RESEARCH ARTICLE

Effect of Age at Slaughter on Various Carcass Characteristics of Hassan Sheep

Kandikere M Shanthesha[1], Savariraj W Ruban [2]*, Rachaiah Guruprasad [3], Honnebagi B Shivappanayaka[4], Kumar S Naveen[5], Rekhyanaik Shivakumar [6], Siggiriyappa Sudarshan [7]

Abstract

The present study was carried out to evaluate the influence of age at slaughter on various carcass characteristics of Hassan sheep. A total of 36 male Hassan sheep 12 each in 3 different age groups, *viz*., 6-8 months (T1), 12-15 months (T2) and 30-32 months (T3) were slaughtered as per standard procedure. The pre-slaughter weight (PSW), hot carcass weight (HCW), dressing percent (DP) and loin eye area (LEA) revealed a significant difference ($p<0.05$) between the three age groups. Age group T3 recorded the highest PSW and HCW, whereas T2 recorded the highest DP (49.74%) and LEA (12.68 cm^2). The age at slaughter was found to have a significant ($p<0.05$) effect on the weight of the non-carcass components and the offal weights. Group T3 recorded a significantly higher ($p<0.05$) weight of liver, head, feet, blood, heart, kidney, spleen, brain followed by T2 and T1. It was evident that in T3 group the per cent of major primal cuts, *viz.,* shoulder, leg and loin cuts decreased significantly ($p<0.05$), whereas there was an increase in per cent of neck and rack cuts clearly indicating that in older/ aged animals the per cent of valuable cuts decreased. No significant difference was observed in the linear carcass measurements with respect to T1 and T2, whereas T3 recorded significantly higher measurements as compared to T1 with respect to all the linear carcass measurements. Based on the results it is concluded that the optimal age of slaughter of Hassan sheep is 12-15 months to obtain better carcass yield and yields of valuable cuts with good muscling.

Keywords: Age at slaughter, Dressing per cent, Hassan sheep, Primal cuts.

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Introduction

Livestock, which is an integral component of the agriculture and allied sector in India, contributes to around 28.4 % of Gross Value Added (GVA) to agriculture and allied sector, which is equivalent to around 4.9 % of total GVA (BAHS, 2019). Though the contribution of agriculture and allied sector to the total GVA is declining over the years, the share of the livestock sector to agricultural GVA and total GVA is showing an increasing trend indicating the important role of the livestock sector in the national economy. Among the various livestock, sheep is one of the most important livestock species providing food and nutritional security to a large resource-scarce section of the human population of India. These animals are a major source of complementary income for a majority of rural households and more importantly provide nourishment to rural pro-poor and less educated farm families (Bettencourt *et al.,* 2015).

As per the records of NBAGR, there are 44 registered well-defined breeds of indigenous sheep, distributed in four agro-climatic zones of the country (www.nbagr.res.in). Hassan sheep, named after its origin from Hassan district of Karnataka is widely distributed in and around Hassan, and is well known for its mutton and coarse wool (Yadav *et al.,* 2013). In order to maximize returns from the lambs, sheep producers need to be aware about the desirable slaughter age and weight to fetch higher returns from their produce (Shinde *et al.,* 2018). Therefore, studies on evaluating the influence of age at slaughter on carcass characteristics in recognized sheep breeds in Karnataka is imperative as it will provide producers as well as governmental agencies with baseline data. Hence the present study was carried out to evaluate the effect of age at slaughter on various carcass characteristics in order to determine the optimal age of slaughter of Hassan sheep.

[1,2,7]Department of Livestock Products Technology, Veterinary College, KVAFSU, Hebbal, Bengaluru-560 024, India.

[3]Animal Husbandry Polytechnique, Hassan-573 201, Karnataka, India.

[4]Department of Animal Genetics and Breeding, Veterinary College, KVSFSU, Hebbal, Bengaluru-560 024, India

[5]Krishi Vigyan Kendra, Tiptur-572 202, Karnataka, India.

