



Carcass traits and value of meat and byproducts of sheep

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ABSTRACT

A study was carried out to evaluate the carcass traits of sheep and in total, data on 1332 sheep were collected from four states covering southern, central and northern part of India. The yield and value of carcass and byproducts of sheep were grouped under 4 different live weight categories, viz. less than 15 kg (group 1), between > 15 to < 20 kg (group 2), >20 to <25 kg (group 3) and more than 25 kg (group 4) and statewise (Andhra Pradesh, Maharashtra, Uttar Pradesh and Tamil Nadu). The results revealed that the overall live weight of sheep ranged from 12.44 to 27.69 kg and dressed carcass weight ranged from 5.63 to 13.22 kg, with dressing percentage of 46.03. Significant differences were observed in the live weight, carcass weight, dressing percentage and yield of byproducts of the sheep of different body weight groups of different states. Sheep belonging to the body weight of >15 to >20 kg were found to be utilized more for mutton production (49.25%). Sheep from states like Maharashtra (20.14 kg) and Andhra Pradesh (20.24 kg) had higher overall average live weight when compared to other states. In sheep, all the byproducts except skin are utilized for human consumption and the yield of edible and inedible (skin) byproducts as percentage of live sheep weight were 43.03 and 11.00%, respectively. Among the saleable portions of sheep, 78.64–82.67% of revenue was contributed by meat, followed by edible offal (14.28–19.19%) and skin (2.17–3.05%).

Keywords: Byproducts, Carcass, Carcass traits, Sheep, Value

Sheep farming provides regular employment and a dependable source of income to a large percentage of small and marginal farmers, landless labourers and shepherds, particularly in the arid, semi-arid and mountainous areas of India. Sheep population in the country in 2019 is 74.26 million, showing an increase of 14.1% over the previous census (DADF 2020). Though there are 43 well defined Indian sheep breeds such as Nellore, Mandya, Muzzafarnagri, large number of sheep are non-descriptive (NBAGR 2020). Sheep are mostly reared for meat and wool. Mutton is one of the most preferred and widely consumed meats in the country without any taboo against. Out of total meat production of 8.1 million tonnes during 2017–18, goat and sheep contributed 1.64 million tonnes, which has a value of ₹ 66,814 crore (DADF 2020). Population growth, changed life style, increased per capita income fueling a massive increase in demand for foods of animal origin including mutton in the domestic market.

Over the years, commercial sheep production in the country has gained momentum in the form of a viable enterprise. Growing demand, remunerative price and guaranteed marketing for mutton are a few of reasons for choosing the commercial rearing of sheep. Several factors including heredity, breed, feeding regimen and prevailing rearing environment have significant impact on carcass

traits. Hence evaluating the meat production potential in terms of carcass traits becomes imperative to estimate the economical potential of sheep (Sen *et al.* 2004). Integrated approach such as optimizing nutritional and managerial inputs with adequate disease control measures need to be evolved and practiced to express the genetic merit of indigenous animals for bringing gainful advantages in body weight gains and carcass yield. The data available on the carcass traits of sheep are mostly restricted to small group of experimental animals, and there is no detailed study covering large number of commercial farm animals of various states. Moreover, particulars on revenue generated through mutton production are meager. Hence, this study was carried out in 4 states covering southern, central and northern part of India to get details on carcass traits and value of carcass and byproducts of sheep.

MATERIALS AND METHODS

Data collection: Telangana state has the highest sheep population in the country and houses about 25.72% of sheep population. It is followed by Andhra Pradesh, Karnataka, Rajasthan and Tamil Nadu, which together accounts for about 41% of the sheep population (DADF 2020). In total, data on carcass traits of 1,332 sheep was collected from undivided Andhra Pradesh (present Telangana and Andhra Pradesh) (330), Maharashtra (302), Uttar Pradesh (300) and Tamil Nadu (400). The data on carcass traits included live sheep weight (by pooling carcass and byproducts weight),

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carcass weight and weights of edible byproducts, viz. blood, head, fore feet, stomach, intestine, pluck (lung, liver and liver), fat, hind feet and trimmings and inedible byproducts (skin), were collected using electronic weighing balances. National Research Centre on Meat, Hyderabad has collected the data from Andhra Pradesh and Tamil Nadu. The data pertaining to Maharashtra and Uttar Pradesh states were collected by Veterinary College, Nagpur and Veterinary College, Mathura, respectively.

