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Comparison of growth performance and carcass traits of native lambs in Bangladesh

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Abstract

The aim of this study was to compare the productive and carcass traits of native region lambs of Bangladesh. A total 30 lambs were taken for productive performances from three regions (Jamuna basin, Barind region and Coastal belt) and total 27 lambs were considered for evaluating carcass traits parameters for 3 treatment groups (T_1= 6 months, T_2= 9 months, T_3=12 months). Statistical analysis was conducted by SAS where statistical model was 3×2(growth performance) and 3×3 (growth performance and carcass traits) factorial experimental model in Completely Randomized Design (CRD). Both sex and lamb types had significant effect ($p<0.05$) on body weight at different ages. Among all lamb types, Coastal belt lamb(CBL) had the highest body weight (1.65, 6.55, 12.81, 15.59, and 19.97) kg followed by Jamuna basin lamb (JBL) (1.45, 6.51, 9.48, 13.86 and 17.21) kg and Barind region lamb (BRL) (1.5, 5.69, 8.88, 11.44 and 13.24) kg at birth, 3, 6, 9 and 12 months, respectively. The ADG was significantly higher in JBL and CBL (59.07 and 61.17g/d) than BRL (53.15 g/d). Dressing % was higher in later ages; 9 and 12 months (47.38 and 47.04%). Lamb types and slaughter ages had significant effect ($p<0.05$) on blood, skin, viscera, head, leg, pluck, neck, shoulder, rack and loin wt. % except shank where only slaughter ages had significant effect but effect of lamb types was not statistically significant ($p>0.05$). Lamb types (T), slaughter ages (L) and its interaction (T×L) had significant effect ($p<0.05$) on kidney, liver, heart, lung and spleen wt%. The CBL showed superior performances over JBL and BRL in terms of overall body weight and their carcass traits parameters largely varied in different lamb types for different slaughter ages were the core findings of the present study.

Introduction

Sheep is one of the most important small ruminant species which is widely distributed throughout the world (Sarker et al., 2017; Islam et al., 2017; Rana et al., 2014; Alam et al., 2011). Native sheep of Bangladesh can be broadly divided into three types based on regions; Jamuna basin, Barind and Coastal belt indigenous sheep. This species is widely adapted to different climatic conditions and is found in all livestock production systems (Berihulay et al., 2019; Haque et al., 2020 & 2022).Sheep is tolerant to disease in the humid and sub-humid tropics. Sheep rearing is directly involved with poverty alleviation, employment generation and good quality nutrient supply(Hashem et al, 2020).Sheep are predominantly raised for meat production in Bangladesh and lamb is the sheep aging below one year of age which is best use for meat purpose. According to Department of Livestock Services (DLS) report sheep population is 3.679 million and contribution of livestock in Gross Domestic Product (GDP) is 1.44%. Meat is the most essential source of animal protein for human consumption. A total need of animal protein is 61.6% which comes from livestock in Bangladesh. Sheep provided 1.15 percent of total meat in Bangladesh, with 12.02 thousand metric tons of meat produced annually (DLS, 2021). The lamb meat is one of the best options for consumers for which they are willing to pay high; however, it fails in gaining market space due to the lack of standardization and quality when it reaches to the consumer (Cirne et al., 2018). Meat quality and price are affected by carcass weight and it is essential to understand the various elements that can influence the primary qualities of meat and carcass quality in this context (Murshed et al., 2014; Moniruzzaman et al., 2002; Kawsar et al., 2006). Age (Barone et al., 2007), sex (Horcada et al., 1998), breed (Crouse et al., 1981) and feed type (Hopkins & Fogarty, 1998) have been found some effects on carcass weight, conformation, fat content, and pH, texture, instrumental color, and nutritional composition. The body weight information can be used in determining the value of lambs and efficiency of rearing (Sun et al., 2020).The carcass traits and meat quality of rams and castrated rams (Dransfield et al., 1990), goats (Zygoyiannis et al., 1999) are strongly influenced by slaughter age. Consumer preferences for a particular carcass weight vary part to part and influenced by local breed, as well as traditional production methods. It is well known that lamb fat increases with weight; both in terms of carcass fat percentage and fat depths (Fourie et al., 1970) and that those lambs reaching a higher mature weight will be less fat at any given weight because they are at a lower proportion of their mature weight (Wood et al., 1980). In Bangladesh, most of the sheep are indigenous, with few crossbreds and are capable of bi-annual lambing and multiple births (Rashid et al., 2013; Hosain et al, 2015; Hossain et al., 2018). At present, Department of Livestock Services has given special attention for sheep up-scaling. Farmers are now interested in sheep farming for lamb production. But almost few research works were carried out yet on determining the effect of optimum slaughter age on productive and carcass traits for these native lambs of Bangladesh. Only limited research is reported on slaughter age determination in beef cattle and lamb in Bangladesh (Ali et al., 2013; Hossain et al., 2021).It is recognized that after certain age, growth rate of lamb is reduced, which is not economical to lamb producers. Earlier a study was conducted to investigate the lamb production potentiality on the basis of nutrient intake and utilization, growth performances, carcass characteristics and meat quality of three regional native sheep under intensive management condition at on-station (Sadek et al., 2018). No research works were yet done at on-farm condition in Bangladesh. There is lacking of researches on compare the production performances and carcass traits of three regional native sheep in Bangladesh which need to be disclosed. The above reviews show a clear significant research gap to know the compare study of three regional native sheep on production performances and carcass traits. Therefore, the present study was conducted to compare the growth performance and carcass traits of three native region lambs of Bangladesh which will help to decide optimum slaughter age for maximum lamb production to ensure the desired level the quality of carcass.