[6]Krishi Vigyan Kendra, KVSFSU, Mangalore- 575 002, Karnataka, India.

Corresponding Author: Wilfred Ruban, S., Department of Livestock Products Technology, Veterinary College, Hebbal, Bengaluru-560 024, India, E-mail: rubanlpt@gmail.com

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Materials and Methods

Animals and Experimental Design

In the present study, pure Hassan breed of sheep maintained at Animal Husbandry Polytechnique, Koravangala Gate, Hassan district as a part of project entitled "Conservation of Hassan sheep" sponsored by Government of Karnataka, were utilized following Ethical Approval from the Institutional Animal Ethics Committee (No.VCH/IAEC/2021/03). A total of 36 male Hassan sheep, *viz*., 12 each in three age groups (6-8 months, 12-15 months and 30-32 months) were selected based on the dentition as well as birth records maintained at Animal Husbandry Polytechnique. The animals were maintained under similar feeding and managemental conditions employing semi-intensive system of rearing with 3-4 h of grazing and concentrates supplement in the evening hours.

Slaughter and Carcass Characteristics

All the animals were fasted for 12 h overnight with *ad-libitum* access to water before slaughter. The animals were slaughtered with all the hygienic measures in the slaughter house unit, Veterinary College, Bangalore. Pre-slaughter weight (PSW) was recorded using weighing machine (Essae-Teraoka Limited, India) in kilogram. Immediately after slaughter, blood was collected in a trough and weighed. The edible offals (liver, heart, kidneys, intestine) and inedible offals (skin, head, feet, spleen, lungs with trachea) were separately weighed. The weight of head was represented in per cent for discussion purpose. The weight of total internal fats (fats from the kidneys, scrotum, pelvic, and heart) was recorded using sensitive balance. The dressing percentage was calculated on the basis of hot carcass weight (HCW) and pre-slaughter weight (PSW) using the formula: HCW/ PSW X100.

Linear Carcass Measurements and Primal Cuts

The various linear carcass measurements were recorded on hot carcass using a flexible measuring tape and callipers. The various parameters; Carcass length, Leg length, Chest depth, Chest width, Buttock circumference, Buttock width, Carcass internal length, Shoulder width and Chest circumference were measured as defined by Naveen *et al*. (2018).

The carcass was divided into fore-saddle and hind-saddle at the intersection of 12^{th} and 13^{th} vertebrae and weight was recorded. The cut surface of M. *longissimus thoracis et lumborum* (LTL) at the interface of 12^{th} and 13^{th} ribs on both side of the carcass was marked on tracing paper and measured by a planimeter and recorded as loin eye area (cm^2). The carcass was cut into different primal cuts, *viz*., leg, loin, rack, neck and shoulder, flank, and breast and fore shank as per specifications of ISI (1963) and these were individually weighed and recorded.

Statistical Analysis

Descriptive statistics of different carcass weights and carcass components were determined as per Snedecor and Cochran (1994). The association of data of carcass traits were analyzed by one way ANOVA using SPSS software (SPSS statistics 20).

Results and Discussion

Pre-Slaughter Weight

The Mean ± SE of pre-slaughter weight (PSW) revealed a significant difference ($p<0.05$) between the three age groups. No significant difference was evident between T1 and T2, whereas a significant difference in PSW was evident with that of T3 compared to T1 and T2 which recorded the highest PSW. The PSW and hot carcass weight were found to increase with increase in the age of the animals, and PSW ranged from 20.81 to 32.05 kg (Table 1). Several researchers have reported pre-slaughter weight of majority of Indian breeds of sheep to vary from 18.20 to 41.10 (Karim *et al*., 2006, 2007; Gadekar *et al*., 2012). The pre-slaughter body weight of Hassan sheep was found to be more than other Indian sheep breeds like Coimbatore (Kandaswamy *et al*., 2006), Madras Red (Devendran *et al*., 2008), Mecheri (Jagatheesan *et al*., 2003) and Vembur (Selvakumar *et al*., 2020) which ranged from 16-18 kg at 6-9 months of age.

