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# A COMPARATIVE STUDY OF EFFECT OF DOCKING FAT-TAILED SHEEP AND CROSSBREEDING FAT-TAILED AND THIN-TAILED SHEEP ON GROWTH AND CARCASS CHARACTERISTICS

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The effects of docking fat-tailed Salt Range lambs and crossbreeding of fat-tailed Salt Range X thin-tailed Kajli rams on growth and carcass quality were studied. Each of the three groups of experimental animals consisted of 12 male and 12 female lambs. Taking into account both breed and sex, the crossbred lambs were found significantly heavier than the purebred docked and undocked lambs at birth and at slaughter (at 13 months). Among the purebreds, undocked lambs showed non-significantly heavier live weight at 120 days weaning age. The trend, however, reversed and docked lambs weighed more by 1.35 kg than the undocked lambs at slaughter. Male lambs in all groups evidently exhibited better weight gain than females. Dressed carcass weight, shoulder and leg weights of purebred docked lambs were significantly ($p<0.05$) higher than those of undocked ones. Dressed carcass weight, dressing percentage and weight of loin and flank and leg cuts of crossbred $F_1$ lambs were higher than those of purebreds. Compared with purebreds, the crossbreds had higher percentage of lean and bone in 9-10-11 rib cut. Among the purebreds, the docked lambs had higher percentage of lean, fat and bone, the difference being non-significant. The thickness of back fat layer in purebred docked lambs was comparatively more than those of undocked and crossbred lambs at all locations except at rear end of the rump, where subcutaneous fat layer was markedly thicker in undocked lambs. Intra- and inter group comparison showed that females had significantly ($p <0.05$) thicker fat layer than that of males. These results may further be substantiated by using larger number of animals in each group.
**Keywords:** Fat-tailed and crossbred sheep, docking, growth, carcass components

## INTRODUCTION

Of nearly 28 million predominantly carpet wool sheep in Pakistan, almost as many are fat-tailed as are thin-tailed (Khan *et al.*, 2005, Khan *et al*., 2007; Pakistan Economic Survey, 20010-11; Lashari and Tasawar, 2010). Sheep meat makes an important contribution to red meat production in Pakistan (FAO STAT, 2009; Raziq *et al*., 2010). Many workers believe that docking the tail of lambs is important for disease prevention and better flock management (Kent *et al*., 1995). Docking fat-tailed lambs may play a further role in changing the physiological functions of sheep. However, as yet it is not a common practice in the areas that raise fat-tailed animals, because consumers prefer carcass with intact fat tail (Marai and Baghat, 2003). The main role of fat tail is undoubtedly to serve as an energy store, providing a survival buffer against periodic food scarcity such as in drought and winter (Negussie *et al*., 2003; Nazifi *et al*., 2010; Njidda and Isidahomen, 2011). The fat percentage in the carcass varies not only in total amount but also in its distribution between the various deposits which changes markedly during active growth period (Negussie *et al*., 2003). In addition, the fat deposition in the body or tail requires more energy than the production of lean tissue. A highly prominent effect of docking on conversion rate of concentrates into meat tissue than into fat tissue has been reported in fat-tailed sheep breeds (Cengiz and Arık, 1994). Moreover, failure to dock fat-tailed lambs may result in their discrimination in the market due to low carcass quality. The presence of fat tail also may predispose the lambs to strike by fleece worm or wool maggots (larval stage of *Phormia regina*) when it becomes soiled by fecal material in the region of dock or in case of injured tail.

Crossbreeding is considered as one of the effective measures for improving the efficiency of market lamb production and obtaining desirable combinations for the future development of more productive mutton breeds/strains. Hence a study of the relative merits of docking fat-tailed Salt Range lambs or crossbreeding them with a thin-tailed comparatively large-sized breed seemed necessary for effecting improvement in carcass quality and productivity of Salt Range sheep. Crossbreeding, therefore, may be instrumental in producing lambs with greater efficiency and prolificacy of Kajli sheep coupled with their thin and short-tailed characteristics, precluding thus the necessity of docking fat tails of the lambs. Not much information is available in literature on relative merits of purebred fat-tailed (docked or undocked) and crossbred (fat-tailed x thin-tailed) lambs. Therefore, a study was designed to investigate whether docking fat-tailed Salt

Range lambs could produce tangible effects on economically important traits like growth rate and carcass yield.

