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Satheesh Raja S

Assistant Professor, Department of Livestock Products Technology, Veterinary College and Research Institute, Udumalpet, TANUVAS, Tamil Nadu, India

Selvamani J

Assistant Professor, Sheep Breeding Research Station, Sandynallah, The Nilgiris, TANUVAS, Tamil Nadu, India

Prema N

Associate Professor and Head, Department of Veterinary and Animal Husbandry Extension Education, Veterinary College and Research Institute, Tirunelveli, TANUVAS, Tamil Nadu, India

Nalini P

Assistant Professor, Department of Livestock Products Technology, Veterinary College and Research Institute, Udumalpet, TANUVAS, Tamil Nadu, India

Muthulakshmi M

Assistant Professor, Department of Livestock Products Technology (Meat Science), Veterinary College and Research Institute, Namakkal, TANUVAS, Tamil Nadu, India

Rajkumar R

Assistant Professor, Department of Livestock Products Technology (Meat Science), Veterinary College and Research Institute, Namakkal, TANUVAS, Tamil Nadu, India

Chandirasekaran V

Professor and Head, Department of Livestock Products Technology (Meat Science), Veterinary College and Research Institute, Namakkal, TANUVAS, Tamil Nadu, India

Jophil Thomas

Assistant Professor, Department of Livestock Products Technology, Veterinary College and Research Institute, Udumalpet, TANUVAS, Tamil Nadu, India

Corresponding Author:

Satheesh Raja S

Assistant Professor, Department of Livestock Products Technology, Veterinary College and Research Institute, Udumalpet, TANUVAS, Tamil Nadu, India

Meat characteristics of Garole x Sandyno crossbreed sheep in Nilgiris, Tamil Nadu

Satheesh Raja S, Selvamani J, Prema N, Nalini P, Muthulakshmi M, Rajkumar R, Chandirasekaran V and Jophil Thomas

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Abstract

The present study evaluated the meat characteristics of Garole × Sandyno crossbred (F2 generation) sheep developed at the Sheep Breeding Research Station, Sandynallah, Nilgiris, Tamil Nadu. Six healthy, uncastrated 12-month-old male sheep were humanely slaughtered to assess carcass yield, cut-up yields, organ yields, proximate composition, and physicochemical properties of meat. The mean live weight, hot carcass weight, and dressing percentage were 20.15 ± 0.22 kg, 8.18 ± 0.42 kg, and $40.10 \pm 0.30\%$ respectively. The major wholesale cuts showed satisfactory yields, while the meat contained $77.74 \pm 0.54\%$ moisture, $17.70 \pm 0.29\%$ protein, $2.78 \pm 0.32\%$ fat, $1.33 \pm 0.17\%$ ash, and a gross energy of 999 ± 46.20 kcal/kg. The mean pH and water-holding capacity were 5.99 ± 0.01 and $30.12 \pm 0.14\%$ respectively. The findings indicate that further studies involving both male and female Garole × Sandyno crossbred sheep are required to comprehensively evaluate their meat characteristics and establish the breed's meat production potential alongside its prolific twinning ability.

Keywords: Garole x Sandyno cross breed (F2) sheep, meat quality parameter, dressing yield, carcass and cut-up yield

1. Introduction

Garole is a highly prolific micro-sheep breed of the coastal saline zone of Sundarbans in West Bengal, India. Garole is the original source of the Booroola FecB gene (Asaduzzaman *et al.*, 2021; Patil *et al.*, 2016; Roy *et al.*, 2023; Sahana *et al.*, 2011) ^[1, 10, 12, 13] with incidence of twinning is 66% (Roy *et al.*, 2023) ^[12]. This unique fecundity profile distinguishes Garole from Sandyno sheep, which are reared primarily for mutton, not for prolific traits (Kumar *et al.*, 2002; Roy *et al.*, 2023) ^[6, 12]. Under improved nutrition at ICAR-Central Sheep and Wool Research Institute, Avikanagar, Garole performance improves substantially overall least-squares means for BWT, 3WT, 6WT, 9WT and 12WT were 1.18 ± 0.02 kg, 6.42 ± 0.12 kg, 9.87 ± 0.18 kg, 11.77 ± 0.25 kg and 13.74 ± 0.32 kg respectively (Prakash *et al.*, 2017) ^[11].