Statistical analysis: The data on yield and value of carcass and byproducts of 1332 sheep collected from 4 states were compiled and grouped under 4 different live weight categories, viz. less than 15 kg (group 1), between > 15 to < 20 kg (group 2), >20 to <25 kg (group 3) and more than 25 kg (group 4) and state-wise (Andhra Pradesh, Maharashtra, Uttar Pradesh and Tamil Nadu). The data on yield of carcass and byproducts of different live weight categories of sheep from 4 states were analyzed using statistical software (SPSS for Windows, version 13.0) following the standard procedure for analysis of variance (Snedecor and Cochran 1989) and Duncan's multiple range tests for comparing the means to establish the effect of slaughter weight and state on carcass traits.

RESULTS AND DISCUSSION

The data on average carcass and byproducts weight (kg) and their yield as percentage of live weight of 1332 sheep are presented in Tables 1 and 2.

Live weight of sheep: The percentage of sheep of different live weight groups utilized for meat production were maximum from between > 15 to < 20 kg live weight

groups (49.25) followed by >20 to <25 kg (20.72), less than 15 kg (19.89) and more than 25 kg (10.14%). Nearly 50% of sheep utilized for mutton production belong to body weight range of between > 15 to < 20 kg (group 2) with a national average weight of 18.47 kg (Table 1). This is in accordance with Karim (2008) who reported that the farmers usually sell off their finisher lambs for slaughter around 9–12 months of age weighing about 20–22 kg. Further, the FAO report also revealed that the average live weights of sheep utilised for mutton production are with a slaughter weight of 20–25 kg (FAOSTAT 2020). Low genetic potential, poor nutritional status (maintained on scrub vegetation under extensive system without concentrate supplement) and early age slaughter (between 6 months to one year of age) are the main reasons for the low productivity of Indian sheep compared to those in more agriculturally developed countries. For scanty suitable grazing lands in most of the states, the shepherds keep on migrating their flocks over extensive areas within or even in the neighboring states (Singh *et al.* 2003, Karim 2008, Das *et al.* 2008, Girish *et al.* 2012).

The overall average live weight of sheep from Andhra Pradesh and Maharashtra were higher when compared to other states (Table 2). Several reports (Karim *et al.* 2002, Sen *et al.* 2004, Muthukumar *et al.* 2006, Das *et al.* 2008, Prabu *et al.* 2009, Ramana Reddy *et al.* 2017) revealed that the kind of breed of sheep available in different states of the country, their managemental practices (extensive, semi-intensive and intensive system of rearing), age of slaughter have significant impact on the body weights of sheep. Slaughter studies of Karim *et al.* (2006) indicated variation

Table 1. Overall yield of carcass and byproducts (%) as percentage of live weight of sheep of different weight groups

Weight groups	No. of sheep	Live animal	Blood	Head	Fore feet	Skin	Stomach	Intestine	Pluck feet	Hind	Fat	Carcass
Below 15 kg	265	12.44 ^a ± 0.14	4.08 ^b ± 0.03 (0.51± 0.01)	7.58 ^d ± 0.05 (0.94± 0.01)	2.20 ^c ± 0.02 (0.27± 0.003)	11.52 ^c ± 0.06 (1.43± 0.02)	13.25 ^a ± 0.10 (1.64± 0.02)	6.60 ^a ± 0.11 (0.84± 0.02)	4.07 ^b ± 0.05 (0.50± 0.01)	1.93 ^c ± 0.02 (0.24± 0.004)	1.77 ^b ± 0.04 (0.21± 0.004)	45.13 ^a ± 0.12 (5.63± 0.07)
> 15 – < 20 kg	656	17.44 ^b ± 0.10	3.99 ^b ± 0.02 (0.69± 0.004)	6.95 ^c ± 0.03 (1.21± 0.01)	1.78 ^b ± 0.01 (0.31± 0.002)	10.84 ^a ± 0.04 (1.89± 0.01)	14.13 ^b ± 0.05 (2.47± 0.01)	8.03 ^b ± 0.07 (1.41± 0.01)	3.73 ^a ± 0.03 (0.65± 0.01)	1.66 ^b ± 0.02 (0.29± 0.003)	1.33 ^a ± 0.02 (0.23± 0.004)	45.97 ^b ± 0.10 (8.02± 0.03)
> 20 – < 25 kg	276	22.17 ^c ± 0.10	3.60 ^a ± 0.03 (0.80± 0.01)	6.33 ^a ± 0.04 (1.40± 0.01)	1.68 ^a ± 0.02 (0.37± 0.007)	11.08 ^b ± 0.07 (2.45± 0.02)	14.15 ^b ± 0.07 (3.13± 0.02)	8.73 ^c ± 0.10 (1.94± 0.03)	4.08 ^b ± 0.05 (0.90± 0.01)	1.35 ^a ± 0.02 (0.30± 0.01)	1.34 ^a ± 0.03 (0.30± 0.01)	46.25 ^b ± 0.13 (10.26± 0.05)
> 25 kg	135	27.69 ^d ± 0.20	3.59 ^a ± 0.04 (1.00± 0.02)	6.63 ^b ± 0.07 (1.84± 0.02)	1.70 ^a ± 0.03 (0.47± 0.01)	10.83 ^a ± 0.08 (3.00± 0.03)	13.23 ^a ± 0.12 (3.66± 0.04)	7.85 ^b ± 0.20 (2.17± 0.05)	4.22 ^b ± 0.07 (1.17± 0.02)	1.36 ^a ± 0.03 (0.38± 0.01)	1.31 ^a ± 0.03 (0.36± 0.01)	47.71 ^c ± 0.20 (13.22± 0.11)
Overall	1332	18.47± 0.13	3.88± 0.02 (0.71± 0.01)	6.91± 0.02 (1.26± 0.01)	1.84± 0.01 (0.33± 0.002)	11.02± 0.03 (2.03± 0.02)	13.86± 0.04 (2.56± 0.02)	7.87± 0.05 (1.48± 0.02)	3.92± 0.02 (0.73± 0.01)	1.62± 0.01 (0.29± 0.002)	1.42± 0.02 (0.26± 0.003)	46.03± 0.06 (8.53± 0.06)