## MATERIALS AND METHODS

The study was conducted on lambs which were obtained from a flock of sheep maintained at the University of Agriculture, Faisalabad, under a USAID financed research project entitled “Replacement of fat-tailed sheep with thin-tailed for increased mutton production”.

Seventy-two lambs were selected, 24 in each of the three experimental groups, i.e. purebred fat-tailed Salt Range docked (PFSD), purebred fat-tailed undocked (PFSU) and crossbreds (CSK). The crossbreds were the $F_1$ progeny obtained by crossing purebred Salt Range (S) fat-tailed ewes with thin-tailed Kajli (K) rams. These groups included equal number of lambs of either sex.

The 1ambs were ear-tagged at birth for identification. The dams and their new born lambs were kept in lambing pens for a week and then turned in with the parent flock. The lambs were weaned at the age of 120 days. The flock was raised on grazing. A. concentrate mixture containing maize-oil cake two parts, wheat bran I part, and grain 1part was fed as supplemental ration.

The lambs in PFSD group were docked surgically at the age of one week, using the method suggested by Shutt *et al.* (1988). Surgical docking was considered necessary since the fatty tissue continued to deposit at the distal end of the docked tail despite the use of elastrator, forming a lump of fat at the site of docking. Moreover, when the elastrator was applied at the first intercoccygeal joint, it could not be stretched adequately to encircle the tail. The lambs in the three experimental groups were reared under similar feeding and management conditions. The data on growth, tail length, blood, and carcass were collected.

The data pertaining to the lambs in three groups were recorded in respect of the following: birth weights within 12 hours of the birth and the weaning weights at the age of 120 days. The monthly body weights were recorded at the end of each month at the same time and date till the age of slaughter (13 months).

From each group, eight animals were selected at random and slaughtered at the age of 13 months. In all, 24 animals were slaughtered. These animals were fasted for 16 hours and weighed before slaughter. Dressed carcass weight, weight of organs and offals were recorded in kilograms. The body fat thickness over the 6th rib, at the end of the rump near the dock, in front of hook bones, i.e. tubercoxae of the ilium, behind the hook bones and at 13th rib was measured with a probe to the nearest millimeter over 5 sites of the carcass.

The carcasses were then quartered between the 12th and 13th rib and disjointed into neck, shoulder, thorax (ribs), loin and flank, legs and tail cuts and weighed. The samples from the loin eye muscles were subjected to chemical analysis of contents such as moisture, ash, crude protein and ether extractable matter on fresh basis according to the Association of Official Analytical Chemists (AOAC, 2000).

Means, standard deviations and standard errors were worked out for the traits studied and analysis of variance was made following Snedecor and Cochron (1989). The differences between the means were tested by Duncan’s multiple range test (Duncan, 1955).

## RESULTS AND DISCUSSION

The production performance of docked and undocked fat-tailed (Salt Range) purebred and crossbred (Salt Range x Kajli rams) lambs was compared for growth and carcass traits. The mean birth weights and those at weaning, 9-months and 13-months (slaughter age) and growth rate along with some carcass traits of lambs in different experimental groups are presented in Table 1.

The crossbreds had significantly ($P<0.01$) higher birth weight than those of the purebreds. However, the difference between birth weights of purebred docked (PD) and purebred undocked (PU) lambs was not significant. The crossbred lambs were 0.90 kg heavier than the purebreds, the difference being significant ($P<0.01$). The superiority of crossbred lambs in birth weight is believed to be due to hybrid vigor inherited from Kajli sire. Kajli (thin-tailed) being a heavy mutton breed of Pakistan (Khan *et al.*, 2007) possesses higher body weight than the fat-tailed Salt Range breed. The F1 crossbred lambs, therefore, exhibited comparatively heavier birth weight. A favorable effect of crossbreeding on birth weight of lambs has been reported by Mukasa-Mugerwa *et al.* (2000), Hassen *et al.* (2004) and Benyi *et al.* (2006). When the means of birth weights of male and female lambs were compared, within each group or on over all basis, it was observed that males had heavier birth weights than those of females. Various studies showed that male lambs were heavier at birth than female lambs (Mukasa-Mugerwa *et al.*, 2000; Hassen *et al.*, 2004).