Dressing Percentage

The dressing percentage of Hassan sheep in the present study ranged from 43.12 to 49.74 % (Table 1). Among the age groups, T2 recorded significantly higher dressing percentage followed by T1 and the lowest was observed in T3 (30-32 months). Kumar *et al*. (2021) observed the dressing percentage of Hassan sheep (9-12 months) as 46.80 %. Almost similar dressing per cent values in Indian sheep breeds have been reported by Gadekar *et al*. (2018) in Kendrapara sheep (49.42 to 50.07 %), Naveen *et al*. (2018) in Bandur sheep (47.77 %), Kumar *et al*. (2017) in Deccani sheep (46.97 %), Paramasivam *et al*. (2021) in Pattanam sheep (49.55-50.69%) and Hussain *et al*. (2019) in Yalaga (50.89 %) and Kenguri sheep (49.06 %).

The inverse correlation observed between dressing percentage and advancing age could be attributed to offals weight and gastro-intestinal content of heavier sheep, which are negatively correlated with dressing percentage (Belhaj *et al*., 2021). Esteves *et al*. (2018) observed lower dressing per cent of 43.65 for culled ewes slaughtered at 48 months of age as compared to ewes slaughtered at 6-9 months of age (49.42%). In similar lines, Budimir *et al*. (2018) also reported a negative correlation between the age of male lambs at slaughter and dressing percentage. In the present study, no significant difference in dressing per cent could be found between T1 and T2, which is in line with the report of Selvakumar *et al*. (2020). Correlation studies of Esteves *et al*. (2018) confirmed that increasing age increased body weight

(BW), carcass length (CL), lower dressing per cent thereby resulting in lower market value of the animals.

Loin Eye Area (LEA)

The Mean ± SE of loin eye area values of Hassan sheep (10.01-12.68 cm^2) showed a significant difference ($p<0.05$) between the three age groups (Table 1). T2 age groups recorded a significantly higher LEA indicating better muscle deposition at 12-15 months of age as compared to young as well as spent/cull animals. In concurrence with our findings LEA in Indian sheep breeds like Madras Red and Malpura have been reported in the range of 7.90 to 13.00 cm^2 (Kumar *et al*. 2017). However, higher LEA (12-15 cm^2) has been documented by researchers in several exotic breeds (Santos *et al*., 2015). Naveen *et al*. (2018) also recorded LEA of 15.3 cm^2 in Bandur sheep in Karnataka, which was higher than this study.

Non-Carcass Components and Offals

In the present study, age at slaughter significantly ($p<0.05$) influenced and had a positive correlation with the weight of non-carcass components and offals (Table 2). T3 recorded a significantly higher weight of liver, head, feet, blood, heart, kidneys, spleen followed by T2 and T1. Similarly Abdullah and Qudsieh (2009) in Awassi ram lambs found significantly higher edible offals weights in higher weight groups. In Malpura ram lambs, significantly higher yield of the edible offals weight were recorded in sheep slaughtered at 9 months compared to 6 and 7.5 months (Shinde *et al*., 2018).

The weight of the head in terms of per cent PSW in Hassan sheep ranged from 8.16-9.06 %. Similar findings have been recorded by Sen and Karim (2009) in Malpura sheep (9.34 %). However, the weight of head in Hassan sheep was found to be higher compared to that reported by Hussain *et al*. (2019) in Yalaga (7.65 %) and Bannur (8.26%). The skin weight of Hassan sheep (2.39-3.00 kg) at different age groups were comparatively higher than that of the weights (kg) recorded in Yalaga (2.07), Bannur (1.97) and Kenguri sheep (2.06) from Karnataka at 6-9 months of age (Hussain *et al*. 2019). The difference in the weights may be attributed to the breed differences, quantity of wool cover of the breeds and their geographical location.