Sandyno is reared for mutton and fine wool production; however, the demand for wool in the state has declined such that selling price often does not cover the cost of shearing, and the focus has shifted entirely to mutton production (Chaudhari *et al.*, 2024) ^[3]. Highest ADG observed in Sandyno elite ewe lambs during 6–9 months is 62.98 ± 2.80 g/day (Kumar *et al.*, 2021) ^[6]. These data confirm Sandyno as a medium-to-large framed, fast-growing mutton genotype, an ideal maternal or sire-line contributor for crossbreeding programmes that aim to lift pre-slaughter weights of smaller-stature native breeds. This establishes Sandyno as a strong-growth, hill-adapted mutton breed that combines well with the prolific but small-stature Garole.

Despite being sourced from a contrasting agro-climatic zone (hot, humid, saline), Garole genetics have been used successfully in several Indian crossbreeding programmes, and a Garole × Sandyno cross in Tamil Nadu offers a scientifically rational basis for combining the prolificacy and disease-resistance advantages of Garole with the superior growth and frame size of Sandyno. Also, a cross between them is of considerable interest to smallholder mutton production in both coastal/saline and dry-land farming systems (Kumar *et al.*, 2021; Roy *et al.*,

2023; Sahana *et al.*, 2001; Sun *et al.*, 2024) [6, 12, 13, 16]. A collaborative study was undertaken by the Sheep Breeding Research Station, Sandynallah, Ooty and the Department of Meat Science and Technology, Veterinary College and Research Institute, Namakkal to investigate the meat production performance and physicochemical quality characteristics of meat obtained from Garole x Sandyno crossbred (F2 Generation) sheep.

2. Materials and Methods

2.1 Experimental Site

The experiment was conducted in two phases. The carcass evaluation was carried out at the Sheep Breeding Research Station, Sandynallah, Ooty, The Nilgiris, Tamil Nadu, while the proximate analysis of meat samples was performed at the Department of Meat Science and Technology, Veterinary College and Research Institute, Namakkal, Tamil Nadu.

2.2 Experimental Animals

Six healthy male Garole × Sandyno cross-bred sheep were selected at twelve months of age for carcass yield and mutton quality evaluation. The animals were maintained under a semi intensive system with uniform feeding and management regime throughout the experimental period, following standard practices at the Sheep Breeding Research Station, Sandynallah, Ooty.

2.3 Pre-slaughter and Slaughter Procedure

The animals were subjected to an overnight fast (approximately 12 hours) prior to slaughter, with free access to clean drinking water, in order to empty the gut and minimise contamination of the carcass during dressing. Pre-slaughter live weight of each animal was recorded immediately before slaughter using an electronic weighing balance. The animals were slaughtered by the humane method, i.e., by performing electrical stunning prior to bleeding (exsanguination), following the standard protocols prescribed for animal welfare in slaughterhouses. After electrical stunning and bleeding, the carcasses were dressed using routine procedures of skinning, evisceration, and washing.

2.4 Carcass Measurements

The carcass traits were recorded for each animal and all cut weights are expressed on the basis of the hot carcass.

2.5 Meat Sample Collection and Proximate Analysis

Representative meat samples from all six animals were collected, packed under refrigerated conditions, and transported to the Department of Meat Science and Technology, Veterinary College and Research Institute, Namakkal, for further analysis. The proximate composition of the meat was determined using standard AOAC methods.

2.6 Statistical Analysis

The data obtained on carcass traits and proximate composition were tabulated and computed using standard formulae, and the results were expressed as means with appropriate measures of variability.

3. Results

3.1 Carcass Parameters

The important carcass parameters were recorded in the present study to analyse the meat-producing ability of the Garole × Sandyno cross-bred (F2) sheep slaughtered at twelve

months of age. The mean values are presented in Table 1.