Materials and Methods

Experimental site

The research was conducted in three regions of Bangladesh. Jamuna basin lambs from Nalitabari upazilla of Sherpur district, Barind lambs from Paba upazilla of Rajshahi district and Coastal lambs from Shubarnachar upazilla of Noakhali district.

Animals and their management

Number of animals

A total 30 lambs having 10 from each region including 5 males and 5 females from 3 regions (Jamuna basin, Barind region and Coastal belt) were taken for growth performance. The 27 selected lambs were divided into three treatments group *viz.* (T_1= 6 months, T_2= 9 months, T_3= 12 months) having 9 lambs from each region were considered for evaluating carcass traits parameters. Animals were selected based on similarity of their body weight both single and twin born. All sheep were marked by ear-tagging.

Housing of animals

All the sheep were housed in well ventilated with slated floor. Four sides of the tin roofed house were encircled with wire made net. Rice straw was provided for ensuring extra cushion and warmth especially during winter.

Management of kids

All male lambs were castrated using rubber ring method before 2 weeks of age. The lambs were reared under common protocol in view of feeding. Every lamb was allowed 20 g concentrate/day from 2 weeks of age with in a weekly increment of 10 g/lamb/day until 8 weeks of age. Weaning period was applied at 12 weeks.

Feeding and drinking management

All the lambs after weaning were reared in semi-intensive system. The lambs were kept inside the house at night and grazed 6-7 hours daily. Leaves of tree *viz.,* mango, jackfruit and banana leaves or chopped grass from cultivated land was fed during rainy season. Farmers used concentrates (crushed maize, soybean meal, wheat bran, rice polish, DCP, vitamin-mineral premix and iodine salt containing 18% CP and 12 MJME/kgDM) in morning and again in afternoon at the rate of 1.5% concentrate mixture on the basis of their live weight during the experimental periods. Pure drinking water and green grass supplied *ad libitum* for sheep. Farmers supplied little bit more grass and tree leaves to their lactating ewes than that of pregnant ewes while they supplied more amount of concentrates feed to their pregnant ewes than that of lactating ewes.

Table 1. Composition of concentrate feed

Ingredients	Percentage
Crushed maize	40
Soybean meal	26
Wheat bran	22
Rice polish	10
Vita-mineral premix	0.5
DCP	0.5
Salt	1
Total	100

18% CP, 12 MJME/kg DM

De-worming and vaccination

Before starting the experiment, the sheep were de-wormed against internal and external parasites at the first month with the injection of ivermectin as prescribed by the manufacturer and it was continued till to the end of the experiment giving 3 months interval. All lambs were vaccinated firstly for PPR disease at 2 months of age followed by booster dose at 6 months of age.

Slaughtering of experimental animals

For carcass traits parameters study, at the end of the feeding trial for 3 months, the animals of three age categories (6 months, 9 months and 12 months) were slaughtered and processed according to routine slaughter house procedures. Feed was withheld overnight with free access to water, weighed and slaughtered following Islamic rituals (HALAL method) by serving the jugular vein, trachea and the esophagus.

Collection of data

For growth performance study, live weight of each lambs was collected every fortnightly up to 12 months using a digital weight measuring balance. The weights of fresh non-carcass organs, the hot carcass and other parts of carcass were immediately recorded after slaughter for the study of carcass traits.

Statistical analysis

Statistical analysis was conducted by SAS (previously "Statistical Analysis System") which is a statistical software suite developed by SAS institute for data management, advanced analysis, multivariate analysis, business intelligence, criminal investigation and predictive analytics. Statistical model was 3×2 (growth performance) and 3×3 (growth and carcass traits) factorial experimental model in Completely Randomized Design (CRD) where each treatment was replicated 5 times and 3 times per cell respectively. Duncan's Multiple Range Test (DMRT) was conducted for mean comparison at 5% level of significance was considered for analyses.

