Consolidated PR-2631-2645
February 1969

RESEARCH REPORTS

Sheep and Angora Goat, Wool and Mohair---1969

TEXAS A&M UNIVERSITY
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PR-2631

Influence of Sex, Ration And Stilbestrol on Feedlot Performance And Carcass Characteristics Of Early-weaned Lambs

Maurice Shelton, Z. L. Carpenter
and J. E. Huston

There has been a general trend in recent years in Texas toward earlier weaning and high concentrate feeding of lambs. At present, there appears to be a trend in the industry toward marketing of heavier lambs. If certain objections can be overcome, the slaughter of heavy lambs should be more efficient to both the producer and the packing industry. However, these are somewhat opposing trends so far as the industry is this state is concerned because excess fat is a major limiting factor to the marketing of heavier lambs, and the two practices mentioned earlier tend to producer a fatter lamb at lighter weights.

The present study was undertaken to investigate the effect of sex of lamb, use of stilbestrol and ration roughage levels on animal performance and carcass characteristics of lambs killed at various weights. The feed treatments employed are as outlined in Table 1. The experimental plan called for killing animals in each treatment group at weights of 85, 105, 125 and 145 pounds. Because only limited data have been obtained on carcasses killed at the heavier weights, only data for animal performance for the first 70 days on feed (up to the time the first group was removed for slaughter) and preliminary slaughter data at 85 and 105 pounds weight are reported here. Carcass data on lambs fed to heavier weights will be reported at a later date.

This study was conducted in three replicates in order to partially eliminate the effect of season (temperature) on animal gains, especially when the animals

TABLE 1. COMPOSITION OF CONCENTRATE AND ROUGHAGE RATIONS[1]

Concentrate ration	percent	Roughage ration	percent
Alfalfa hay	12	Cottonseed hulls	20
Sorghum grain	72	Alfalfa hay	20
Cottonseed meal	13	Sorghum grain	43
Urea	1	Cottonseed meal	14
Calcium carbonate	1	Urea	1
Salt	1	Calcium carbonate	1
Vitamin A—500 I.U. per pound ration		Salt	1
Aureomycin—15 milligrams per pound ration		Vitamin A—500 I.U. per pound ration	
		Aureomycin—15 milligrams per pound ration	

[1]Potassium chloride at the rate of 0.5 percent was added to both rations in the middle of the experiment when it appeared that problems with urinary calculi might be developing. This modification did not completely control the problem as some losses from calculi did occur among animals which had been on feed for more than 100 days.

were carried to heavier weights. All lambs went on experiment after early weaning at 60 to 70 days of age. Only crossbred lambs out of fine wool ewes were used.

Results and Discussion

Animal Performance Data

The performance data for the 189 lambs involved are shown in Table 2. Significant differences in average daily gain were obtained for the study as a whole, but no attempt was made to determine significance of the differences between any two treatment groups. Since feed efficiency data are available for group means only, no statistical analyses were possible for this variable.

As expected, rams gained faster than ewes or wethers. A comparison of gains of rams and wethers at each of the two roughage levels shows a difference approaching 0.10 pound daily in each case (.09 and .08). A much smaller difference was observed between ewe and wether lambs. The use of stilbestrol, either orally or as an implant, made only a small improvement in gain. This is somewhat in contrast to findings in many studies, which show a much more marked response to the use of stilbestrol. A possible explanation for this is that these were young lambs fed under optimum conditions when the natural growth stimulus was at its greatest, whereas, most studies with stilbestrol have been with older lambs. Based on the summary, daily gains for the two roughage levels were essentially the same. However, there appears to be some variation in the replicates in this respect, and this can possibly be explained by the season in which they were fed. The higher roughage level would be expected to perform less satisfactorily in the summer season (Replicate 3). Extensive work at the research center at McGregor has shown that the addition of roughage up to approximately 20 percent will consistently improve animal performance. Above this level, the quality of the roughage becomes important. A high quality roughage like alfalfa hay will usually improve, or at least maintain, performance to 50-60 percent of the ration. However, poor quality, such as cottonseed hulls, will generally lower performance when included in the ration at much above 20 percent. In this case, a mixture of the two fed at 40 percent level permitted the animals to perform comparably to those on the higher concentrate ration.

