of wool per shearing (308 g) are almost similar to common sheep breed of India.

DISCUSSION

The dressing percentage was little lower in its native tract than Kolkata slaughter houses might be due to humane slaughter, better dressing practices and economic utilization of offals. In this study, dressing percent was slightly higher than that of previous reports (Banerjee and Banerjee, 2000) which might be due to prolonged fasting of animals during transportation before slaughter in their study.

Parameters of different meat quality in Garole meat like pH, WHC and refrigeration loss was little lower than normal values for mutton (Crosby, 2000). Lowered pH and WHC is good for appearance and juiciness of meat, respectively and can prevent bacterial growth and meat spoilage (Watt and Merrill, 1963). Therefore, these qualities coupled with lowered refrigeration loss may improve shelf life of Garole sheep (Watt and Merrill, 1963). Average fiber diameter of Garole meat was also little lower than known values for other sheep (Crosby, 2000). The lower fiber diameter signifies more tenderness of Garole meat which plays most important role in the acceptability of meat. However, in a different study (Banerjee and Banerjee, 2000) it was reported that the Garole meat was slightly tougher than goat meat which might due to higher age of the sheep selected for the study.

Meat is mainly composed of water, fat, protein, minerals (ash) and a small amount of carbohydrate. Water is the most variable of these components, but is closely and inversely related to the fat content. In Garole meat similar relation is reflected by higher moisture

content with a lowered fat percent. The slightly lower level of protein content in Garole meat might be due to lower nutritional status of the animals, since they are not reared under scientific feeding. Difference of protein percentage in Garole meat was 0.7%, which was slightly lower than other sheep meat. However, it should not be serious concern for human consumption. Fat content is one of the most important concerns to meat consumer due to its association with cardiac disease and obesity etc. Although fat provides 2.25 times more energy than equal quantity of carbohydrate or protein, animal fat is a source of cholesterol, which has got synergetic effect in heart diseases and related circulatory disorders in human (Lawrie and Ledward, 2006). Due to this reason, in spite of low palatability, people prefer to consume white meat with low fat content (2-3%) avoiding red meat with average fat content of 6-13%. Therefore, Garole meat can be considered as advantageous to other red meat due to its lower fat content like white meat for human consumption.

Carbohydrate content is in consistent with the average sheep standards (0-1%). In case of meat importance of carbohydrate is less. However, it serves an important function in controlling physic-chemical properties of meat like pH and water holding capacity (Lawrie and Ledward, 2006). Present results suggest that the meat from Garole sheep is equivalent to mutton and in some context is better for human consumption.

Higher value of ash content than normal sheep standards indicated higher mineral content in Garole sheep. Higher mineral content in Garole meat might be due to its adaptation in native coastal saline tract since long back.

Previously mineral study in meat was confined to five minerals like sodium, potassium, iron, calcium and phosphorus. Recently Indian Council of Medical Research strongly recommended that the magnesium, copper and zinc levels in meat or meat products and baby foods should be monitored (Mathur, 2004). One of the important advantages of red meat is higher mineral content particularly phosphorus, iron, zinc, manganese (Lawrie and Ledward, 2006) which plays very important roles through vitamins and coenzymes. The higher mineral content in Garole meat further emphasizes its nutritional strength as a good source of dietary minerals essential for balanced diet.

The size of the skins of Garole sheep were quite optimum to fetch good price from the local leather market. Demand for good quality skin from indigenous sheep is very high which offers high market price. However, its marketing is neglected or not well developed till now which sometimes leads to lower price. The data generated in this work will provide better understanding about the quality of Garole sheep skin and may stimulate its utilization and marketing, however, research need to be done to assess its leather quality.

Shearing was uncommon in its native tract, although few non-government organizations do it twice a year generally in the month of March and October. Wool was coarse type and 59% were hairy. Wool quality evaluated in this study was in agreement with the earlier reports (Banerjee and Banerjee, 2000). Quantity of fiber per shearing estimated in this study was higher than the earlier report of Bose (1995) and this difference might be due to gradual improvement of management practices in its native tract and better shearing by semi trained personnel from the non-government organizations. On an average 600 g of wool can be obtained from each sheep per year from two shearing which can fetch a very good economic return and need to be properly exploited from Garole sheep of Bengal. The value addition and economic potentiality of Garole fiber was also recommended earlier (Pan *et al*., 2004). It is suggested that this hairy fiber should be extensively used for production of carpets, blankets and other useful items which may generate employment through byproducts industry. Small scale cottage industry should be promoted to stimulate rural economy utilizing this Garole wool with self-help group amongst educated unemployed.

CONCLUSION

It is concluded that the mutton from Garole sheep can be a good source of red meat with lower fat and adequate nutritive value and these qualities of Garole meat should increase the acceptance of consumers. This study provides better understanding about the quality of Garole sheep skin and may stimulate its utilization and marketing. The coarse wool fiber should be useful for carpets, blankets and other items which may generate employment through small scale cottage industry to stimulate rural economy.

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