Table 1: Carcass and Organs parameters of Garole × Sandyno cross-bred (F2) sheep

Parameter	Male sheep (%)
Live weight (kg)	20.15±0.22
Hot Carcass weight (kg)	8.18±0.42
Dressing Yield	40.10±0.30
Head	8.18±0.15
Blood	4.20±0.16
Liver	2.20±0.15
Heart	1.07±0.05
Lungs / Trachea	1.03±0.05
Spleen	0.26±0.01
Rumen, Reticulum, Omasum, Abomasum	4.08±0.10
Intestines	7.10±0.11
Testicle	1.05±0.07
Kidney	0.50±0.01
Feet	2.95±0.04
Skin	10.92±0.14

The mean live weight of the experimental animals was 20.15 ± 0.22 kg (mean ± SEM) with a narrow range of 19.50–20.90 kg, indicating a highly uniform group were selected. Mean dressing percentage was 40.10 ± 0.30%, ranging from 39.00 to 41.00%. Among the non-carcass components, skin (10.92%) and head (8.18%) contributed the largest proportions of live weight, followed by intestines (7.10%), blood (4.20%) and the stomach compartments (4.08%); spleen (0.26%) and kidney (0.50%) were the smallest.

3.2 Wholesale Cut Weights

The mean weights of the principal wholesale cuts are presented in Table 2.

Table 2: Mean weights (%) of wholesale cuts of Garole × Sandyno cross-bred (F2) sheep

Parameter	Male sheep (%)
Fore Quarter	53.35±0.19
Hind Quarter	46.45±0.19
Neck	6.85±0.09
Shoulder, Fore shank	25.52±0.12
Rib	20.98±0.13
Loin	7.72±0.11
Rump	10.63±0.14
Leg, Hind shank	28.10±0.11

The carcass is divided into a fore quarter of 53.35 ± 0.19% and a hind quarter of 46.45 ± 0.19%. Among the primal cuts the leg with hind shank was the largest at 28.10 ± 0.11% (2.27 kg), followed by the shoulder with fore shank at 25.52 ± 0.12% (2.06 kg) and the rib at 20.98 ± 0.13% (1.70 kg); together these three accounted for 74.60% of the carcass. The rump (10.63%), loin (7.72%) and neck (6.85%) made up the balance.

3.3 Physicochemical properties of Meat

The mean values of pH, Water Holding Capacity (WHC) are 5.99 ± 0.01 and 30.12 ± 0.14 respectively.

3.4 Proximate Composition of Meat

The proximate composition and gross energy of twelve-month-old Garole × Sandyno cross-bred sheep are presented in Table 3.

Table 3: Proximate and Gross Energy of Garole × Sandyno crossbred (F2) sheep

Parameter	Male sheep (%)
Moisture	78.74±0.54
Crude Protein	17.70±0.29
Crude Fibre	BDL of 1%
Crude Fat	2.78±0.32
Crude Ash	1.33±0.17
Gross Energy	999 ± 46.20 kcal/kg

3.5 Summary of the Results

The Garole × Sandyno cross-bred (F2) sheep at twelve months of age showed an average live weight of 20.15 ± 0.22 kg with a hot carcass weight of 8.18 ± 0.42 kg and a dressing percentage of $40.10 \pm 0.30\%$, indicating satisfactory meat-producing ability for a 12-month-old breed-cross slaughter weight. The proportional yields of the wholesale cuts were consistent in healthy males also reflects a favourable edible-meat and bone proportion. With a reasonable protein content ($17.70 \pm 0.29\%$) and an ether-extractable fat content ($2.78 \pm 0.32\%$), the meat from this cross can be characterised as a lean, good-protein mutton source with an average gross energy value of 999 ± 46.20 kcal/kg.

4. Discussion

The Garole × Sandyno crossbred (F₂) sheep recorded a mean live weight of 20.15 ± 0.22 kg at 12 months of age, which was lower than the reported yearling weight of approximately 28 kg in elite Sandyno sheep. The relatively smaller mature body size of the Garole breed may have contributed to the lower body weight of the crossbreds, although the growth potential inherited from Sandyno appears to support better growth during the early growing phase, with reported average daily gains (ADG) at 6–9 months exceeding those of the Nilgiri parent (Kumar *et al.*, 2021; Venkataraman *et al.*, 2015) [6, 17].