In terms of feed efficiency, two points seem worthy of mention: (1) Ewe lambs gained less efficiently than rams or wethers. This can no doubt be explained by a greater tendency of ewe lambs to put on fat at an earlier age. (2) In this study, the increased gains obtained from ram lambs, or through the use of stilbestrol, did not improve feed efficiency as might have been expected.

The explanation for this is not clear. As would be expected, gains were produced more efficiently on the high concentrate ration. The gains on the high concentrate ration also were produced much more economically. Based on feed prices as of this writing, feed cost per pound of gain was approximately 12.01 cents for the high concentrate ration as compared to 15.26 cents for the roughage ration. As will be pointed out later, the high concentrate fed lambs were also higher yielding. Thus, if gains were expressed as carcass weight gains, an even greater advantage would be realized in favor of the high concentrate ration. The feed efficiency and feed cost data reported here represent only "in lot" gains and should be adjusted for shrinkage to market and death losses in order to make these comparable to commercial feedlot conditions.

Carcass Traits

Preliminary carcass data for lambs slaughtered at 85 and 105 pounds are shown in Tables 3 and 4. The yield values are calculated values based on a 4 percent

TABLE 2. INFLUENCE OF SEX, ROUGHAGE LEVEL AND STILBESTROL ON ANIMAL PERFORMANCE (APPROXIMATELY FIRST 70 DAYS ON FEED), 1968

Treatment		Replicate 1 January 1-April 4		Replicate 2 March 13-May 22		Replicate 3 August 5-October 14		Summary	
Sex	Ration	Average daily gain, pounds	Feed per pound gain, pounds	Average daily gain, pounds	Feed per pound gain, pounds	Average daily gain, pounds	Feed per pound gain, pounds	Average daily gain, pounds	Feed per pound gain, pounds
Rams	High concentrate	.720	4.92	.696	4.27	.618	4.62	.678	4.60
Females	High concentrate	.610	5.28	.612	4.48	.495	4.77	.572	4.84
Wethers	High concentrate	.638	4.69	.621	4.17	.536	5.06	.598	4.64
Wethers	High concentrate Stilbestrol in feed[1]	.697	4.86	.679	4.26	.511	4.89	.629	4.67
Wethers	High concentrate Stilbestrol implant[2]	.648	5.00	.588	4.26	.597	4.59	.611	4.62
Rams	Roughage	.756	6.06	.733	5.13	.546	6.55	.678	5.91
Wethers	Roughage	.590	6.41	.702	5.05	.471	6.84	.588	6.10

[1]Stilbestrol fed at the rate of 1 milligram per pound of feed.

[2]6 milligram implants in the ear were employed. In the first replicate some of the lambs were reimplanted after approximately 70 days on feed; however, because of concern over urinary blockage, this second implant was not employed in the second and third replicates.

TABLE 3. INFLUENCE OF SEX AND RATION TREATMENTS ON CERTAIN CARCASS CHARACTERISTICS FOR LAMBS KILLED AT APPROXIMATELY 85 POUNDS LIVE WEIGHT

Treatment: Sex	Treatment: Ration	Dressing, percent[1]	Hind saddle, percent	Kidney fat, percent	Rib-eye area, square inches	Fat thickness, inches	Estimated total retail cuts, percent	Estimated leg, loin, rack and shoulder percent	Tenderness shear, pounds
Rams	High concentrate	54.4	49.0	1.7	2.24	.19	86.8	65.3	9.6
Females	High concentrate	53.4	49.8	3.2	1.89	.30	84.4	62.3	9.3
Wethers	High concentrate	53.0	48.0	2.3	1.91	.26	86.2	64.0	9.8
Wethers	High concentrate Stilbestrol in feed	51.7	49.0	2.0	2.04	.26	85.8	64.6	10.1
Wethers	High concentrate Stilbestrol implant	50.0	48.5	2.3	1.79	.28	86.5	63.9	10.4
Rams	Roughage	47.3	49.1	1.6	1.95	.13	88.3	66.7	11.8
Wethers	Roughage	50.5	49.6	1.9	1.94	.21	87.8	65.5	10.4