Results and discussions

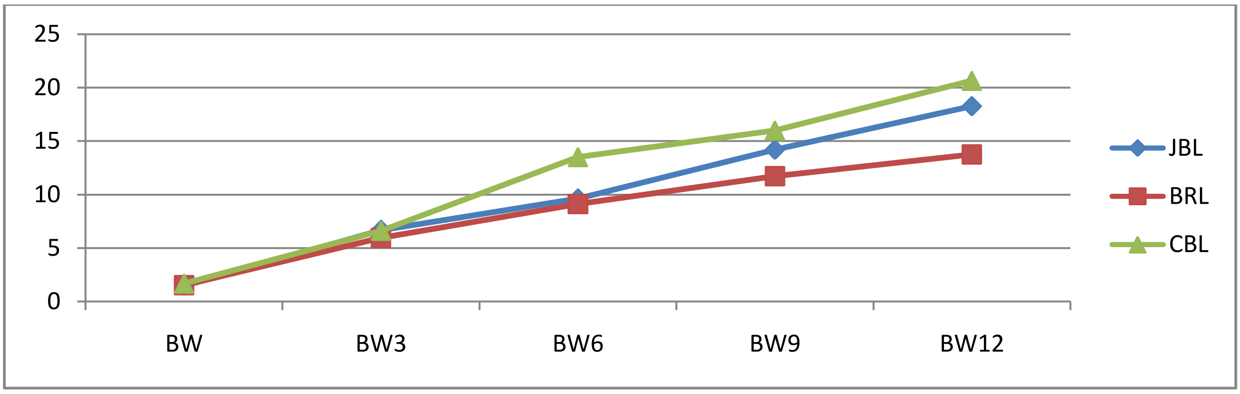
Comparison of body weight of male and female lambs for JBL, BRL and CBL at different slaughter ages

Both sex and lamb types had significant effect ($p<0.001$)on body weight at different ages but their combined effect was not statistically significant (Table 2). Male lambs of all three types showed higher body weights (1.58, 6.42, 10.75, 13.97, 17.55) kg at birth, 3, 6, 9 and 12 months compared to female lambs (1.48, 6.07, 10.03, 13.29, 16.06) kg respectively. Birth weight was significantly ($p<0.05$) higher in Coastal lamb than that of Barind and Jamuna region which was similar to Hassan and Talukder (2011).According to Hashem et al. (2020) the average body weight of Jamuna basin lambs were 1.46, 3.58, 6.65, 9.84, 14.74 and 17.00 kg, respectively at birth, one, three, six, nine and twelve months of age. These results did not agree to the present study. Sex had a significant effect ($p<0.001$) at 6 to 12 months of age. The positive combined effect was found in 6 months of age. Body weight and average daily gains (ADG) were higher in male than female lambs at different ages. Male lambs were dominated in weight and daily gain over female lambs in all age groups and breed difference were found significant (Asaduzzaman et al., 2020). A slight superiority of male over female lambs was also found by Panayotov et al. (2018).Among all lamb types CBL had the highest body weights (1.65, 6.55, 12.81, 15.59, and 19.97) kg followed by JBL (1.45, 6.51, 9.48, 13.86, and 17.21) kg and BRL (1.50, 5.69, 8.88, 11.44, and 13.24) kg at birth, 3, 6, 9 and 12 months, respectively. The highest growth potentiality of CBL might be the reason for its better performance according to superior breed characteristics and genetic resources. The ADG and total live weight gain were significantly ($p<0.01$) higher in Costal sheep than Jamuna and Barind sheep found by Ahmed et al., 2018 which supported the results with the present study.

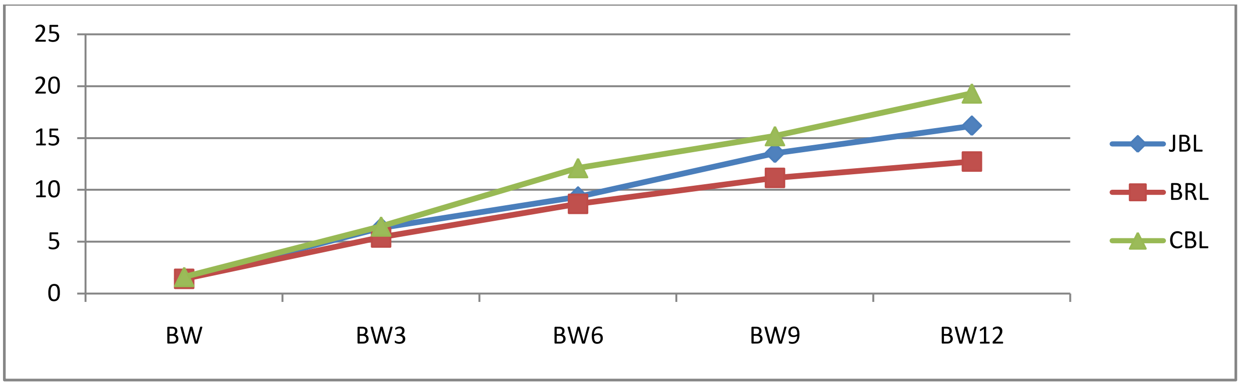
Table 2. Comparison of body weight of male and female lambs of JBL, BRL and CBL at different slaughter ages