The weight of purebred docked, undocked and crossbred lambs weaned at the age of 120 days averaged 11.78, 12.17 and 14.12 ± 0.08 kg, respectively (Table 1). This showed that crossbred lambs weighed more *(*$P<0.01$) than the docked and undocked purebreds. Better weaning weights of crossbreds than purebred lambs as observed in the present study tended to show their better performance in this regard. These results are fully or partially supported by those of several workers (Croston *et al.*, 1983; Mukasa-Mugerwa *et al.*, 2000; Hassen *et al.*, 2004). Heavier weaning weights gained by crossbred lambs could be attributed to the hybrid vigor expressed by Kajli sire. In other studies too, the significant effects of breed of sire on weaning weights have been reported (Fall *et al.*, 1983; Croston *et al.*, 1983).

**Table 1. Means of values of growth traits for purebred (docked and undocked) and crossbred lambs**

| Growth traits | Purebred docked | | | Purebred undocked | | | Crossbred | | |
|---|---|---|---|---|---|---|---|---|---|
| Birth weight (kg) | 2.28±0.05$^{a}$ | | | 2.27±0.03$^{a}$ | | | 3.18±0.03$^{b}$ | | |
| Weaning weight (kg) | 11.78±0.15$^{a}$ | | | 12.17±0.28$^{a}$ | | | 14.12±0.08$^{b}$ | | |
| Daily gain during pre-weaning period (kg) | 0.52±0.005$^{a}$ | | | 0.57±0.003$^{a}$ | | | 0.118±0.004$^{b}$ | | |
| Daily gain during pre-weaning period less birth weight | 0.079±0.03$^{a}$ | | | 0.083±0.02$^{a}$ | | | 0.091±0.04$^{b}$ | | |
| Weight at 9 months (kg) | 21.84±0.12$^{a}$ | | | 20.00±0.08$^{b}$ | | | 22.99±0.11$^{c}$ | | |
| Slaughter weight at 13 months (kg) | 31.35±018$^{a}$ | | | 30.00±0.19$^{b}$ | | | 33.95±0.12$^{c}$ | | |
| Overall daily gain (kg) | 0.080±0.001$^{a}$ | | | 0.076±0.002$^{b}$ | | | 0.086±0.001$^{c}$ | | |
| Overall daily gain slaughter weight less birth weight | 0.073±0.02$^{a}$ | | | 0.07±0.02$^{b}$ | | | 0.078±0.01$^{c}$ | | |
| **Sex** | **Male** | **Female** | **Diff.** | **Male** | **Female** | **Diff.** | **Male** | **Female** | **Diff.** |
| Birth weight (kg) | 2.41 | 2.15 | 0.26$^{NS}$ | 2.37 | 2.17 | 0.20$^{NS}$ | 3.35 | 3.00 | 0.35$^{NS}$ |
| Weaning weight (kg) | 12.24 | 11.32 | 0.92** | 12.50 | 11.38 | 0.67** | 14.25 | 13.99 | 0.26* |
| Daily gain during pre-weaning period (kg) | 0.104 | 0.094 | 0.01$^{NS}$ | 0.105 | 0.099 | 0.006$^{NS}$ | 0.119 | 0.117 | 0.002$^{NS}$ |
| Weight at 9 months (kg) | 22.73 | 20.95 | 1.78** | 21.39 | 20.55 | 0.84** | 23.68 | 22.30 | 1.38** |
| Slaughter weight at 13 months (kg) | 33.50 | 29.20 | 4.30** | 31.20 | 28.80 | 2.40** | 35.50 | 32.40 | 3.10** |
| Overall daily gain (kg) | 0.085 | 0.074 | 0.011$^{NS}$ | 0.078 | 0.075 | 0.003* | 0.089 | 0.082 | 0.007$^{NS}$ |

*Means in the row with different superscripts differ significantly; *=Significant at 5 % level, **=Significant at 1 % level, NS=Non-significant*

Higher weights at weaning are desirable in commercial sheep production as in most cases the lambs are marketed soon after weaning. The comparison between male and female weight at weaning showed that the male lambs had higher body weights than their female flock mates in each group (Table 1). Higher mean weights in male than in female lambs have also been reported by Fall *et al*. (1983).

