Some Unique Features of Karakul Fat-Tail Sheep

Maurice Shelton
Texas Agricultural Experiment Station
7887 North Highway 87
San Angelo, Texas 76901 USA

Fat-tail sheep constitute one of the more prevalent types found in the world, and they almost certainly make the greatest contribution to mankind. Most of these are triple purpose animals producing meat, milk and fiber. Most fat-tail sheep tend to have certain traits in common which, in addition to accumulation of fat in the tail, include the production of carpet wool, adaptation to arid regions or more specifically arid regions with great variability in temperature and feed supply, a higher rate of milk production than most breeds and generally low fecundity with good lamb survival. There are many breeds or genotypes of fat-tail sheep, but perhaps the two most widespread, or at least best known, are the Awassi and the Karakul. The latter is thought of as a fur type with the lambs being sacrificed at a very young age to produce Persian lamb skins. However, in practice many lambs are not sacrificed at birth, but are utilized at later ages for meat. The only breed of fat-tail sheep known to be present in the U.S. is the Karakul. These are often used to produce wool for the handicraft trade because of their color and some unique characteristics of the fleece. The genetics of color in the breed are reasonably well worked out and will not be reviewed at this point. However, there are a number of characteristics of this type of sheep which should be of interest.

The Texas Agricultural Experiment Station established a small flock of Karakul sheep approximately 10 years ago. One of the reasons for doing this was to assist in the preservation of a genetic resource which appeared to be in danger of being lost in this country. The second reason had to do with using this breed as an example of the larger fat-tail population of the world in a series of studies contributing to the U.S. AID Small Ruminant Collaborative Research Support Program. The flock was managed under Texas range conditions with winter or very early spring lambing. A series of studies have been conducted and the results will be reviewed and summarized in this paper. Many of these studies have been previously reported in more detail.

Results and Discussion

Fleece Quality

A bulk lot of 865 pounds of Karakul wool was evaluated for a number of characteristics with the following results by Lupton and Shelton.[4]

Average grease fleece weight, 2.86 kg.
Yield, 58.1%
Residual grease (following scouring), 0.6%
Vegetable matter, 1.3%
Fiber diameter, 29.2 microns
Standard deviation in diameter, 11.1 microns

The color ranged from white to black. There were significant differences in fiber diameter between colors, but it is not known what significance to attach to this. It may in fact represent purity of the type. Black colored wools were of the

coarsest type. Variability within the fleeces was high (standard deviation of 11.1 microns) compared with typical values of less than 5.0 microns for finewool type sheep. A substantial portion of the fleeces were medullated, but it proved difficult to provide a value for the percent of medullation because the pigmentation prevented evaluation of medullation in the usual manner.

Reproductive Efficiency

Karakul ewes have been maintained on the same property as other breeds (primarily the Rambouillet) or crosses, but they were not always managed as one group. In general, Karakuls were easier keepers (required less supplemental feed), but tended to be more difficult to handle. Most of the ewes cycled beginning in mid-summer, but some difficulty was encountered concerning servicing ability of the ram due to the fat tail. The lambing rate tended to be low (i.e. 1.17 lambs per ewe lambing compared to 1.43 for Rambouillet) or below all other types maintained in experimental flocks. Lamb survival was the highest of the various breeds, even when adjusted for type of birth. Milk production data were not collected, but early lamb growth rates indicate they were the best milking ewes available on the station.

Effect of Docking on Reproduction

It is possible to dock fat-tail lambs, but it must be done very early as fat accumulates in the tail at a rapid rate. In the experimental flock, one-half of the lambs were docked and one-half left undocked. The ewe lambs were subsequently followed through a productive cycle. In this study, a higher percentage of the docked ewes lambed (92.9 vs. 78.9%); lambed earlier (7.8 days) and had a higher lambing rate (1.23 vs. 1.12). The first two traits apparently reflect the difficulty the rams experienced in mating the undocked ewes. The explanation for the docked ewes having a higher lambing rate is not apparent. In any case producers who raise these sheep would be encouraged to dock their ewe lambs.

Grazing Behavior of Karakul vs. Other Types of Sheep

Since these types of sheep evolved in an arid environment, often with very sparse feed conditions it appeared reasonable that they might exhibit different grazing behavior. The primary point of interest would be their willingness to consume a wider variety of plant material such as shrubs. As a part of other studies, the grazing behavior of Karakul sheep was compared with the Rambouillet and the Barbados Blackbelly (a hair sheep). There was no significant difference between the Karakul and Rambouillet as intake patterns of the two were almost exact duplicates.[7] In some cases the Barbados Blackbelly did browse more extensively than the other two breeds. The explanation for this is not apparent, but should hold interest.