Parameter	Sex	Lamb Types			Mean ± SE	Level of Significance		
		JBL	BRL	CBL		Sex	Lamb Types	S*L
Birth Weight	Male	1.47±0.009	1.58±0.043	1.69±0.020	1.58±0.024[a]	<0.0001	<0.0001	0.0835
	Female	1.42±0.011	1.42±0.023	1.61±0.014	1.48±0.016[b]			
	Mean ± SE	1.45±0.010[c]	1.50±0.033[b]	1.65±0.017[a]				
BW 3	Male	6.68±0.117	5.95±0.256	6.63±0.108	6.42±0.160[a]	0.0008	<0.0001	0.2660
	Female	6.34±0.031	5.42±0.093	6.47±0.075	6.07±0.066[b]			
	Mean ± SE	6.51±0.074[a]	5.69±0.175[b]	6.55±0.092[a]				
BW 6	Male	9.62±0.130	9.12±0.181	13.52±0.222	10.75±0.178[a]	<0.0001	<0.0001	0.0072
	Female	9.34±0.089	8.64±0.171	12.10±0.115	10.03±0.125[b]			
	Mean ± SE	9.48±0.110[b]	8.88±0.176[c]	12.81±0.169[a]				
BW 9	Male	14.18±0.207	11.73±0.072	16.00±0.139	13.97±0.139[a]	<0.0001	<0.0001	0.7709
	Female	13.54±0.273	11.14±0.089	15.18±0.133	13.29±0.165[b]			
	Mean ± SE	13.86±0.240[b]	11.44±0.081[c]	15.59±0.136[a]				
BW 12	Male	18.25±0.285	13.75±0.158	20.65±0.242	17.55±0.228[a]	<0.0001	<0.0001	0.1209
	Female	16.16±0.338	12.72±0.250	19.29±0.200	16.06±0.263[b]			
	Mean ± SE	17.21±0.312[b]	13.24±0.204[c]	19.97±0.221[a]				

Superscripts of the same letter in each row and column did not differ significantly ($p>0.05$); JBL= Jamuna Basin Lamb, BRL=Barind Region Lamb, CBL= Coastal Belt Lamb, BW3= 3 months body weight, BW6= 6 months body weight, BW9=9 months body weight, , BW12= 12 months body weight, S*L= Level of significance for combined effect of lamb types and sex.



Graph1: Line graph of body weight gain of male lambs (kg)



Graph 2: Line graph of body weight gain of female lambs (kg)

Comparison of growth performance and dressing% of JBL, BRL and CBL at different slaughter ages

The initial and final mean body weight of lambs from Jamuna basin, Barind region and Coastal belt and mean body weight of three slaughter ages (T_1, T_2, T_3) were found significant effect (p<0.001) (Table 3). The CBL had the highest mean IBW and BRL had the lowest. The final mean body weight of lambs from three regions with three slaughter ages were 13, 11.72, 15.48 and 9.69, 13.57, 16.94 kg, respectively which showed a significant effect (p<0.001). The CBL had the highest mean FBW and BRL had the lowest. These results were almost similar to Hossain et al. (2021) where they worked on Jamuna basin lambs. However, ADG was significantly (p<0.001) higher in JBL and CBL (59.07 and 61. 17) g/day than BRL (53.15) g/day. Lamb types had significant effect on ADG (p<0.001) but not statistically significant for slaughter ages and their combined effect. The ADG was 57.39, 59.80 and 58.15 g/d in all treatments of JBL respectively (Hossain et al.2021) which was very close to the present study in terms of JBL part. Hashem et al., (2020) showed ADG at 6, 9 and 12 months aged lambs were 54.75, 53.59 and 48.81 g/d which were not similar to the present study. Both lamb types and slaughter ages had significant effect (p<0.001) on HCW having 6.08, 5.46 and 7.15 values for JBL, BRL and CBL; and 4.30, 6.43 and 7.96 values for T_1, T_2 and T_3, respectively. Santos-Silva and Portugal (2001) observed that the effect of hot carcass weight (HCW) was significant for all carcass traits. All variables showed linear relationships with HCW. The result was completely supported by the present research works. Slaughter age and T*L had significant effect (p<0.001) on dressing%. Similar results were found for different lamb types. Dressing% was highest in advanced ages like 9 months and 12 months (47.38 and 47.04%), respectively. Hot carcass wt (kg) and dressing% were found significantly (p>0.001) increased with the increasing of age Hossain et al. (2021) addressing similar results with the present study. These results differed to the findings of Claffey et al. (2018) where they stated that hot carcass (kg) and dressing % were 25.7 and 47.9 of 12 months aged lambs. Similar result was found by Polidori et al. (2017). Breed and environmental effect might be a cause of difference in that case. Dressing% is both yielding and value determining factor as an important parameter in the assessment performance of meat producing lambs showing insignificant (p>0.05) variation, dressing% were increased with the advancement of age (Haque et al., 2022). Skapetas et al. (2006) observed the highest dressing % at the slaughter age of 45 days, with a decrease at 60 days and a further increase at 75 and 90 days of age.