[1]Based on estimated sale weight (final feed lot weight with a 4 percent calculated shrink). Since lambs were killed by weight, the amount of fleece varied, but it is assumed that the pelt weights are relatively comparable among treatments.

shrink of the feedlot weight. This was done in order to make the values as near as possible to those in commercial practice. The concentrate fed lambs had a higher yield (52.3 versus 50.0) than the roughage fed lambs. Ewe and wether lambs had a higher yield than ram lambs (54.1 for ewes, 53.5 for wethers and 51.4 for rams). These results are as expected and can be explained by amount of fill (roughage lots) and greater amount of fat deposition of the ewe and wether lambs. Stilbestrol appeared to reduce yield (control wether, 53.6; stilbestrol in feed, 52.5 and stilbestrol implant, 51.0) with the implants showing a greater effect than feeding. Since fat deposition appears to be the key to variation in the carcass traits, the fat thickness over the loin muscle is shown graphically in Figure 1 for both the 85 and 105 pound weight groups. The percent total retail cuts, as well as percent retail loin, leg, rack and shoulder, vary inversely with the fat cover. It will be seen from Tables 3 and 4 and Figure 1 that ewe lambs are consistently fatter than ram lambs with the wether lambs intermediate. In this study the use of stilbestrol, either orally or as an implant, did not reduce fat cover although it appeared possibly to reduce the amount of internal fat, especially at the heavier weight. If it is assumed that 0.2 inch represents the maximum desirable fat cover, ewe and wether lambs exceeded this amount at 85 pounds, whereas, ram lambs did not reach 0.2 inch cover until they reached 105 pounds slaughter weight. It should be remembered that these data are based on early-weaned lambs placed on feed at light weights (30-50 pounds) and would not be expected to apply to lambs grown out at a slower rate and put on feed at heavier weights as would be true with the majority of Texas lambs. However, under the conditions of this study, it appears that ram lambs would offer