Comparison of the weight gain during pre weaning growth period revealed that purebred docked lambs weighed lesser than those of purebred undocked. This may probably be due to stress of docking which was done in early days of life. Similar results have been reported by Sefidbakht and Ghorbon (1972). The rate of daily gain in certain other breeds during pre weaning period has been reported to range between 60 to 240g (Fall *et al*., 1983). The comparison of these results with those of the other workers shows an evident need to improve the growth rate of Salt Range and crossbreeding has been found to be one of the most effective measures to enhance the rate of growth (Fall *et al*., 1983; Asiedu and Appiah, 1983). In the present study too, it was observed that the crossbred lambs of both sexes had significantly higher rate of gain in comparison to those of the purebred lambs showing thereby that the crossbreeding did improve the rate of growth in fat-tailed Salt Range breed. The superiority of crossbred over purebred lambs for growth rate during pre-and post-weaning periods has been abundantly reported. The comparison between male and female lambs for growth rate in all groups revealed that the former had faster growth rate than those of the latter. These findings are in agreement with those of Fall *et al*. (1983).

A comparison of the data obtained from the two purebred groups indicated that during post-weaning growth, the purebred undocked lambs could not maintain the superiority in weight gain, over the docked ones, which they had till weaning at 120 days age. It became evident from these results that docking of fat tails of Salt Range sheep did result in considerable gain in weight during post-weaning period probably due to better ability of docked group to avert the weaning stress. The results of this study are in complete agreement with those reported by Cengiz and Arık (1994) and Moharrery (2007).

In the present study, comparison of live weights of the three groups at 9 and 13 months age showed that the crossbred lambs significantly ($P<0.01$) outweighed purebreds (Table 1). These findings tended to show that the crossbreeding of the seemingly slow gaining Salt Range ewes with Kajli rams resulted in the lambs which attained noticeably better weights than those of the purebred at the same age. This potential of crossbred lambs for higher weight gain may be beneficially exploited commercially. While comparing the relative merits of docking and crossbreeding in Salt Range sheep, it could be inferred that in contrast to docking, crossbreeding appeared to be a better tool for improving economically important growth traits in case of fat-tailed

Salt Range sheep. When the data on growth traits of male and female lambs were compared within each of the three experimental groups or on overall basis, it was observed that from birth till the age at slaughter (13 months), the male lambs weighed consistently heavier than females (Table 1).

The slaughter data for purebred docked, undocked and crossbred lambs have been presented in Table 2. The comparison of the two purebred groups of lambs showed that the docked lambs yielded heavier cuts than those of undocked lambs. Similar reports in favour of docked fat-tailed sheep breeds have been reported by Marai and Baghat (2003) and Bingol *et al*. (2006). The carcasses of docked lambs were also superior in conformation, to those of undocked ones.

The comparison of crossbred and purebred lambs revealed that crossbreds had heavier meat cuts than the purebreds. Several workers reported the better performance of crossbreds in yielding heavier weights of commercially important meat cuts (Azar *et al.,* 2007; Keshtkaran and Lavvaf, 2010). The higher weights of cuts yielded by crossbreds could be due to their higher live- and carcass weights. Significantly positive correlations of live weight at the age of slaughter and carcass & weight have been reported with weight of leg, weight of meat in leg and weight of meat in the carcass (Cloete *et al*., 2007).

It was found that mean carcass weight and dressing percentage of purebred docked lambs was higher than those of the undocked (Table 2). The dressing percentage of undocked group of lambs was calculated both with and without fat tail. Since it is customary that the tail fat is mostly not considered an edible tissue, therefore, the weight of fat tail (2.0 kg) and that of lump of accumulated fat at the dock region in docked (0.37 kg) animals were deducted from their respective carcass weights. Consequently, the carcass weight calculated without fat tail for undocked and then its comparison with those of the docked showed a significant difference (P<0.01) between these two groups in respect of carcass weight and dressing percentage. Higher carcass weight and dressing percentage in docked lambs have also been reported by Bingöl *et al*. (2006).

According to the general practice of retaining tail with the dressed carcass in case of thin-tailed sheep in the country, the carcasses in case of crossbred thin-tailed animals were weighed along with tail portion while calculating the dressed carcass weight and dressing percentage. The dressing percentage of some purebred sheep has been reported to range from 44 to 56 % or more in improved mutton breed types (Farid, 1991; Keshtkaran and Lavvaf, 2010). The dressing percentage obtained in this study for purebred groups was close to the minimum of the range mentioned above for improved sheep breeds. This difference may be due to breed variation and the methods of rearing. However, these results indicated that the fat-tailed purebred Salt Range yielded low carcass weight and dressing percentage. The higher values for carcass weight and dressing percentage obtained for crossbred lambs in comparison to those of the purebred lambs are in agreement with those reported by Izadifard and Dadpasand (2007) and Azar *et al.* (2007).

