Research Article

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Effect of age on Carcass Characteristics of Nellore Brown Rams

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ABSTRACT

The present study was undertaken to assess the influence of age on carcass characteristics and meat production potential of Nellore Brown rams under field conditions in Anantapuram district of Andhra Pradesh. A total of twelve apparently healthy male animals were selected from local slaughter facilities and stratified into three age groups based on dentition, namely 1 year, 1.5 years, and 2 years (n = 4 per group). Standard slaughter and carcass evaluation procedures were employed to record pre-slaughter weight, carcass traits, edible offals, non-carcass components, and wholesale cut yields. The results demonstrated a highly significant ($P < 0.01$) effect of age on major carcass parameters. Pre-slaughter weight increased from 27.30 ± 0.23 kg to 30.15 ± 0.23 kg, while hot carcass weight increased from 13.47 ± 0.11 kg to 15.07 ± 0.11 kg with advancement of age. Dressing percentage also showed a significant improvement, increasing from 48.05 ± 0.10% to 49.52 ± 0.10%, indicating enhanced carcass yield efficiency in older animals. Furthermore, the weights of edible offals and non-carcass components exhibited a significant upward trend, reflecting progressive physiological growth and organ development. The yield of wholesale cuts, including neck, shoulder, rack, loin, leg, and breast, increased significantly across age groups, indicating improved carcass conformation and distribution of commercially valuable meat portions. Muscle development parameters also showed significant enhancement, as evidenced by an increase in loin eye area from 11.55 ± 0.12 to 12.85 ± 0.12 cm^2, suggesting superior muscularity in older rams. In conclusion, the findings indicate that carcass yield, composition, and muscling characteristics improve significantly with advancing age, and slaughtering Nellore Brown rams at approximately 2 years of age may be considered optimal for maximizing meat production efficiency and economic returns.

Keywords: Nellore brown rams; Age; Carcass characteristics; Meat quality

INTRODUCTION

Sheep husbandry constitutes a vital component of the livestock sector in India, particularly in arid and semi-arid regions where crop production is often constrained by erratic rainfall and poor soil fertility. Among the indigenous breeds, Nellore Brown sheep is recognized as an important meat-type breed predominantly reared in the southern parts of Andhra Pradesh, especially in districts such as Anantapuram. This breed is well adapted to harsh agro-climatic conditions, characterized by high ambient temperatures, low rainfall, and sparse vegetation. Its inherent ability to thrive under extensive and semi-intensive production systems, coupled with notable disease resistance and efficient feed utilization, makes it highly suitable for resource-poor farmers (Bhaskar Reddy et al. 2015). Consequently, Nellore Brown sheep plays a significant role in sustaining the livelihoods of rural communities by providing a steady source of income through meat production.

In recent years, there has been a growing demand for quality mutton in both urban and peri-urban markets, necessitating improvements in meat production efficiency

and carcass quality. Carcass characteristics such as live weight, dressing percentage, carcass yield, distribution of wholesale cuts, edible offal proportion, and muscle development are considered critical determinants of meat production potential and economic returns (Aberle et al. 2012; Lawrie and Ledward, 2014). Among these, dressing percentage serves as a key indicator of the efficiency with which live animals are converted into marketable carcass, while parameters such as loin eye area and body wall thickness provide insights into muscling and fat deposition, which directly influence meat quality attributes like tenderness, juiciness, and flavor (Bhaskar Reddy et al. 2022).

Age is one of the most important biological factors influencing growth performance, carcass composition, and meat quality in sheep. As animals advance in age, there is a shift in growth pattern from skeletal development to muscle accretion and subsequently to fat deposition. This results in significant changes in carcass traits, including increased carcass weight, improved dressing percentage, enhanced development of prime cuts, and alterations in fat distribution (Kumar et al. 2018; Silva et al. 2021). Younger animals generally exhibit higher proportions of bone and lower fat content, whereas older animals tend to have better carcass finish due to increased subcutaneous and intramuscular fat deposition. However, excessive age may lead to undesirable increases in fat content and reduced feed efficiency, thereby affecting economic returns.