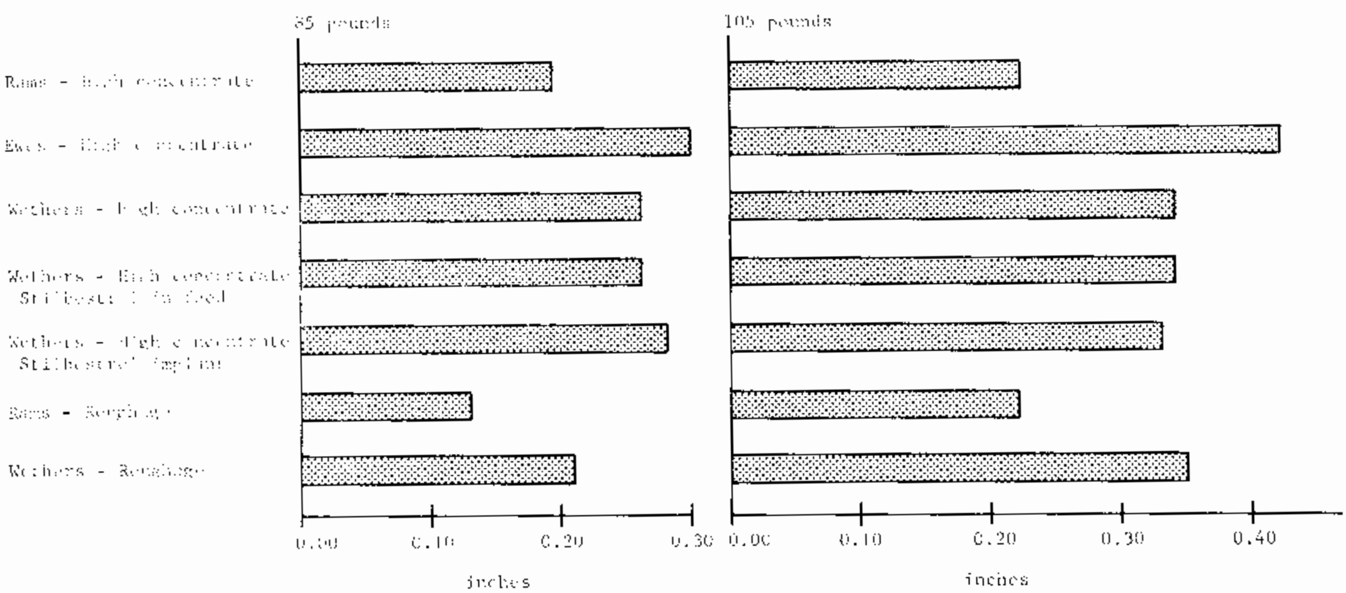

Figure 1. Fat thickness measurements — inches over *L. dorsi.*

TABLE 4. INFLUENCE OF SEX AND RATION TREATMENTS ON CERTAIN CARCASS CHARACTERISTICS FOR LAMBS KILLED AT APPROXIMATELY 105 POUNDS LIVE WEIGHT

Treatment: Sex	Treatment: Ration	Dressing, percent	Hind saddle, percent	Kidney fat, percent	Rib-eye area, square inches	Fat thickness, inches	Estimated total retail cuts, percent	Estimated leg, loin, rack and shoulder, percent	Tenderness shear, pounds
Rams	High concentrate	51.7	48.0	2.1	2.32	.22	85.1	63.3	11.4
Females	High concentrate	54.8	50.3	3.3	2.00	.42	82.5	59.7	9.4
Wethers	High concentrate	54.1	49.2	2.5	2.13	.34	84.4	61.7	11.0
Wethers	High concentrate Stilbestrol in feed	53.3	48.7	1.7	2.31	.34	84.4	62.3	8.7
Wethers	High concentrate Stilbestrol implant	51.9	48.3	1.9	2.13	.33	84.6	62.2	10.4
Rams	Roughage	50.8	49.1	2.3	2.13	.22	85.9	63.7	12.1
Wethers	Roughage	51.4	48.3	2.4	2.11	.35	84.5	61.9	10.8

substantial advantage, in both rate of gain and carcass merit, over ewe or wether lambs. When slaughtered at or before 105 pounds live weight, there is no evidence that ram lamb carcasses are markedly inferior in terms of percent in hind-saddle weight or tenderness shear. Ram lambs did appear to have slightly higher shear force values, especially on the roughage ration, but the magnitude of the shear force values obtained does not indicate that lack of tenderness would be a problem with these carcasses.

PR-2632

Utilization of Urea In Sustained-release Pellets

J. E. Huston, Maurice Shelton and L. H. Breuer

Sheep and Angora goat producers have expressed their interests in urea as a source for satisfying supplemental protein requirements. Most of the increased interest in urea feeding is due to its apparent economy relative to natural protein sources such as cottonseed meal and soybean meal. However, urea-containing rations are normally inferior to those containing natural proteins. Typical results of feeding urea were obtained (Table 5) in a 38-day lamb feeding experiment at the research center at McGregor. Ration 1 (control) is slightly deficient in protein, whereas the protein levels of rations 2 (cottonseed meal) and 3 (urea) appear to be adequate. However, daily gain, feed intake and feed conversion of the lambs fed the urea-containing ration were intermediate to those for the lambs fed rations 1 and 2. Many research workers have suggested that a major cause of poor utilization of urea as a protein source is the very rapid rate at which it is broken down to ammonia in the rumen. Excess ammonia is absorbed directly into the bloodstream, converted again to urea in the liver and lost through the urine. This report describes an attempt to reduce the rate of ammonia production in the rumen when urea is fed and gives the results obtained.