The higher dressing percentage of crossbreds than those of purebreds obtained in the present study could be an indication of better carcass quality of the crossbred lambs. According to Yeates *et al.* (1975), the dressing percentage has often been considered as a fair to good measure of carcass quality at carcass competitions. The comparison of data for male and female lambs within the experimental groups and on overall basis showed that males had significantly heavier meat cuts than the female lambs (Table 2). The physical separation of three rib joint revealed that lean percentage in this cut was higher for purebred docked than that of undocked lambs, though the difference was non-significant. Similarly, bone percentage was higher in the docked group, but the percentage of fat was higher in the undocked lambs. The differences between the two groups were not significant (Table 2). The findings of Cengiz and Arık (1994) support those of the present study. The comparison of crossbreds with purebreds for these three components of 9-10-11 rib cut showed different percentage values. Contrary to those of purebred groups, crossbred lambs had significantly higher lean and fat, but lower bone content. In the present study, the crossbred lambs were found to be superior to both the purebred groups so far as carcass tissue ratio in the three rib joint was concerned. The higher meat tissue in the carcass of crossbred as compared to that of purebred lambs was also reported by Abdullah *et al*. (2003)

The fat thickness was measured at five different locations on the carcass i.e. (i) over $6^{th}$ rib, (ii) over 13th rib, (iii) in front of hook bones, (iv) behind hook bones, and (v) at the end of rump near the dock. The docked lambs were found to have comparatively thicker fat layer at the above given five locations than the purebred undocked lambs. The higher values for fat thickness over the carcass of the docked fat-tailed lambs appeared to confirm the findings of Sefidbakht and Ghorbon (1972) and Kyanzad (2001). The thicker fat cover over the carcass of docked lambs might be a compensatory phenomenon, since the fat which could have accumulated in the fat depot in the form of fat tail had probably triggered back and accumulated over the rest of the carcass. The fat was observed as being distributed around the tail region and the internal organs of the docked lambs. Similar results have been reported by Sefidbakht and Ghorbon (1972) and Bingöl *et al*. (2006). The findings of the present study and those of certain earlier studies showed that post-docking pattern of fat distribution was altered in the carcass of docked fat-tailed sheep. It was found from this study that in the docked group the fat layer was still thicker