Values in parenthesis indicate weight in kg. ^{a-c}Means within a column, not sharing a common superscript, differ significantly (P<0.05).

Table 2. Overall yield of carcass and by products (%) as percentage of live weight of sheep of different states

Name of the states	No. of sheep	Live weight	Blood	Head	Fore feet	Skin	Stomach	Intestine	Pluck	Hind feet	Fat	Carcass
Andhra Pradesh	330	20.24 ^b ± 0.30	3.91 ^b ± 0.03 (0.78± 0.01)	6.35 ^b ± 0.02 (1.28± 0.02)	1.78 ^{ab} ± 0.01 (0.36± 0.004)	11.18 ^b ± 0.08 (2.26± 0.03)	15.03 ^b ± 0.07 (3.02± 0.04)	9.57 ^c ± 0.08 (1.92± 0.03)	3.96 ^b ± 0.02 (0.8± 0.01)	1.61 ^b ± 0.01 (0.33± 0.004)	1.78 ^c ± 0.01 (0.36± ±0.01)	43.98 ^a ± 0.13 (8.96± ±0.13)
Uttar Pradesh	300	16.50 ^a ± 0.20	4.42 ^c ± 0.02 (0.73± ±0.003)	7.67 ^d ± 0.03 (1.26± 0.01)	1.84 ^b ± 0.01 (0.30± ±0.001)	10.71 ^a ± 0.05 (1.76± 0.01)	13.46 ^a ± 0.10 (2.24± 0.03)	6.52 ^b ± 0.03 (1.07± 0.01)	2.90 ^a ± 0.02 (0.4± ±0.003)	1.26 ^a ± 0.02 (0.21± ±0.005)	2.16 ^d ± 0.03 (0.36± ±0.003)	46.98 ^c ± 0.11 (7.75± 0.10)
Maharashtra	302	20.14 ^b ± 0.18	3.64 ^a ± 0.03 (0.73± 0.01)	6.13 ^a ± 0.04 (1.24± 0.01)	1.74 ^a ± 0.02 (0.35± 0.01)	10.74 ^a ± 0.04 (2.16± ±0.02)	13.92 ^a ± 0.06 (2.80± ±0.03)	9.64 ^c ± 0.04 (1.94± ±0.02)	3.86 ^b ± 0.03 (0.7± ±0.01)	1.72 ^c ± 0.02 (0.35± ±0.01)	1.08 ^a ± 0.02 (0.22± ±0.002)	46.11 ^b ± 0.09 (9.30± ±0.10)
Tamil Nadu	400	17.21 ^a ± 0.30	3.65 ^a ± 0.02 (0.62± 0.01)	7.41 ^c ± 0.03 (1.26± 0.02)	1.95 ^c ± 0.02 (0.32± 0.004)	11.33 ^b ± 0.04 (1.93± 0.03)	13.15 ^a ± 0.04 (2.24± 0.04)	6.16 ^a ± 0.05 (1.07± 0.02)	4.68 ^c ± 0.04 (0.8± 0.02)	1.80 ^d ± 0.02 (0.29± 0.003)	1.50 ^b ± 0.02 (0.24± 0.003)	46.97 ^c ± 0.08 (8.20± 0.16)
Overall	1332	18.47± 0.13	3.88 ^a ± 0.02 (0.71± 0.01)	6.91 ^a ± 0.02 (1.26± 0.01)	1.84± 0.01 (0.33± 0.002)	11.02± 0.03 (2.03± 0.02)	13.86± 0.04 (2.56± 0.02)	7.87± 0.05 (1.48± 0.02)	3.92± 0.02 (0.7± 0.01)	1.62± 0.01 (0.29± 0.003)	1.42± 0.01 (0.26± 0.002)	46.03± 0.06 (8.53± 0.10)