Several studies conducted on different sheep breeds have demonstrated that slaughter age significantly affects carcass yield and composition. For instance, Sen et al. (2004) and Karim et al. (2007) reported that carcass weight and dressing percentage increased with age and body weight in Indian sheep breeds. Similarly, studies by Stenberg et al. (2020) and Shanthesha et al. (2023) indicated that muscle development, organ weight, and fat deposition are positively correlated with advancing age. Despite these findings, there exists limited systematic and region-specific information on the effect of age on carcass characteristics of Nellore Brown sheep, particularly under field conditions prevalent in Andhra Pradesh.

In Anantapuram district, sheep rearing is predominantly practiced under traditional management systems, where animals are often marketed based on visual appraisal rather than scientific evaluation of optimal slaughter age. This may lead to suboptimal utilization of the animal's growth potential and reduced economic returns to farmers. Therefore, determining the appropriate age for slaughter is essential to achieve a balance between growth performance, carcass yield, and meat quality, ultimately enhancing profitability in sheep production systems. In this context, the present study was undertaken to systematically evaluate the effect of age on carcass characteristics of Nellore Brown rams. The study specifically aimed to assess variations in carcass weight, dressing percentage, non-carcass components, edible offals, wholesale cuts, and muscle development parameters across different age groups (1, 1.5, and 2 years) under field conditions in Anantapuram district of Andhra Pradesh. The findings of this study are expected to provide valuable insights for optimizing slaughter age and improving meat production efficiency in Nellore Brown sheep, thereby contributing to the sustainable development of small ruminant farming in semi-arid regions.

MATERIALS AND METHODS

The present investigation was undertaken to evaluate carcass characteristics of sheep slaughtered in and around organized and unorganized slaughter facilities located in the Anantapuram district of Andhra Pradesh, India. The study utilized a total of twelve apparently healthy male sheep, which were randomly selected from different slaughter and retail points to ensure representation of field-level production systems. The animals were categorized into three distinct age groups, namely 1 year, 1.5 years, and 2 years, with four animals in each group. Age determination was carried out based on dentition patterns, a widely accepted and reliable method in small ruminants, involving the eruption and wear of incisor teeth to classify animals into respective age categories.

The selected animals were subjected to standard pre-slaughter management practices, including overnight fasting (12 hours) with free access to potable water. This fasting period was essential to minimize gut fill, thereby reducing the risk of contamination during evisceration and ensuring accurate estimation of carcass yield parameters. The live weight of each animal was recorded immediately prior to slaughter using a calibrated weighing balance, and this value was considered as the pre-slaughter weight for subsequent calculations. Slaughtering was performed following traditional practices using the Halal method, ensuring compliance with ethical and hygienic standards. The procedure involved restraining the animal in lateral recumbency, followed by a swift and precise incision using a sharp knife to sever the trachea, esophagus, carotid arteries, and jugular veins. This technique facilitates rapid and efficient exsanguination, which is critical for improving meat quality and shelf life. Bleeding was allowed to proceed for approximately 5–6 minutes to ensure maximum removal of blood from the carcass.

Subsequent to bleeding, the carcass was hoisted by suspending it from the hind limbs using appropriate hooks, which aids in maintaining hygienic conditions during further processing. Skinning was carried out carefully to

prevent contamination of the underlying musculature. Initial incisions were made along the hind limbs and mid-ventral line, and the skin was gradually removed using a combination of manual pulling and knife assistance. Special care was taken to avoid contact between the outer surface of the skin and the exposed muscle tissue to minimize microbial contamination. Evisceration was performed immediately after skinning by making a controlled incision along the abdominal midline. The gastrointestinal tract and associated organs were carefully removed without rupturing the rumen or intestines to prevent spillage of ingesta. Thoracic organs, including the heart and lungs, were also removed systematically. All visceral organs were separated into edible and inedible offals, thoroughly cleaned, and weighed individually using a precision balance to assess their contribution to total body weight.

The dressed carcass obtained after removal of head, skin, feet, and viscera was weighed immediately to determine the hot carcass weight. Dressing percentage was calculated as the ratio of hot carcass weight to pre-slaughter weight and expressed as a percentage, serving as a key indicator of carcass yield efficiency. Further, carcass evaluation included measurement of body wall thickness and loin eye area, which are important indicators of carcass composition and meat quality. Body wall thickness was measured at standardized anatomical locations, particularly over the loin region, using a vernier caliper to assess subcutaneous fat deposition and carcass finish. The loin eye area, representing the cross-sectional area of the Longissimus dorsi muscle, was determined by making a transverse cut between the 12th and 13th ribs. The exposed muscle surface was traced on a transparent sheet, and the area was measured using a planimeter or graph paper method, providing an estimate of muscularity and lean meat yield.