The live weight of Garole × Sandyno sheep at 12 months (20.15 ± 0.22 kg) was comparable to that reported for Kenguri sheep at the same age (20.78 ± 0.84 kg). However, the mean hot carcass weight of Garole × Sandyno sheep (8.18 ± 0.42 kg) was slightly lower than that of Kenguri sheep (9.30 ± 0.39 kg) (Dodamani *et al.*, 2025; Meel *et al.*, 2024; Suliman *et al.*, 2021) [4, 7, 15]. The dressing percentage of $40.10 \pm 0.30\%$ was comparatively lower than the values reported for Bandur, Hassan and Kenguri sheep (Dodamani *et al.*, 2025; Muthukumar *et al.*, 2021) [4, 9]. This relatively lower dressing percentage may be associated with the compact and smaller body conformation inherited from the Garole parent. Although the Sandyno component contributes desirable growth and carcass characteristics, the crossbreds may not yet have attained the larger-frame and improved finishing characteristics associated with temperate wool breeds.

The Leg + Hind shank (28.10%) and Shoulder + Fore shank (25.52%) constituted approximately 53.6% of the total carcass weight, indicating that these regions contributed substantially to the overall carcass yield. A similar predominance of major meat cuts has been reported in Bandur ram lambs, where the leg and chuck accounted for 2.090 and 2.036 kg, respectively. The Loin + Rump (18.0%) represented an important proportion of the carcass and contributed to the yield of commercially valuable premium cuts. The Sandyno breed is also reported to contribute favourable carcass characteristics, including a larger body frame and greater loin eye area, which may have potential for further improvement of carcass quality in subsequent generations (Gadekar *et al.*, 2012; Kumar *et al.*,

2021) [5, 6].

The ultimate pH of the Garole × Sandyno crossbred meat was 5.99 ± 0.01 , which was comparable to the value reported for the Garole parent (5.91) (Mondal *et al.*, 2023) [8]. The water-holding capacity (WHC) recorded in the present study was $78.88 \pm 0.14\%$, which was substantially higher than the value reported for Garole sheep ($31.26 \pm 0.25\%$) (Mondal *et al.*, 2023) [8]. This marked difference indicates that the crossbred meat exhibited considerably greater moisture-retention capacity than the Garole parent. Therefore, while the ultimate pH was comparable between the crossbred and Garole sheep, the WHC showed a distinct improvement in the Garole × Sandyno crossbred meat. The high WHC observed in the present study may be associated with favourable muscle characteristics and could contribute to reduced moisture loss during storage and cooking.

Moisture constituted the major component of the meat, followed by protein, ether extractable fat, total ash and gross energy. The overall proximate composition was broadly comparable to that reported for the Garole parent. The crude fat content of 2.78% was relatively low compared with higher-finishing Indian sheep breeds such as Bandur (7.23%) and adult Malpura (5.16%) (Bhatt *et al.*, 2020) [2], indicating that the Garole × Sandyno crossbred produced comparatively lean meat. This lower fat deposition may be attributed to the relatively limited finishing and concentrate supplementation commonly associated with tropical small-ruminant production systems (Mondal *et al.*, 2023) [8].

The favourable WHC observed in the present study is also consistent with the desirable meat-quality characteristics reported for Garole sheep, including lower cooking loss, good water-holding capacity and acceptable tenderness (Sen and Karim, 2010) [14]. When compared with the Malpura benchmarks obtained using standardized AOAC proximate-analysis procedures, the meat from Garole × Sandyno crossbred sheep in the present study exhibited a leaner composition with relatively higher moisture content (Bhatt *et al.*, 2020) [2]. Overall, the findings indicate that Garole × Sandyno crossbred meat possesses favourable physicochemical characteristics, particularly its high WHC, together with a relatively low-fat content, suggesting its potential to produce lean and consumer-acceptable mutton.

5. Conclusion

The investigation was designed to generate standardised carcass and meat-quality data on this crossbreed at a slaughter age appropriate to small hill holder sheep-production systems in Tamil Nadu. With this inference, the Garole × Sandyno cross-bred sheep at twelve months of age yielded a carcass weight exceeded the actual Garole breed along with its twinning characters. Also, further studies involving both male and female Garole × Sandyno crossbred sheep are required to comprehensively evaluate their meat characteristics and establish the breed's meat production potential alongside its prolific twinning ability.

Conflict of Interest

Not available

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