Values in parenthesis indicate weight in kg. ^{a-c}Means within a column, not sharing a common superscript, differ significantly ($P<0.05$).

in the pre-slaughter weight due to breed (6.6 kg–Garole, 22.8 kg–Malpura and 20.9 kg–Garole Malpura cross lambs). Das *et al.* (2008) reported pre-slaughter weight of 35.27 and 22.52 kg for 6 months old pure breed Muzaffarnagari sheep reared under intensive and semi-intensive system of management in an organized farm in Uttar Pradesh. Whereas, Girish *et al.* (2012) have reported that the live body weights of 6 months old Nellore sheep reared under traditional grazing and natural grazing along with nutrient supplementation (feeding of balanced concentrate feed) in Andhra Pradesh were 22.05 and 23.11 kg, respectively.

Carcass weight and dressing percentage of sheep: The carcass weight and dressing percentage of group 1, group 2, group 3 and group 4 sheep were 5.63, 8.02, 10.26 and 13.22 kg and 45.13, 45.97, 46.25 and 47.71%, respectively (Table 1). The carcass characteristics in terms of carcass weight and dressing percentage observed in the present study corroborated with findings of earlier reports. Dressing percentages of 41.77 to 51.6% were reported for different breeds of Indian sheep reared under different nutritional and managerial conditions (Girish *et al.* 2012, Singh *et al.* 2003, Das *et al.* 2008, Gadekar *et al.* 2018). Karim *et al.* (2006) indicated variation in the carcass weight due to breed. Singh *et al.* (2003) reported dressing percentages on live weight basis were 50.2 on low and 51.6 on high energy ration, 50.5 at 20 kg and 51.3 at 25 kg slaughter weight and 51.0 in Malpura and 50.8 in Mutton synthetic lambs in Rajasthan, respectively. However, Ramana Reddy *et al.* (2017) recorded dressing percentages of 42.63 to 46.40% for Deccani sheep grown with or without feed supplement under grazing system in Andhra Pradesh.

The analysis revealed that the live weight of sheep had significant ($P<0.05$) influence on the overall dressing percentage and the dressing percentage increased with increase in the body weight. Rajkumar *et al.* (2014), Gadekar *et al.* (2012) also observed similar trend of increase in dressing percentage with increase in pre-slaughter weight of sheep. The states also showed significant ($P<0.05$) influence on the overall average carcass weight of sheep, which ranged from 7.75 (Uttar Pradesh) to 9.30 kg (Maharashtra). The variations in the carcass weight of sheep produced in different parts of the country could be due to genetic (breed) and managerial practices in each location. Gadekar *et al.* (2012) also noticed the effect of genotype on carcass weight. Slaughter studies of Karim *et al.* (2006) also indicated variation in the dressed carcass weight due to breed. Similarly, Rajkumar *et al.* (2014) reported an overall carcass weight of 11.63 to 16.41 kg with a dressing percentage of 44.46 to 46.20% for Muzaffarnagari lambs in Uttar Pradesh. Girish *et al.* (2012) have reported that the carcass weights of 6 months old Nellore sheep reared under traditional grazing and natural grazing along with nutrient supplementation (feeding of balanced concentrate feed) in Andhra Pradesh were 10.48 and 11.80 kg, respectively.

The present study recorded an overall carcass weight of 8.53 kg and dressing percentage of 46.03% (Table 1). The average carcass weight recorded in the present study finds consonance with the observations of Rajkumar *et al.* (2014) who stated that traditionally, lambs produced in our country are slaughtered at 6–9 months of age, producing carcasses weighing in the range of 8 to 11 kg. Further, the BAHS

2016 data also reported the average slaughter weight for a lamb is 20–35 kg and average carcass yield per animal is only 9.05/kg/animal (DADF 2017). The FAO report on average carcass yield for Indian sheep also estimated as 12 kg (FAOSTAT 2020).