Carcass fabrication into wholesale cuts was performed following standard butchery procedures. The major cuts obtained included leg, loin, rack, shoulder, and breast & flank. The leg portion was separated by cutting between the last lumbar vertebra and the sacrum, representing one of the most muscular and economically important regions. The loin, located between the last rib and pelvic girdle, was separated by making perpendicular cuts to the vertebral column and is considered a premium cut due to its tenderness and high muscle content. The rack, derived from the thoracic region (typically between the 6th and 12th ribs), is another high-value cut known for its superior eating quality. The shoulder was separated by cutting between the 5th and 6th ribs and included the forelimb along with associated musculature. The breast and flank region comprised the ventral thoracic and abdominal portions and was separated along the sternum and abdominal wall. All carcass components and wholesale cuts were weighed individually, and the data generated were used for comparative analysis of carcass yield and composition across different age groups. This systematic approach ensured accurate assessment of growth-related changes in carcass traits and provided a comprehensive understanding of meat production potential in Nellore Brown sheep under field conditions. The collected data were analyzed statistically using one-way analysis of variance (ANOVA) to study the effect of age on carcass characteristics, and significance was tested at $P \leq 0.01$ level.

RESULTS AND DISCUSSION

The detailed evaluation of carcass characteristics, non-carcass components, edible offals, wholesale cuts, and muscle development parameters of Nellore Brown rams across different age groups (1, 1.5, and 2 years) is presented in Table 1. The statistical analysis revealed a highly significant ($P \leq 0.01$) influence of age on all measured traits, indicating that advancing age plays a crucial role in determining growth dynamics, carcass composition, and overall meat production efficiency in this indigenous breed. The progressive increase in these parameters reflects coordinated physiological, anatomical, and biochemical changes associated with maturation.

A significant increase in live weight (28.43 ± 0.24 to 30.88 ± 0.24 kg), pre-slaughter weight (27.30 ± 0.23 to 30.15 ± 0.23 kg), and hot carcass weight (13.47 ± 0.11 to 15.07 ± 0.11 kg) was observed with advancing age (Table 1). This trend can be attributed to enhanced anabolic processes, including increased protein accretion, muscle fiber hypertrophy, and lipid deposition. The improvement in carcass weight with age is indicative of better feed conversion efficiency and nutrient partitioning towards muscle and fat tissues rather than maintenance requirements. Additionally, the increase in dressing percentage from 48.05% to 49.52% suggests a more efficient conversion of live body mass into carcass mass in older animals. This improvement is likely due to a reduction in the relative proportion of non-carcass components (such as gastrointestinal contents and external body parts) and an increase in edible carcass tissues. These findings are in agreement with earlier reports indicating that dressing percentage improves with age due to increased muscling and fat deposition. These findings are consistent with established reports in small ruminants, where dressing percentage has been shown to increase with age due to improved carcass conformation, enhanced muscling, and greater fat deposition (Sen et al. 2004; Karim et al. 2007; Aberle et al. 2012). The results thus reaffirm that age is a critical biological factor influencing carcass yield and

composition, with older animals demonstrating superior meat production potential under comparable management conditions.

The external body components, including skin (2.35 to 2.70 kg), head (1.60 to 1.82 kg), shank (0.90 to 1.12 kg), and blood (1.40 to 1.62 kg), exhibited a significant increase ($P \leq 0.01$) with advancing age (Table 1). This increase is primarily associated with the overall somatic growth and skeletal development of the animals. The proportional increase in these components reflects the normal growth trajectory, wherein structural tissues such as bone and integument develop in parallel with body mass expansion.

The weights of visceral organs, particularly digestive components such as the full stomach (4.42 to 5.00 kg), empty stomach (1.20 to 1.42 kg), and intestines (2.71 to 3.21 kg full; 1.00 to 1.22 kg empty), increased significantly with age (Table 1). This can be attributed to enhanced rumen-reticulum development, increased microbial fermentation capacity, and greater feed intake in older animals. The expansion of digestive organs is a critical adaptive mechanism that supports higher nutritional intake and metabolic demands, thereby facilitating improved growth performance and carcass yield. This improvement may be attributed to a decline in the proportional weight of non-carcass components and a concomitant increase in muscle and fat deposition, as reported by Sen et al. (2004) and Karim et al. (2007).