Table 3. Comparison of growth performance and dressing% of JBL, BRL and CBL at different slaughter ages

Parameter	Lamb types	Slaughter Ages			Mean ± SE	Level of Significance		
		T_1	T_2	T_3		Lamb types	Slaughter ages	T*L
IBW (kg)	JBL	4.53±0.101	7.95±0.076	10.97±0.073	7.68±0.083^{b}	<.0001	<.0001	<0.0001
	BRL	4.13±0.044	7.47±0.130	9.22±0.044	6.94±0.072^{c}			
	CBL	4.77±0.109	9.58±0.088	15.58±0.192	9.98±0.129^{a}			
	Mean ± SE	4.48±0.085^{C}	8.33±0.098^{b}	11.79±0.103^{a}				
FBW (kg)	JBL	9.78±0.044	13.32±0.044	15.90±0.029	13.00±0.039^{b}	<.0001	<.0001	<0.0001
	BRL	9.10±0.087	12.12±0.093	13.90±0.161	11.72±0.114^{c}			
	CBL	10.18±0.033	15.23±0.089	21.03±0.309	15.48±0.144^{a}			
	Mean ± SE	9.69±0.054^{c}	13.57±0.075^{b}	16.94±0.166^{a}				
ADG (g/d)	JBL	58.33±0.641	59.63±0.979	59.26±1.033	59.07±0.884^{a}	<.0001	0.7380	0.3746
	BRL	55.18±0.927	52.22±2.314	52.04±1.934	53.15±1.725^{b}			
	CBL	60.18±1.127	62.78±1.700	60.55±1.700	61.17±1.509^{a}			
	Mean ± SE	57.90±0.898^{a}	58.21±1.664^{a}	57.28±1.556^{a}				
HCW (kg)	JBL	4.33±0.017	6.22±0.142	7.68±0.088	6.08±0.082^{b}	<.0001	<.0001	<0.0001
	BRL	4.10±0.029	5.78±0.033	6.50±0.029	5.46±0.030^{c}			
	CBL	4.47±0.044	7.30±0.050	9.68±0.170	7.15±0.088^{a}			
	Mean ± SE	4.30±0.030^{c}	6.43±0.075^{b}	7.96±0.144^{a}				
Dressing%	JBL	44.29±0.690	46.68±0.920	48.32±0.470	46.31±0.693^{a}	0.3485	<.0001	0.0153
	BRL	45.07±0.654	47.53±0.101	46.77±0.440	46.46±0.398^{a}			
	CBL	43.86±0.300	47.92±0.464	46.04±0.180	45.94±0.315^{a}			
	Mean ± SE	44.41±0.548^{b}	47.38±0.495^{a}	47.04±0.363^{a}				

Superscripts of the same letter in each row and column did not differ significant (p>0.05), T_1= Six months age, T_2= Nine months age and T_3=Twelve months age; JBL= Jamuna Basin Lamb, BRL= Barind Region Lamb, CBL= Coastal Belt Lamb; IBW= Initial Body Weight, FBW= Final Body Weight, ADG= Average Daily Gain, HCW= Hot Carcass Weight, T*L= Level of significance for combined effect of lamb types and slaughter ages.

Comparison of carcass traits for inedible part (on live weight basis) of JBL, BRL and CBL at different slaughter ages