Edible byproducts weight and yield: In case of sheep, most of the offal and byproducts except skin are utilized for human consumption as variety meat. There was a significant variation ($P < 0.05$) in the overall yield of edible byproducts (blood, head, feet, pluck (liver, heart and lung), kidneys, stomach, intestine and fat) among the sheep of different body weight groups collected from various states (Table 1). However, Rajkumar *et al.* (2014) reported non-significant difference in the yield of edible byproducts except head and GI tract (empty) due to variation in the age and body weight of Muzaffarnagri sheep. The overall yield of edible offal and byproducts (blood, head, feet, pluck (liver, heart and lung), kidneys, stomach, intestine and fat) obtained in the study (43.03%) finds consonance with the observations of Rajkumar *et al.* (2014) (45.24%) and Girish *et al.* (2012) (42.35%).

Inedible byproducts weight and yield: Skin is the very important and high valued inedible byproduct from sheep. Well finished value added skin fetches high remuneration. There was a significant ($P < 0.05$) difference in the overall yield of skin of sheep of different body weight groups collected from various states. However, Rajkumar *et al.* (2014) reported no significant influence of slaughter weight on the yield of skin. The skin constituted about 10.84 to 11.52% of the total live weight of sheep with a national average weight of 2.03 kg. The per cent yield of skin recorded in the present study is comparable to those reported by Girish *et al.* (2012) (10.10 to 12.26%).

Value of saleable meat and byproducts of sheep: The meat, edible and inedible byproducts constitute the commercial value of the sheep. Meat constitutes only one-third of slaughtered animal and the edible and inedible byproducts and waste comprise rest (Ockerman and Hansen 1999). Unlike bovines, most of the byproducts of small ruminants including blood, head, pluck (heart, liver and lung), stomach and intestine and fore and hind feet are utilized for human consumption (Mehta *et al.* 2000). These organs and byproducts together constituted 43.79% of the live weight of sheep. These edible offal and byproducts are called as variety meats and utilized for preparing various delicacies and are usually sold as unit, not on weight basis. The fore- and hind-feet of food animals after removing the hairs are used for popular traditional delicacies like *Paya* (soup) and curry preparation (Lakshmanan *et al.* 1984). Similarly, head is used for preparing several delicacies like brain fry, curry, etc. Blood is also utilized for preparing different kinds of pudding. Fat also forms edible part of sheep. Based on the prevailing market price collected from the various parts of the country, the value of meat, edible byproducts and skin contributed about 78.64–82.67%, 14.28–19.19% and 2.17–3.05% of total value of sheep, respectively. Mehta *et al.* (2000) reported that the meat,

skin and edible byproducts of goat grown under intensive system weighing 40–45 kg represented around 88.75–89.35%, 6.38–6.62% and 4.26–4.50% of value of animal. Similar values were also reported by Solanki *et al.* (2009).

Contribution of livestock sector to the Indian economy is growing over the years and at current prices, the value of output from livestock sector is reported to be ₹ 1,043,656 crore and contributes 4.9% to nation's Gross Domestic Product (GDP) and 28.4% to Agricultural GDP in the year 2017–18. Large number of small and marginal farmers, landless labourers and shepherds in the country are dependent on sheep husbandry for their livelihood, nutritional security and prosperity. The nationwide study revealed that there is a wide variation in the live weight of sheep (12.44 to 27.69 kg) utilized for meat production in different states. The overall average live weight of sheep was 18.47 kg and average carcass weight was 8.53 kg, which indicates an average dressing percentage of 45.97%. There was a significant difference ($P < 0.005$) in the overall live weight, carcass weight, dressing percentage and overall yield of blood, skin and intestine of sheep of different body weight groups collected from various states. The majority of the sheep slaughtered were in the weight group of >15 to >20 kg (49.25%). When expressed as percentage of live sheep weight, the yield of edible (blood, head, feet, stomach and intestine, pluck (heart, liver and lungs), kidney and fat) and inedible byproducts (skin) were 43.03 and 11%, respectively. The major revenue comes from the sale of meat (81.07–85.78%), followed by edible offal (11.55–16.47%) and skin (2.39–2.68%).

Efficiency in production has been necessitated than ever before because of increase in cost of animals as well as cost of rearing. India with only 2.29% of the land area of the World, is maintaining about 10.71% of the livestock population. India achieved horizontal growth in terms of animal numbers, there is need to achieve vertical growth in terms of improving productivity. Though the body weight and carcass yield of Indian sheep is lower than those of agriculturally more advanced countries, their productivity cannot be considered as inefficient considering the nutritional and physical environment in which they are grown. Several studies in the sector have shown that the carcass traits of economical interest can be improved through nutritional and husbandry practices, viz. inclusion of certain amounts of concentrates in the diet of grazing lambs, periodical deworming, vaccination, etc.

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