The Eating Quality of the Meat of Fat-Tail Sheep

There is a widespread belief in many parts of the world that the meat of fat-tail sheep is superior to other types from the standpoint of its organoleptic properties (taste and smell). In view of the generally low level of (and frequent aversion to) lamb consumption in the U.S., this feature held considerable interest. Several studies were conducted which were directed at identifying or elucidating this point. Two studies were conducted in which sensory panel ratings were obtained from loin chops and leg steaks of different breeds of sheep in which the Karakul was included. The results did not identify a significant or consistent difference favoring the Karakul breed. Since taste is generally considered to be attributable to the fat component of the meat, the fatty acid content (C14 to C18) of the fat from the various breeds was determined. In one of the studies, the Karakul had a significantly lower level of C18 fatty acids and a higher level of unsaturated fatty acids. This was not corroborated in a second set of data. The general conclusions from these studies were that the alleged difference did not exist or that the approach used did not identify a difference. In discussing the meat of these type of sheep, people often refer to odor or the lack of odor. It has been recently suggested that the source of odor in meat is not found in the fatty acids of the C14 to C18 range, but in more volatile, shorter chain acids.[8] This possibility needs to be investigated. The potential of altering the acceptability of sheep meat in the U.S. market through genetic means should hold considerable interest.

Carcass Traits of Fat-Tail Compared to Other Breeds

Several studies have been made which involved comparison of carcass traits of Karakul and other breeds or types. One set of data is shown in Table 1. These data were derived from wether lambs fed to produce U.S. Choice grade lamb carcasses. These data have been reported in more detail by Edwards, et al.[1] The crossbred animals in this tabulation represent Rambouillet x Suffolk crosses. The overwhelming conclusion from these data is that under comparable feeding conditions and at comparable slaughter weights the Karakul is fatter. This resulted in a carcass fat trim of 15.4% as compared to 6.6% and 6.7% respectively for the Rambouillet and crossbred groups. This fat trim was largely associated with the tail as identified as trim from the leg and loin in Table 1. However, the Karakul was fatter overall as evidenced by a significantly higher dressing percentage and a greater fat thickness over the 12th rib. The Karakul also had a markedly lower yield of trimmed wholesale cuts due to the necessary fat trim. Other studies have supported similar

TABLE 1 Influence of Breed of Lamb on Selected Carcass Traits

Carcass trait	Breed Group			SD
	Rambouillet	Crossbred	Karakul	
No. observations	20	16	20	
USDA yield grade*	2.7[c]	2.4[c]	3.0[d]	.63
USDA quality grade*	11.1	11.5	10.9	1.05
Dressing percentage	52.6[c]	53.8[c]	56.1[d]	2.94
Carcass fat trim (%)	6.6[c]	6.7[c]	15.4[d]	2.21
Trimmed wholesale cuts (%)	78.9[c]	80.2[c]	72.7[d]	2.65
Fat trim from leg (%)	8.7[c]	8.1[c]	32.1[d]	3.69
Fat trim from loin (%)	9.8[c]	9.0[c]	21.0[d]	5.08
Ribeye area, 12 rib (cm^2)	14.3	14.7	14.2	1.91
Leg conformation score*	11.7[c]	12.7[d]	10.5[e]	.92
Fat thickness, 12 rib (mm)	3.2[c]	3.1[c]	4.4[d]	1.40

[c,d,e]Means on the same line concerning all breeds with different superscripts are different (P 0.05). The same applies to other tables in this report.
*These are coded values with the lower values for yield grades representing leaner carcasses. Higher values are more desirable in case of leg conformation or quality grade.

conclusions. O'Donavan et al.[5] reported a carcass fat percentage of 33.3 for Iranian fat-tail sheep. This high level of body fat is perhaps the major factor contributing to survival of these sheep under arid conditions or periods of nutritional stress, but it represents a very serious waste in terms of carcass value in those countries which do not have a ready market for carcasses of this type.

The Influence of Docking on Growth and Carcass Traits

The previous section indicated a considerable amount of waste in the fat trim from the Karakul lambs. Most, though not all, of this was that associated with the tail fat or fat tail. Thus a logical question is what would docking do to the accumulation of fat which must be trimmed to make the carcasses acceptable in non-traditional markets.