BRL had the highest mean blood wt% (4.47) followed by CBL (4.01) and JBL (3.61); 12 months aged lamb (4.33) had highest followed by 9 months (3.98) and 6 months aged lambs (3.77). Both slaughter age and lamb type had significant effect (p<0.001) on blood wt % (Table 4). Lamb type and slaughter age of skin wt % had significant (p<0.001) effect. It was highest in JBL (11.61) and lowest in BRL (8.68). Skin and head wt % significantly (p<0.001) decreased due to the increase of slaughter ages. At 6 months for viscera wt. (25.06), slightly increased in 9 months (26.08) but decreased in 12 months of age (20.34). Solomon et al., (1980) and (Cifuni et al., 1999) in their study observed that younger lambs were not functional as ruminants whereas older lambs were, thus reducing their carcass yield. The result was partially supported by present research. Lamb types and slaughter ages for viscera wt % were found significantly (p<0.001) differed. Positive interaction found between lamb types and slaughter ages whereas shank wt % for slaughter age sand their interaction were significant except lamb types. According to Biçer et al. (1995), Carcass length, skin weight and most of the fat estimating parameters continued to increase with increase in slaughter weight but in the present study skin wt% increase in 9 months compared to 6 months but later in 12 months it was almost similar to previous proportion. Highest head wt% was recorded for BRL (7.91) compared to JBL (6.83) and CBL (7.62) and at 6 months (8.49) compared to9 months (7.93) and 12 months (6.74). Male lambs had greater proportions of head (5.39% vs 4.62%, p<0.001), feet (2.65% vs 2.46%, p<0.01) and visceral organs (4.53% vs 4.15%, p<0.05), while females had a greater proportion of visceral fat (1.76% vs 1.05%, p <0.001). These results were similar to Ekiz et al. (2019).

Table 4. Comparison of carcass traits of inedible part (on live weight basis) of JBL, BRL and CBL at different slaughter ages

Parameter (%)	Lamb Types	Slaughter ages			Mean ± SE	Level of significance		
		T_1	T_2	T_3		Lamb types	Slaughter ages	T*L
Blood wt	JBL	3.35±0.009	3.29±0.031	4.18±0.007	3.61±0.016^{c}	<0.0001	<0.0001	<0.0001
	BRL	3.97±0.065	4.73±0.040	4.69±0.075	4.47±0.060^{a}			
	CBL	4.00±0.064	3.91±0.023	4.12±0.520	4.01±0.202^{b}			
	Mean ± SE	3.77±0.046^{c}	3.98±0.031^{b}	4.33±0.201^{a}				
Skin	JBL	12.63±0.012	12.42±0.332	9.79±0.003	11.61±0.116^{a}	<0.0001	<0.0001	0.001
	BRL	9.07±0.062	8.85±0.032	8.14±0.090	8.68±0.061^{c}			
	CBL	10.36±0.507	9.34±0.147	8.55±0.234	9.43±0.296^{b}			
	Mean ± SE	10.69±0.194^{a}	10.22±0.170^{b}	8.83±0.109^{c}				
Viscera wt	JBL	23.43±0.012	22.75±0.006	14.34±0.019	20.17±0.012^{c}	<0.0001	<0.0001	0.0002
	BRL	26.46±0.924	28.43±0.339	25.94±1.063	26.95±0.775^{a}			
	CBL	25.27±0.120	27.05±0.782	20.72±1.23	24.35±0.711^{b}			
	Mean ± SE	25.06±0.352^{a}	26.08±0.376^{a}	20.34±0.771^{b}				
Head wt	JBL	8.67±0.009	6.31±0.009	5.52±0.003	6.83±0.007^{c}	<0.0001	<0.0001	<0.0001
	BRL	8.30±0.020	7.85±0.033	7.59±0.019	7.91±0.024^{a}			
	CBL	8.51±0.060	7.24±0.047	7.11±0.081	7.62±0.063^{b}			
	Mean ± SE	8.49±0.030^{a}	7.13±0.030^{b}	6.74±0.034^{c}				
Shank wt	JBL	2.82±0.006	3.81±0.003	2.09±0.006	2.91±0.005^{a}	0.7368	<.0001	<.0001
	BRL	2.59±0.021	3.21±0.052	3.10±0.070	2.97±0.048^{a}			
	CBL	2.64±0.060	3.03±0.065	3.19±0.248	2.95±0.124^{a}			
	Mean ± SE	2.68±0.029^{b}	3.35±0.040^{a}	2.80±0.108^{b}				

T*L= Level of significance for combined effect of lamb types and slaughter ages.

Comparison of carcass traits for edible part (on live weight basis) of JBL, BRL and CBL at different slaughter ages