Carcass Primal Cuts

In the present study, the weights of all the primal cuts were higher in T3 followed by T2 and T1 (Table 3), which is mainly because of higher pre-slaughter weight in T3. However, the weight of primal cuts in comparison of hot carcass weight, it was evident that the weight of major primal cuts, *viz.,* shoulder, leg and loin cuts decreased significantly, whereas there was an increase in weight of neck and rack cuts in T3 group, clearly indicating that as the age of the animal increases the weight of valuable cuts decreased. However in T2 and T1 the valuable cuts per cent was much higher indicating that slaughter of animals at optimal age would result in better yield of valuable cuts with good muscling. Judge *et al*. (2019) opined that age at slaughter, sex and

Table 1: Effect of slaughter age on carcass characteristics of Hassan sheep

Parameter	Age group		
	T1 (n =12)	T2 (n =12)	T3 (n =12)
Pre-slaughter weight (PSW) (kg)	20.81 ± 1.389^a	22.80 ± 1.313^a	32.05 ± 1.504^b
Hot carcass weight (HCW) (kg)	9.94 ± 0.682^a	11.41 ± 0.770^a	13.78 ± 0.633^b
Dressing Percentage (%)	47.79 ± 0.828^a	49.74 ± 1.233^a	43.12 ± 0.882^b
Loin eye area (LEA) (cm^2)	10.01 ± 0.573^a	12.68 ± 0.549^b	11.51 ± 0.448^a

Means ± SEs bearing different superscripts (a, b, c) differ significantly ($p<0.05$) between age groups.

Table 2: Effect of slaughter age on non-carcass components and offals in Hassan sheep

Parameter	Age group		
	T1 (n =12)	T2 (n =12)	T3 (n =12)
Blood (kg)	0.682 ± 0.056^a	0.8209 ± 0.061^a	1.233 ± 0.072^b
Head (kg)	1.698 ± 0.105^a	1.859 ± 0.136^a	2.904 ± 0.118^b
Skin (kg)	2.397 ± 0.137^a	2.595 ± 0.175^{ab}	3.000 ± 0.137^b
Feet (kg)	0.588 ± 0.032^a	0.621 ± 0.031^a	0.962 ± 0.046^b
Heart (kg)	0.124 ± 0.010^a	0.123 ± 0.007^a	0.221 ± 0.017^b
Liver (kg)	0.351 ± 0.024^a	0.449 ± 0.021^b	0.598 ± 0.032^c
Kidney (kg)	0.135 ± 0.013	0.155 ± 0.021	0.161 ± 0.011
Spleen (kg)	0.056 ± 0.006^a	0.072 ± 0.007^a	0.122 ± 0.013^b
Lung+ Trachea (kg)	0.283 ± 0.019^a	0.311 ± 0.014^a	0.661 ± 0.112^b

Means ± SEs bearing different superscripts (a, b, c) differ significantly ($p<0.05$) between age groups.

Table 3: Effect of slaughter age on different primal cuts of Hassan sheep

Weight of Primal cuts (kg)	Age group		
	T_1	T_2	T_3
Fore Saddle	5.286 ± 0.384[a]	6.319 ± 0.4508[ab]	7.629 ± 0.382[b]
Neck	0.680 ± 0.041[a]	1.016 ± 0.108[b]	1.395 ± 0.055[c]
Shoulder	2.687 ± 0.184	3.138 ± 0.226	3.113 ± 0.190
Rack	1.228 ± 0.144[a]	1.277 ± 0.089[a]	1.904 ± 0.130[b]
Breast	0.328 ± 0.025[a]	0.474 ± 0.044[b]	0.651 ± 0.038[c]
Shank	0.364 ± 0.038[a]	0.415 ± 0.031[a]	0.566 ± 0.024[b]
Loin	0.799 ± 0.071	1.055 ± 0.080	0.877 ± 0.071
Flank	0.402 ± 0.032[a]	0.375 ± 0.047[a]	0.885 ± 0.034[b]
Leg	3.455 ± 0.224[a]	3.658 ± 0.242[ab]	4.391 ± 0.210[b]
Hind Saddle	4.656 ± 0.303[a]	5.088 ± 0.342[a]	6.154 ± 0.264[b]

Means ± SEs bearing different superscripts (a, b, c) differ significantly ($p<0.05$) between age groups.