As mentioned earlier, one-half of the lambs born in the experimental flock were docked with the remainder left undocked. Some of the males (castrated) were processed through a research laboratory along with comparable Rambouillet lambs as controls. Some of these data are shown in Tables 2 and 3 and in Figure 1.

Death losses and the relative growth rates of the docked vs undocked lambs are shown in Table 2. Differences between years, sex and type of birth were statistically significant. Differences in growth rate between lambs which were docked and those that were not docked were not significant, but when differences existed, they favored the docked lambs. Other researchers have reported slower growth rates for docked animals. In this study, docked lambs had a higher death loss although this difference was not statistically significant. Further research on this point seems warranted.

As shown in Figure 1, docking markedly reduced the tail or dock fat trim from 6.5% to 1.7% of the carcass. This reduced the overall fat-trim in the carcass by 5%. In this study, docking did not increase the thickness of the external fat cover and only a marginal increase in kidney and pelvic fat content. In a study conducted by Joubert and Ueckermann,[3] the docked animals showed a slight, but non-significant, increase in kidney and pelvic fat, but no increase in external fat cover. Other studies have shown an increase in subcutaneous and internal (kidney/pelvic) fat deposition, but such an increase was not sufficient to compensate for the total reduction of fat in the tail. Sefidbakht and Ghorban[6] reported 16% separable fat of docked animals as compared to 27% for non-docked controls. These data suggest a reduced total fat deposition in docked animals. This should be advantageous to carcass value in all cases except potential markets outlets where the price received for fat is equal to that of red meat. Other work has shown a tendency for increased intramuscular fat deposition of the loin in docked animals (i. e., 4.5% for docked vs 4.1% for undocked animals).

TABLE 2 Least Square Means for Weaning Weight (kg) and Lamb Survival (%) by Treatment Group

Year	Type of birth	Sex	Type of Tail	Wean wt.	Lamb survival (%)
1981 — 29.4[b]					
1982 — 30.9[b]	Single — 34.7[a]	Male — 34.8[a]	Docked	33.4	84.3
1983 — 25.0[c]					
1984 — 39.6[a]	Twin — 28.1[b]	Female — 31.5[b]	Undocked	33.0	90.7
1985 — 39.4[a]					

TABLE 3 Comparison of Rambouillet and Docked vs Non-Docked Karakuls with Respect to Certain Carcass Traits

Trait	Rambouillet	Karakul	
		Docked	Non-Docked
Dressing percentage	54.03[a]	56.73[b]	57.13[b]
Cooler shrink (%)	6.23	6.94	7.35
Fat thickness, 12 rib (mm)	3.81	6.10	6.85
Ribeye area (cm^2)	14.19	14.45	13.09
Total fat (%)	9.00[a]	15.53[b]	19.76[c]
Rack fat (%)	0.68	1.14	1.11
Dock fat (%)	0.25[a]	1.68[b]	6.49[c]
Kidney/pelvic fat (%)	4.44	4.34	4.00

Epstein[2] reports a total body fat content of undocked Awassi lambs at 14.0%, compared to 12.4% for docked lambs. These values are of interest in that this researcher reports much lower fat percentages. This could potentially relate to the breed used, but much more likely is explained by lower slaughter weights (approximately 27 kg as compared to 50+ kg in the Texas study). Observations indicate that fat stores increase, both in actual terms and as a percentage as the animal matures. This is true for all types of sheep, but appears to be more marked for the fat-tail types.