TABLE 5. RATIONS AND PERFORMANCE OF LAMBS IN A PROTEIN SOURCE STUDY

	Control	Cottonseed meal	Urea
Cottonseed hulls	25	25	25
Sorghum grain	50	50	50
Oats	19		17
Cottonseed meal		19	
Urea			2
Mineral Premix	1	1	1
Molasses	5	5	5
	100	100	100
Calculated crude protein	7.5	13.0	12.8
Initial weight	74.9	75.6	75.7
Average daily gain (38 days)	0.60	0.77	0.69
Daily feed intake	3.72	4.18	4.08
Feed conversion	6.2	5.4	5.9

Experimental Procedure

A series of experiments was conducted at the research center at McGregor which included laboratory studies and a feedlot trial to develop and test a sustained-release preparation of urea for inclusion in ruminant rations.

Several pelleting techniques were examined for their capacity to sustain-release urea into distilled water. Figure 2 shows release patterns of three of the pellet preparations compared with that of urea. Pellet preparation 3, which contained urea, starch, minerals and a high molecular weight resin, was selected for testing. The pellets swell when placed in water, and the urea dissolves slowly.

A feedlot growth trial was conducted to compare the performance of lambs fed sustained-release urea pellets as a supplemental nitrogen source with the performance of lambs on a low protein ration, those on rations containing cottonseed meal and those on rations containing urea. Forty lambs were randomly assigned to the four experimental groups and

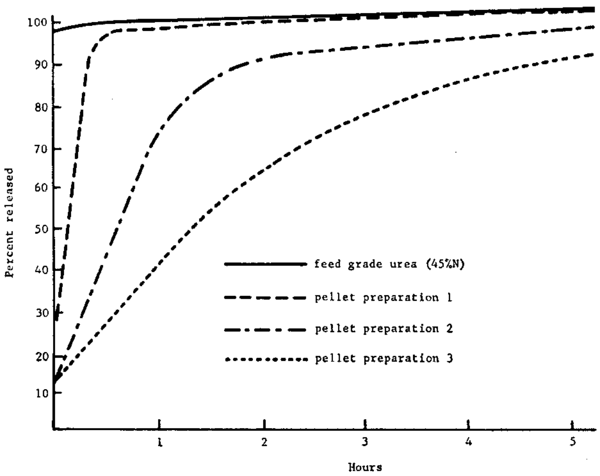

Figure 2. Rate of release of urea into distilled water.

placed on the rations shown in Table 6 for 49 days. The urea pellets included in ration 4 were produced in quantity by dry mixing the ingredients of pellet preparation 3 (above), adding enough water to form a dough and running the dough through a large sausage mill. The individual strings, which resembled wet spaghetti, were separated by hand and dried in a draft oven at 140° F. When the dry material had cooled, it was cracked in a small, low speed hammermill; the cracked material was screened into various particle sizes; and the pellets, 1/8 to 1/4 inch in diameter, were used in the feeding study. All of the experimental rations were then made into 3/8-inch pellets to eliminate any selectivity by the lambs. Initially all four groups were fed the same amount per daily feeding, the amount being determined by the group which voluntarily consumed the least. Incremental increases in feed allowances were made about every 6 to 7 days. After the lambs had been on experiment for 5 weeks, blood samples for blood urea analysis were taken from all before feeding and 1, 4 and 8 hours after feeding. From 5 weeks to the end of the feeding period, the lambs were allowed to eat as