Edible offals, including liver, spleen, kidneys, lungs and trachea, heart, and testicles, also showed a statistically significant increase with advancing age (Table 1). The liver weight increased from 0.90 to 1.12 kg, kidneys from 0.18 to 0.21 kg, and lungs from 0.90 to 1.12 kg, indicating progressive organ development and increased metabolic activity. These organs are metabolically active tissues involved in vital physiological functions such as detoxification, circulation, respiration, and reproduction. Their growth reflects the overall maturation and functional efficiency of the animal. The increase in testicular weight further suggests reproductive maturity and endocrine activity in older rams. Comparable findings were reported by Shanthesha et al. (2023), indicating that organ growth is closely linked with overall body development in sheep and indigenous breeds (Reddy et al. 2021).

Muscle development parameters further substantiated the improvement in carcass quality with age. The loin eye area, which increased from 11.55 ± 0.12 cm^2 to 12.85 ± 0.12 cm^2, serves as a reliable indicator of muscle mass and carcass muscling (Table 1). The enlargement of this area reflects increased cross-sectional muscle fiber area and enhanced protein deposition. Similarly, the body wall thickness increased from 2.37 to 2.87 cm, indicating greater subcutaneous fat deposition and improved carcass finish (Table 1). Adequate fat cover is essential for minimizing moisture loss during chilling, improving meat juiciness, and enhancing palatability. The simultaneous increase in muscling and fat deposition suggests a balanced growth pattern, which is desirable for both carcass quality and consumer acceptability. These findings are consistent with the reports of Kumar et al. (2018), Stenberg et al. (2020), and Silva et al. (2021), who observed that age and nutritional status significantly influence muscle growth and fat deposition in small ruminants.

The wholesale cut components demonstrated a highly significant increase with age, indicating improved carcass conformation and distribution of muscle mass (Table 2). The weights of neck (1.37 to 1.54 kg), shoulder (3.03 to 3.38 kg), rack (2.63 to 2.98 kg), loin (2.23 to 2.53 kg), leg (3.97 to 4.53 kg), and breast & fore shank (1.93 to 2.98 kg) increased progressively across age groups. Among these, the leg and shoulder contributed the largest proportion to total carcass weight, followed by rack and loin. These regions are anatomically associated with major muscle groups, and their development is a direct indicator of meat yield. The loin and rack, being prime cuts, are particularly important due to their superior tenderness, higher lean content, and greater consumer preference. The observed increase in these cuts with age highlights the economic advantage of slaughtering animals at a later stage of maturity. Similar trends were reported by Girish et al. (2012) in Nellore sheep and Bhaskar Reddy et al. (2016) in carcass characteristics of improved varieties.

Table 1: Influence of age on carcass characteristics of Nellore brown sheep*

S.No.	Carcass characteristics	1Year	1.5 Year	2 Year
1.	Live weight	28.43±0.24 ^{a}	29.43±0.24 ^{b}	30.88±0.24 ^{c}
2.	Pre Slaughter Weight	27.30±0.23 ^{a}	28.75±0.23 ^{b}	30.15 ±0.23 ^{c}
3.	Skin weight	2.35±0.03 ^{a}	2.52±0.03 ^{b}	2.70±0.03 ^{c}
4.	Head weight	1.60±0.01 ^{a}	1.70±0.01 ^{b}	1.82±0.01 ^{c}
5.	Toung weight	0.18±0.00 ^{a}	0.19±0.00 ^{b}	0.20±0.00 ^{c}
6.	Blood weight	1.40±0.01 ^{a}	1.50±0.01 ^{b}	1.62±0.01 ^{c}
7.	Shank Weight	0.90±0.01 ^{a}	1.00±0.01 ^{b}	1.12±0.01 ^{c}
8.	Stomach full weight	4.42±0.05 ^{a}	4.67±0.05 ^{b}	5.00±0.05 ^{c}
9.	Stomach Empty weight	1.20±0.01 ^{a}	1.30±0.01 ^{b}	1.42±0.01 ^{c}
10.	Intestine full weight	2.71±0.03 ^{a}	2.92±0.03 ^{b}	3.21±0.03 ^{c}
11.	Intestine empty weight	1.00±0.01 ^{a}	1.10±0.01 ^{b}	1.22±0.01 ^{c}
12.	Fat weight	0.70±0.02 ^{a}	0.82±0.02 ^{b}	1.00±0.02 ^{c}