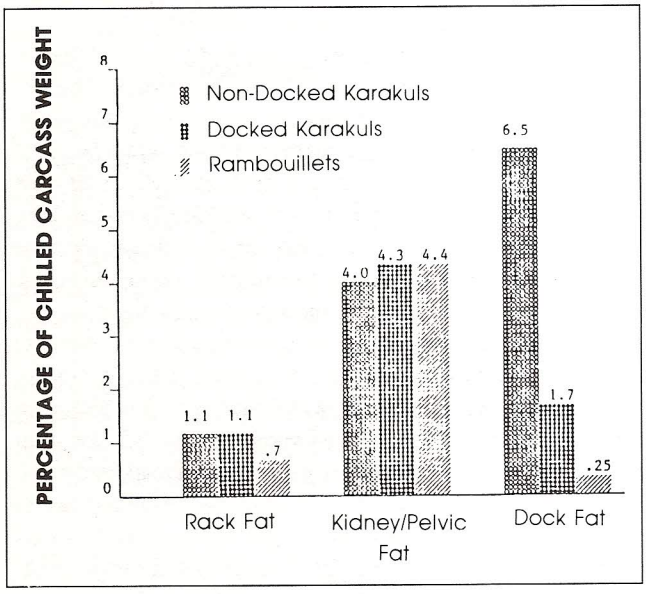

Figure 1 Comparison of Percentages of Rack Fat, Kidney/Pelvic Fat and Dock Fat Among Non-Docked and Docked Karakuls and Rambouillet Sheep.

The Influence of Crossbreeding on Growth and Carcass Traits

Producers of fat-tail (in this case Karakul) sheep, either for the unique pelt or fiber types or because of their unique adaptation to arid environments, have the option of crossing the ewes to rams of other breeds to possibly improve the carcass value of the resulting lambs. Except for the case of Karakuls maintained for pelt production, this could be done with a large portion of the ewe flock while breeding a smaller portion of the ewe flock to generate replacements.

In one study, four different types of lambs were generated by breeding Rambouillet, Suffolk or Karakul rams to Rambouillet or Karakul ewes. The four types of lambs are outlined below:

Rambouillet x Rambouillet
Rambouillet x Suffolk
Rambouillet x Karakul
Karakul x Karakul

It can be seen that the two crossbred types of lambs were generated from Rambouillet ewes as the number of available Karakul ewes were few. Within the four groups, approximately one-half of the males were castrated with one-half left intact, resulting in 12 breed x sex groups. Within each of these groups, one-half of the lambs were docked and one-half were left undocked resulting in 24 breed x sex x docking subgroups.

All of the lambs were grown to approximately 45 kgs and were slaughtered through a commercial abattoir. Data collected include birth weight, pre- and post-weaning gains and a variety of carcass data. The latter included dressing percent, carcass and leg length and several measures of degree of fatness. In addition, the tail was removed and weighed for a total tail weight as well as trimmable fat from the tail and dock region.

Lambs out of Karakul ewes had heavier birth weight and better preweaning gains. This almost certainly traces to a higher level of milk production. Lamb survival also favored Karakul lambs. Sex and type of birth (single vs twins) effects generally followed the expected trends. Irrespective of the tail fat, Karakul and Karakul cross lambs were fatter in all measures of fatness (fat thickness over loin, kidney and pelvic fat as well as condition scores). The pure Karakul lambs had greater leg and carcass length and both pure Karakul and one-half Karakul lambs had lower leg conformation scores. A major interest in the study was the influence of docking and crossbreeding on tail fat trim. The undocked female Karakul lambs had an average of fat trim of 1151.1 grams or 4.5% of the carcass. For the docked crossbred female this value was

318.5 grams or 1.3% of the carcass. As expected, the male lambs had slightly less fat than females.

Thus the combination of the practices of crossbreeding and docking largely eliminated the problem of waste fat trim. In the case of wether lambs the crossbred lambs had only 174 grams more fat than the Suffolk cross lambs.

What is the Significance or Explanation for the Accumulation of Fat in the Tail?

A phylogenetic explanation for the accumulation of fat in the tail must hold theoretical, as well as practical, interest. Most fat-tail sheep are located in arid regions which are subject to extended periods of feed shortage. In addition, such sheep tend to be concentrated in areas subject to great variation in environmental temperature between night and day or between seasons. Few fat-tail sheep are found in humid or tropical climates, although fat rumped sheep may be present in these areas. This is generally explained in that animals in tropical environments do not need large deposits of fat, and climatic conditions do not encourage deposition of fat (i.e., total feed intake is reduced under conditions of high temperature stress). It has also been observed that fat-tail animals suffer in humid environments because the skin covered by the tail flap does not dry out—resulting in unsanitary and sometimes necrotic conditions.

If one seeks an explanation for the presence of the fat-tail from people in the areas where these sheep are produced, an almost invariable answer is that the fat tail is necessary for the animal to survive extended dry periods. However, this is a valid answer only if the accumulation of fat in the tail is physiologically different to fat deposited at some other place in or on the body.