**Table 2. Mean values of some carcass traits for purebred (docked and undocked) and crossbred lambs**

| Carcass traits | Purebred docked | | | Purebred undocked | | | Crossbred | | |
|---|---|---|---|---|---|---|---|---|---|
| Live weight (kg) | 31.35$^{a}$ | | | 30.00$^{b}$ | | | 33.95$^{c}$ | | |
| Neck (kg) | 1.10$^{a}$ | | | 0.94$^{a}$ | | | 1.29$^{a}$ | | |
| Shoulder (kg) | 2.38$^{a}$ | | | 1.89$^{b}$ | | | 2.96$^{c}$ | | |
| Thorax (kg) | 3.61$^{a}$ | | | 3.00$^{b}$ | | | 4.41$^{c}$ | | |
| Loin & flank (kg) | 3.24$^{a}$ | | | 2.66$^{a}$ | | | 3.35$^{b}$ | | |
| Leg (kg) | 3.07$^{a}$ | | | 2.44$^{a}$ | | | 3.45$^{b}$ | | |
| Tail (kg) | 0.37$^{a}$ | | | 2.00$^{b}$ | | | 1.63 | | |
| Kidney (kg) | 0.08$^{a}$ | | | 0.07$^{a}$ | | | 0.21$^{a}$ | | |
| Plucks (kg) | 0.53$^{a}$ | | | 0.47$^{a}$ | | | 0.68$^{a}$ | | |
| Mesentry (kg) | 0.08$^{a}$ | | | 0.10$^{a}$ | | | 0.09$^{a}$ | | |
| Dressed carcass weight (kg) | 14.46$^{a}$ | | | 13.57$^{b}$ | | | 16.44$^{c}$ | | |
| **Dressing percentage** | | | | | | | | | |
| a) With fat tail | 46.12$^{a}$ | | | 38.57$^{a}$ | | | 48.42$^{b}$ | | |
| b) Without fat tail | - | | | 42.76$^{b}$ | | | - | | |
| **Sex** | **Male** | **Female** | **Diff.** | **Male** | **Female** | **Diff.** | **Male** | **Female** | **Diff.** |
| Live weight (kg) | 33.50 | 29.20 | 4.30** | 31.20 | 28.80 | 2.40** | 33.50 | 32.40 | 3.10** |
| Neck (kg) | 1.20 | 1.00 | 0.20$^{NS}$ | 0.98 | 0.89 | 0.09$^{NS}$ | 1.35 | 1.22 | 0.13$^{NS}$ |
| Shoulder (kg) | 2.72 | 2.03 | 0.69* | 2.36 | 1.41 | 0.95* | 3.38 | 2.54 | 0.84* |
| Thorax (kg) | 3.90 | 3.32 | 0.58* | 3.25 | 2.74 | 0.51* | 4.56 | 4.26 | 0.30$^{NS}$ |
| Loin & flank (kg) | 3.48 | 2.99 | 0.49* | 2.95 | 2.36 | 0.59* | 3.74 | 2.97 | 0.77* |
| Leg (kg) | 3.31 | 2.82 | 0.49$^{NS}$ | 2.60 | 2.28 | 0.32$^{NS}$ | 3.96 | 3.24 | 0.72* |
| Tail (kg) | 0.39 | 0.40 | 0.01$^{NS}$ | 2.00 | 1.99 | 0.01$^{NS}$ | - | - | - |
| Kidney (kg) | 0.08 | 0.07 | 0.01$^{NS}$ | 0.08 | 0.06 | 0.02$^{NS}$ | 0.09 | 0.06 | 0.03$^{NS}$ |
| Plucks (kg) | 0.58 | 0.48 | 0.10 | 0.48 | 0.46 | 0.02$^{NS}$ | 0.72 | 0.63 | 0.09$^{NS}$ |
| Mesentry (kg) | 0.08 | 0.08 | - | 0.43 | 0.60 | 0.17 | 0.09 | 0.09 | - |
| Dressed carcass weight (kg) | 15.74 | 13.19 | 2.55** | 14.75 | 12.32 | 2.43** | 17.89 | 15.60 | 2.29** |
| **Dressing percentage** | | | | | | | | | |
| a) With fat tail | 46.95 | 44.32 | 2.60** | 47.38 | 42.67 | 4.71** | 48.53 | 46.47 | 2.06** |
| b) Without fat tail | | | | 41.63 | 35.73 | 5.90** | - | - | - |
| **Back fat thickness** | | | | | | | | | |
| Over the 6$^{th}$ rib (cm) | 0.22 | | | 0.20 | | | 0.18 | | |
| Over the last rib (13$^{th}$ rib) (cm) | 0.40 | | | 0.35 | | | 0.32 | | |
| In front of hook bones (cm) | 0.44 | | | 0.40 | | | 0.35 | | |
| Behind hook bones (cm) | 0.42 | | | 0.48 | | | 0.17 | | |
| End of rump (cm) | 2.00 | | | 4.00 | | | 0.25 | | |
| **Sex** | **Male** | **Female** | **Diff.** | **Male** | **Female** | **Diff.** | **Male** | **Female** | **Diff.** |
| Over the 6$^{th}$ rib (cm) | 0.13 | 0.30 | 0.17$^{NS}$ | 0.12 | 0.25 | 0.13$^{NS}$ | 0.10 | 0.26 | 0.16$^{NS}$ |
| Over the last rib (13$^{th}$ rib) (cm) | 0.34 | 0.45 | 0.11$^{NS}$ | 0.29 | 0.35 | 0.06$^{NS}$ | 0.28 | 0.35 | 0.07$^{NS}$ |
| In front of hook bones (cm) | 0.39 | 0.43 | 0.09$^{NS}$ | 0.24 | 0.40 | 0.16$^{NS}$ | 0.21 | 0.40 | 0.19$^{NS}$ |
| Behind hook bones (cm) | 0.45 | 0.50 | 0.05$^{NS}$ | 0.32 | 0.45 | 0.13$^{NS}$ | 0.20 | 0.30 | 0.10$^{NS}$ |
| End of rump near the dock (cm) | 2.50 | 2.20 | 0.30$^{NS}$ | 2.00 | 2.50 | 0.50* | 0.16 | 0.13 | 0.02$^{NS}$ |
| Intramuscular fat (%) in loin eye muscle | 14.00 | 14.50 | 0.60* | 12.00 | 12.80 | 0.80* | 12.50 | 13.00 | 0.50* |