The comparison of carcass traits for edible part (on live weight basis) of JBL, BRL and CBL at different slaughter ages are presented in Table 5. Leg wt % was found higher in BRL (14.36) compared to JBL (12.02) and CBL (13.83)as per increasing of ages which had significant effect ($p<0.0001$).Neck and rack wt% were found higher in BRL (4.69, 9.55) followed by CBL (4.46, 8.58) and JBL (4.29, 8.02) of increasing ages which was significantly differed ($p<0.001$).Shoulder and loin wt% were found higher in JBL (9.44, 3.77) followed by BRL (8.25, 3.45) and CBL (8.8.91, 3.51) of increasing ages which was significantly differed ($p<0.001$). Pluck weight% was found higher in JBL (6.46) compared to BRL (4.33) and CBL (5.12) and highest in 9 months (5.88) followed by 12 months (5.23) and 6 months (4.79). Loin gives highest weight at 7 to 9 months of age thus results suggest those 7 to 9 months of age may be favorable to slaughter for lamb production was concluded by Islam et al. (2018). Skapetas et al. (2006) stated as the age at slaughter increased, the proportion of bones decreased ($p< 0.05$) which is related to present study. Cifuni et al., (1999) observed that first grade wholesale cuts (rack, loin and leg) were not significantly ($p>0.05$) affected by age at slaughter and percentage of second grade cuts; shoulder and neck decreased with the advancement of age. He also mentioned that shoulder was greater ($p<0.01$) in young animals and the observation was similar to present result where shoulder also differed ($p>0.05$) among groups. D'Alessandro and Martemucci (2013) observed that in winter aged (60 days) lambs had higher percentages of neck ($p< 0.05$), shoulder ($p< 0.01$) and loin ($p< 0.01$) in comparison with young lambs (45 days of age). The slaughter age had markedly influenced by the carcass proportion of the commercial cuts of lambs slaughtered in the winter; in fact, compared to lambs of 45 days of age, those of 60 days had higher percentages of neck ($p< 0.05$), shoulder ($p< 0.01$) and loin ($p< 0.01$). In their study in the spring, the differences due to the slaughter age were observed for the proportions of shoulder and leg, which were greater ($p< 0.01$) in 60-day and 45-day lambs, respectively. The carcass measures and compactness indexes increased with higher slaughter weight and breed and age at slaughter had a significant effect on carcass traits ($p<0.001$) (Belhaj et al. 2021) which was similar to the current study. With increased live weight at slaughter the percentage of neck, back and rib with flank increased and chuck, shoulder and hindleg decreased according to There were found positive significant interaction of lamb type and slaughter ages among leg, neck, shoulder, rack, & loin and pluck wt%, respectively.

Table 5. Comparison of carcass traits for edible part (on live weight basis) of JBL, BRL and CBL at different slaughter ages

Parameter (%)	Lamb Types	Slaughter ages			Mean ± SE	Level of significance		
		T_1	T_2	T_3		Lamb types	Slaughter ages	T*L
Leg wt	JBL	12.23±0.006	13.50±0.009	10.33±0.006	12.02±0.007^{c}	<0.0001	<0.0001	<0.0001
	BRL	14.57±0.075	14.35±0.180	14.16±0.400	14.36±0.218^{a}			
	CBL	13.95±0.205	13.63±0.188	19.91±0.186	13.83±0.193^{b}			
	Mean ± SE	13.58±0.095^{a}	13.83±0.126^{a}	12.80±0.197^{b}				
Neck wt	JBL	3.92±0.003	5.32±0.006	3.64±0.000	4.29±0.003^{b}	0.0021	<0.0001	<0.0001
	BRL	4.66±0.061	4.71±0.044	4.69±0.100	4.69±0.068^{a}			
	CBL	4.17±0.140	4.60±0.265	4.60±0.127	4.46±0.177^{b}			
	Mean ± SE	4.25±0.111^{b}	4.88±0.105^{a}	4.31±0.076^{b}				
Shoulder wt	JBL	8.38±0.006	11.34±0.012	8.61±0.032	9.44±0.016^{a}	<0.0001	<0.0001	<0.0001
	BRL	8.35±0.055	8.33±0.037	8.07±0.048	8.25±0.047^{c}			
	CBL	8.37±0.036	9.47±0.276	8.88±0.315	8.91±0.209^{b}			
	Mean ± SE	8.37±0.032^{b}	9.71±0.108^{a}	8.52±0.132^{b}				
Rack wt	JBL	6.06±0.015	8.20±0.009	9.79±0.018	8.02±0.014^{c}	<0.0001	<0.0001	<0.0001
	BRL	9.23±0.088	9.61±0.142	9.80±0.113	9.55±0.114^{a}			
	CBL	8.01±0.064	9.28±0.073	8.46±0.150	8.58±0.096^{b}			
	Mean ± SE	7.77±0.056^{c}	9.03±0.075^{b}	9.35±0.094^{a}				
Loin wt	JBL	3.55±0.006	3.31±0.007	4.43±0.006	3.77±0.006^{a}	0.0001	<0.0001	0.0009
	BRL	3.27±0.033	3.39±0.064	3.69±0.151	3.45±0.083^{b}			
	CBL	3.31±0.052	3.28±0.093	3.92±0.102	3.51±0.082^{b}			
	Mean ± SE	3.38±0.030^{b}	3.33±0.055^{b}	4.01±0.086^{a}				
Pluck wt	JBL	5.31±0.015	7.18±0.006	6.87±0.003	6.46±0.008^{a}	<0.0001	<0.0001	<0.0001
	BRL	4.53±0.015	4.14±0.012	4.31±0.105	4.33±0.044^{c}			
	CBL	4.52±0.060	6.31±0.212	4.52±0.179	5.12±0.150^{b}			
	Mean ± SE	4.79±0.030^{c}	5.88±0.077^{a}	5.23±0.096^{b}				