Table 4: Effect of slaughter age on linear carcass measurements of Hassan sheep

Parameter	Age group		
	T1 (n =12)	T2 (n =12)	T3 (n =12)
External Carcass Length (cm)	63.42 ± 1.994[a]	63.83 ± 2.156[a]	69.67 ± 2.641[b]
Internal Carcass Length (cm)	44.38 ± 1.324[a]	47.33 ± 1.815[a]	55.33 ± 2.140[b]
Buttock Circumference (cm)	31.17 ± 0.912[a]	38.33 ± 2.553[b]	42.42 ± 2.275[b]
Leg Width (cm)	12.58 ± 0.621[a]	13.00 ± 0.444[ab]	14.92 ± 0.621[b]
Chest Circumference (cm)	64.00 ± 1.950[a]	66.17 ± 2.103[a]	74.50 ± 2.872[b]
Chest Depth (cm)	16.54 ± 0.916[a]	17.79 ± 0.638[ab]	20.25 ± 0.854[b]
Chest Width (cm)	5.58 ± 0.336[a]	5.92 ± 0.313[a]	7.21 ± 0.311[b]
Shoulder circumference (cm)	29.00 ± 1.376[a]	31.17 ± 1.576[ab]	35.33 ± 1.534[b]
Leg length (cm)	27.75 ± 1.207[a]	31.08 ± 0.892[ab]	34.08 ± 1.422[b]

Means ± SEs bearing different superscripts (a, b, c) differ significantly ($p<0.05$) between age groups.

breed significantly affected the weight of the primal cut weight. Similarly, Esteves *et al*. (2018) observed that increase in the age at slaughter causes a loss in quantity of valuable commercial cuts.

Linear Carcass Measurements

Statistical analysis of the data on linear carcass measurements between the three age groups are presented in Table 4. No significant difference was observed in the linear carcass measurements with respect to T1 and T2, whereas T3 recorded significantly higher measurements as compared to T1. No significant difference could be observed in buttock circumference, leg width, chest depth, shoulder circumference and leg length between T2 and T3. Carcass linear measurements and carcass indexes are one of the most important criteria that help to predict carcass conformation and are often used as an index to assess the commercial value of the carcass (Belhaj *et al*., 2020). There are no earlier reports with regard to carcass measurements in Hassan sheep for comparison and also the carcass measurements are primarily based on the morphology of the animals which would vary among various breeds. Belhaj *et al*. (2021) also observed that linear carcass measurements increased significantly with age at slaughter in two indigenous sheep breeds. In similar lines, correlation between age and linear carcass measurements have been reported in Cordeiro Mirandes female lambs (Santos *et al*., 2015), and Cornigliese female lambs (Sabbioni *et al*., 2016).

Conclusion

The results of the present study provided clear evidence that age at slaughter had a significant influence on various carcass characteristics of Hassan sheep. Hassan sheep slaughtered at 12-15 months of age had better dressing percentage, higher muscling as indicated by Loin eye area (LEA), optimal non-carcass components, better yield of high value primal cuts like loin, shoulder and leg as compared to animals slaughtered at 6-8 months and 30-32 months of age. Hence, to get better yield and profitability the optimum age at slaughter for Hassan sheep should be 12-15 months of age. However, further research on meat quality characteristics including

various subjective and objective measurement of eating quality of meat as affected by age needs to be carried out before drawing conclusion on the optimum age of slaughter of Hassan sheep

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