*Means in the row with different superscripts differ significantly; * = Significant at 5 % level, ** = Significant at 1 % level, NS= Non-significant*

*Note: The fat tail weight in undocked lamb was 14.74 % of the dressed carcass weight and 6.67 % of the live weight in the study.*

at the dock region near the rump in comparison to that of undocked animals. In contrast to fat-tailed purebreds (docked and undocked), crossbreds had developed comparatively thinner subcutaneous fat layer over the carcass. This showed that purebred fat-tailed sheep had greater tendency for fat deposition in the carcass as compared to crossbred when slaughtered at the same age. This also led to postulate that at the same age, fat-tailed sheep were likely to convert feed energy into more fat, less lean and attain early maturing smaller size than the thin-tailed crossbreds.

The comparison of means of subcutaneous fat measurements at five locations over the carcasses of male and female animals, within each experimental group, revealed that the depth of subcutaneous fat was more in females than that recorded in males (Table 2). Similarly, females had higher intramuscular fat percentage than those of the males when measured for loin eye muscle. These findings are in agreement with those of McClinton and Carson (2000) and Kashan *et al*. (2005). The higher contents of fat in carcasses of purebred in contrast to thin-tailed crossbred lambs tended to indicate the slow growth and early maturing carcass of fat-tailed purebred Salt Range sheep used in this study. In such breeds of sheep, the body seems to put on more fat and less muscle with advancing age. Contrary to this, the crossbred lambs slaughtered at the same age had more muscle tissue than fat. This reflects a considerable degree of improvement in growth and development of crossbred lambs due to the breed of sire. Work done earlier also showed significant effect of breed of sire for higher weights of carcass components (Kashan *et al*., 2005).

The weight of fat tail of purebred undocked lambs averaged 2.0 kg as against 0.37 kg in the form of fat accumulated around the tail stub in docked lambs (Table 2). The difference of 1.63 kg in the tail weight of these two groups was statistically significant ($P<0.01$). The accumulation of 0.37 kg fat in the docked group around the tail stub appeared to be due to the inherent characters of fat-tailed animals although a part of fat appeared to have triggered back into the body and deposited around the tail head in the form of thicker fat layer. If the weight of fat tail (2.0 kg) is subtracted from the average live weight of purebred undocked group, it markedly declines.

The fat tail weight in the undocked animals accounted for 14.74% of the dressed carcass weight and 6.67% of the live weight in this study. Fat tails in various sheep breeds have been reported to constitute varying percentages of live- and carcass weights (Zamiri and Izadifard, 1997; Safdarian *et al*., 2008). The results of the present study together with the findings of the earlier investigations tend to show that raising of fat-tailed sheep under intensive management appears to be less profitable. Since the consumption by human beings of fat deposited in the tail, is rapidly declining except in certain areas of the country. Moreover, fat deposition in the tail costs much in terms of feed energy. This holds true in Pakistan as well where the production of meat is already too short to meet the ever increasing demand of exploding population. To meet such a situation that prevails in this country, among other measures, the wastage of about 2.00 kg weight in each fat tail may be checked by eliminating the fat tail through docking or by replacing it through crossbreeding fat-tailed and thin-tailed breeds and by further selective breeding for short-tailed character.

## CONCLUSIONS

It may be inferred from the results of the present study that fat tail in Salt Range sheep could be eliminated by selective crossbreeding with Kajli without adversely affecting the carpet wool characters of this breed. Besides, this would effect improvement in growth rate, quantity and quality of carcass and prolificacy. The selective crossbreeding will preclude the necessity of docking when these sheep are raised under range conditions.

The crossbreeding of the slow gaining Salt Range fat-tailed sheep with Kajli males resulted in the lambs which attained noticeably better market weights than those by purebreds (docked or undocked) at the same age. This potential of crossbred lambs for higher weight gain may be beneficially exploited commercially.

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