Mean in each row having different superscripts varies significantly at values $p<0.05$,T_1= Six months age, T_2= Nine months age and T_3=Twelve months age, JBL= Jamuna Basin Lamb, BRL= Barind Region Lamb, CBL= Coastal Belt Lamb, T*L= Level of Significance for Combined effect of Lamb types and Slaughter ages

Comparison of carcass traits (on hot carcass basis) of JBL, BRL and CBL at different slaughter ages

The comparison of carcass traits (on hot carcass basis) of JBL, BRL and CBL at different slaughter ages are presented in Table 6.Kidney wt % was found higher in JBL (0.63 compared to BRL (0.52) and CBL both (0.52) (Table 6) and it increased with the advancement of age from 0.47, 0.59 and 0.62 in 6, 9 and 12 months of age. Liver, heart, lung, spleen wt% had comparatively higher in JBL (2.88, 0.77, 1.43, 0.38) than in BRL (2.33, 0.49, 1.33, 0.32) and CBL (2.44, 0.60, 1.32, 0.35), respectively. They also tended to be higher in wt% in later ages by increasing in 12 months (2.96, 0.63, 1.43, and 0.47) than in 9 months (2.46, 0.66, 1.39, and 0.31) and 6 months (2.23, 0.56, 1.27, and 0.27). Lamb types, slaughter ages and T×L had significant effect ($p<0.05$) on kidney, liver, heart, lung and spleen wt%. Haque et al. (2022) showed different results from the present study.

Table 6. Comparison of carcass traits (on hot carcass basis) of JBL, BRL and CBL at different slaughter ages

Parameter (%)	Lamb types	Slaughter ages			Mean ± SE	Level of Significance		
		T_1	T_2	T_3		Lamb types	Slaughter ages	T*L
Kidney wt	JBL	0.48±0.006	0.66±0.003	0.75±0.009	0.63±0.006[a]	<0.0001	<0.0001	0.0015
	BRL	0.47±0.027	0.53±0.019	0.56±0.038	0.52±0.028[b]			
	CBL	0.44±0.023	0.56±0.023	0.55±0.006	0.52±0.017[b]			
	Mean ± SE	0.47±0.019[b]	0.59±0.015[a]	0.62±0.018[a]				
Liver wt	JBL	2.01±0.006	2.75±0.028	3.87±0.003	2.88±0.012[a]	<0.0001	<0.0001	<0.0001
	BRL	2.48±0.015	2.19±0.052	2.32±0.360	2.33±0.142[c]			
	CBL	2.21±0.052	2.43±0.060	2.68±0.104	2.44±0.072[b]			
	Mean ± SE	2.23±0.024[c]	2.46±0.047[b]	2.96±0.156[a]				
Heart wt	JBL	0.62±0.009	0.86±0.012	0.82±0.009	0.77±0.010[a]	<0.0001	<0.0001	<0.0001
	BRL	0.50±0.003	0.48±0.015	0.48±0.018	0.49±0.012[c]			
	CBL	0.56±0.010	0.63±0.047	0.60±0.015	0.60±0.024[b]			
	Mean ± SE	0.56±0.007[b]	0.66±0.021[a]	0.63±0.014[a]				
Lung wt	JBL	1.12±0.003	1.55±0.003	1.63±0.006	1.43±0.004[a]	0.0095	0.0008	<0.0001
	BRL	1.44±0.009	1.26±0.019	1.30±0.045	1.33±0.024[b]			
	CBL	1.25±0.040	1.36±0.076	1.35±0.083	1.32±0.066[b]			
	Mean ± SE	1.27±0.017[b]	1.39±0.033[a]	1.43±0.045[a]				
Spleen wt	JBL	0.20±0.006	0.29±0.000	0.64±0.058	0.38±0.021[a]	0.0218	<0.0001	<0.0001
	BRL	0.31±0.007	0.31±0.007	0.32±0.012	0.32±0.009[b]			
	CBL	0.28±0.017	0.31±0.020	0.45±0.035	0.35±0.018[ab]			
	Mean ± SE	0.27±0.010[b]	0.31±0.009[b]	0.47±0.035[a]				

Superscripts of the same letter in each row and column did not differ significant ($p>0.05$), T_1= Six months age, T_2= Nine months age and T_3=Twelve months age; JBL= Jamuna Basin Lamb, BRL= Barind Region Lamb, CBL= Coastal Belt Lamb; T*L= Level of Significance for Combined effect of Lamb types and Slaughter ages.

Conclusions

In conclusion, the study reflects the superiority of CBL over JBL and BRL in terms of overall body weight and carcass traits. Hence, CBL showed better performances in three native region lambs of Bangladesh.

Conflicts of Interest

The authors declare that there are no potential conflicts of interests.

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