13.	Lungs and Trachea weight	0.90±0.01[a]	1.00±0.01[b]	1.12±0.01[c]
14.	Heart weight	0.25±0.00[a]	0.26±0.00[b]	0.28±0.00[c]
15.	Kidney weight	0.18±0.00[a]	0.19±0.00[b]	0.21±0.00[c]
16.	Liver weight	0.90±0.01[a]	1.00±0.01[b]	1.12±0.01[c]
17.	Spleen weight	0.15±0.00[a]	0.16±0.00[b]	0.17±0.00[c]
18.	Testicles weight	0.35±0.00[a]	0.36±0.00[b]	0.38±0.00[c]
19.	Tail weight	0.44±0.00[a]	0.48±0.00[b]	0.52±0.00[c]
20.	Hot carcass weight	13.47±0.11[a]	14.35±0.11[b]	15.07±0.11[c]
21.	Dressing percentage (%)	48.05±0.10[a]	48.95±0.10[b]	49.52±0.10[c]
22.	Lion eye area(cm^2)	1.55±0.12[a]	12.32±0.12[b]	12.85±0.12[c]
23.	Body wall thickness (cm)	2.37±0.05[a]	2.65±0.05[b]	2.87±0.05[c]

Note: Mean values within row bearing different superscripts are differ significantly (P<0.01). *n=12

From a physiological perspective, the observed improvements in carcass traits with age can be attributed to shifts in growth patterns, where early growth is dominated by skeletal development, followed by muscle growth, and later by fat deposition. The results clearly indicate that animals at 2 years of age have reached a stage of optimal muscle development and desirable fat cover, leading to superior carcass characteristics.

Table 2. Influence of age on wholesale cuts of Nellore brown sheep*.

S.No	Wholesale cuts	1 Year	1.5 Year	2 Years
1.	Neck	1.37±0.01[a]	1.48±0.01[b]	1.54±0.01[c]
2.	Shoulder	3.03±0.03[a]	3.25±0.03[b]	3.38±0.03[c]
3.	Rack	2.63±0.02[a]	2.86±0.02[b]	2.98±0.02[c]
4.	Breast and fore shank	1.93±0.02[a]	2.15±0.02[b]	2.98±0.02[c]
5.	Lion	2.23±0.02[a]	2.41±0.02[b]	2.53±0.02[c]
6.	Leg	3.97±0.05[a]	4.33±0.05[b]	4.53±0.05[c]

Note: Mean values within row bearing different superscripts are differ significantly (P<0.01).

* n=12

This research outcome presents valuable findings regarding the influence of age on various carcass traits of Nellore Brown rams. However, some limitations of this study may impact the study's conclusions: (a) This small sample size (4 rams in each group) may not provide a robust representation of the entire population of Nellore Brown rams due to variability within a larger population may not be adequately captured, thus affecting the reliability of the findings; (b) Conducting the study under field conditions, introduces numerous uncontrolled variables can affect carcass characteristics. (c) There can be individual variances within the same age group related to genetics and environmental factors that might have significant impacts on carcass characteristics; (d) The findings are specific to the Anantapuram district of Andhra Pradesh and may not be generalized to other regions or contexts and different agro-climatic conditions, management systems, and genetic backgrounds in other areas could yield different results; (e) This study provides a cross-sectional analysis of three distinct age groups rather than longitudinal data tracking individual animals over time. A longitudinal approach would allow for more dynamic insights into the growth patterns and changes in carcass characteristics. Further, intense studies are required to address above said limitations in future research, the obtained results could enhance the robustness and applicability of present findings regarding the carcass characteristics of Nellore Brown rams.

CONCLUSIONS

In conclusion, this study establishes that Nellore Brown sheep possess considerable potential as a meat-producing breed under field conditions. Optimizing the age at slaughter to approximately two years can significantly enhance carcass quality, maximize meat yield, and improve profitability for farmers and stakeholders in the meat production chain. These findings provide valuable scientific insights for developing age-specific management and marketing strategies aimed at improving small ruminant meat production in semi-arid regions. But aforementioned limitations, future research that addresses these limitations, perhaps by increasing sample sizes, implementing controlled nutritional studies, or examining qualitative meat traits, will be necessary before robust guidelines can be established for optimal slaughter age that aligns with both animal performance and market demands in India.

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