In the simplest terms, an accumulation of fat in the tail must result from natural or artificial (that imposed by man) selection. There is actually a tendency for accumulation of fat in the posterior regions in many breeds or species. For instance, there are several breeds of sheep characterized by deposition of fat around the rump. Thus, fat-tail sheep differ from other types of sheep only in the degree and specific location of their fat deposition. If man has actually selected for the fat tail it may be hypothesized that: (a) such animals were thought to be more adaptable or productive, (b) the meat of this type was preferred, and (c) the fat of the sheep was needed for cooking, seasoning or for use in preservation of other food products. This use might be comparable to that made of pork fat by farm families in the U.S. in earlier years. A quotation cited earlier that the tail fat was "the butter of Central Asia, and ideal for cooking purposes" emphasizes this point. There is an important distinction in that these sheep evolved and were used in the Middle East over thousands of years. In an arid or desert environment, animal fat (from sheep) could be collected much more easily if it was concentrated at one place in or on the body. The author is of the opinion that this is the most likely explanation for selection/propagation of sheep with this unique accumulation of fat. With the widespread availability and use of vegetable oils and changes in dietary habits, the fat tail or tail fat is no longer in great demand and in many markets it is removed from the carcass before delivery to retail outlets. In some cases, it has almost no value or is used for industrial purposes at very low prices. Thus, heavy fat accumulation constitutes considerable loss or waste for up to one-third of the world's sheep population. Many carcasses in market channels have the fat tail removed before shipment, suggesting some resistance to the excess fat on the part of the consuming public.

On the other hand, if natural selection is the primary mechanism for the accumulation of fat in the tail, an explanation for the adaptive advantages must hold interest. Other potential sites for fat deposition are internal (kidney and pelvic region), subcutaneous, intermuscular and intramuscular. It could be theorized that the presence of large amounts of internal fat interfere with the ability of the animal to consume large amounts of feed when it is available, or that subcutaneous fat would interfere with heat dissipation at times of heat stress. Both of these could possibly be true at some time or some place, but are these factors adequate to overcome the interference of the tail with reproduction under natural mating conditions? A series of investigations was carried out to compare Karakul with other sheep in terms of their response to heat stress, and to compare docked vs undocked animals. It might be expected that docking results in an increase in subcutaneous or internal fat deposition and thus these comparisons should provide some information on the question of tail fat deposition as a factor in dealing with heat stress.

Karakul sheep were less affected by temperature stress than Rambouillets, but were more stressed than meat-type (non-fiber producing) sheep or goats. In general, there was little difference between docked and undocked animals, and differences that did exist tended to favor the docked animals. These studies did not support the theory that the accumulation of fat in the tail is beneficial to the animal in dealing with heat stress, and strongly indicated the reverse—that docking is beneficial. The existence of breed differences in respect to heat stress between Karakul and Rambouillet perhaps has an alternative explanation.

Another suggested or potential advantage for accumulation of fat in the tail is that reduced internal fat storage would permit greater feed intake if intake became a critical factor. This would be more likely to be critical only for the pregnant ewe, particularly for those carrying twins. Also, docking the ewe could theoretically increase the internal (kidney/pelvic) fat deposition, but this has not been proven to be the case. An experiment was conducted in which ewes of three breeds (Rambouillet, Karakul and Finnish Landrace), in late pregnancy, were provided *ad libitum* feeding of a mixed and pelleted ration. The Karakul group contained docked and undocked ewes. The ewes were kept on feed for a period of

time after lambing to coincide with the early stage of lactation. The results of these studies have not been clear cut. Two differences were noted. The Karakul ewes carrying twin fetuses ate significantly less feed in late gestation than those carrying singles when this was expressed as a function of body weight. This was not true with the other breeds. This may be explained by the fact that Karakul lambs were larger, which resulted in more crowding or limitation in capacity. When expressed as a function of body weight, the Karakul ewes ate more total feed than the other breeds. In another independent study Karakul ewes ate more feed than finewool or hair type sheep. This was true in actual terms and also when expressed in terms of body weight. Docked Karakul ewes tended to eat less than non-docked ewes, but these differences were not statistically significant.

These series of studies suggest to the writer that fat-tail sheep are adapted to arid regions because of greater total body fat reserves, as established in carcass studies. Also, that a higher level of feed intake at times when forage is available facilitates greater fat deposition. These studies do not confirm or deny that the presence of the fat in the tail facilitates greater total feed intake or total fat deposition. Any differences which were observed are very small, and in these studies, non-significant. However, small differences may take on added significance when considered over thousands of years of evolutionary development.

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