TABLE 6. RATIONS FOR FEEDER LAMBS IN NITROGEN SOURCE STUDY

	Treatment ration percent			
	Control	Cottonseed meal	Urea	Urea pellets
Cottonseed hulls	20.0	20.0	20.0	20.0
Dehydrated alfalfa meal	5.0	5.0	5.0	5.0
Sorghum grain	68.0	51.0	65.5	63.5
Cottonseed meal		17.0		
Urea			2.25	
Urea pellets				4.5
Calcium carbonate	1.0	2.0	1.0	1.0
Dicalcium phosphate	1.0		1.0	1.0
Trace mineralized salt	1.0	1.0	1.0	1.0
Molasses	4.0	4.0	4.0	4.0
	100.0	100.0	100.0	100.0

TABLE 7. EFFECT OF RATION NITROGEN SOURCE ON BLOOD UREA LEVELS

Time following feeding	Treatment (mg blood urea N/100 ml serum)			
	1 Control	2 Cottonseed meal	3 Urea	4 Urea pellets
0 hour	10.2	23.5	20.8	17.5
1 hour	9.4	21.6	21.3	15.9
4 hours	4.7	14.8	23.4	17.5
8 hours	3.5	14.0	27.0	20.0
Average	7.0[a]	18.5[b]	23.1[c]	17.7[b]

[a,b,c]Values with different superscripts are significantly different (P<.05).

much as they wanted. Results of the blood analyses and the total period lamb performance are given in Tables 7 and 8, respectively.

The rumen walls of sheep, goats and cattle have the capacity to absorb small compounds. Ammonia, resulting from hydrolysis of urea, is readily absorbed by the rumen wall, passes into the bloodstream and appears in the circulation as urea. Therefore, blood urea analysis was selected as a measure of the rate of ammonia production in the rumen. However, urea is a normal constituent of the blood even during a protein deficiency as indicated by the control values (Table 7). If it can be assumed that the blood urea levels of the cottonseed meal-fed group represent normal, the average urea level from lambs receiving the urea pellets compared closely with normal. Those receiving urea in the free form had blood urea levels substantially higher, and statistical examination revealed that the probability that the higher levels were due to chance was less than 5 percent. Likewise, the performance of the lambs fed the urea pellets ration was very similar to that of the cottonseed meal group, whereas the urea fed group performed much like the control group. The poor performance of the urea group was unexpected, and there is no obvious explanation for it. Perhaps these lambs were suffering

TABLE 8. PERFORMANCE OF LAMBS FED VARIOUS NITROGEN SOURCES

	Treatment			
	1 Control	2 Cottonseed meal	3 Urea	4 Urea pellets
Number of lambs	9	9	9	9
Weights (pounds)				
Final	60.3	60.2	63.9	60.8
Initial	80.9	89.6	83.3	87.0
Gain (49 days)	20.6	29.4	19.4	26.2
Daily gain	.42[a]	.60[b]	.40[a]	.54[b]
Daily feed intake	2.94	3.10	2.93	3.08
Feed conversion	7.00	5.17	7.40	5.76

[a,b]Values with different superscripts are significantly different (P<.05).

from chronic urea toxicity. Incorporating the urea into the sustained-release pellets apparently overcame the effect and promoted significantly better gain and feed conversion. The difference in performance between groups 2 and 4 is within the accepted range of variation. These results strongly support the hypothesis that rapid ammonia production from urea in the rumen is a major cause of poor utilization of urea as a protein source. Additional research is necessary to determine how this finding can be used in a practical situation.

Summary

Laboratory studies and a feeding trial were conducted to develop and test a preparation which would release urea into the rumen at a rate favorable for its utilization. A preparation was selected which releases urea at a fairly uniform rate for several hours. Lambs fed a ration containing this sustained-release urea preparation had an average blood-urea level similar to lambs consuming a cottonseed meal-containing ration and significantly lower than lambs consuming free urea. Sustained-release urea-fed lambs performed better than control and urea-fed lambs and not significantly different from lambs receiving cottonseed meal-containing rations.

PR-2633

Influence of Clomiphene On Certain Reproductive Phenomena Of Sheep

Maurice Shelton

Difficulties have been experienced in working with gonadotrophins to stimulate artificial reproduction in sheep. Because of these and other difficulties, the gonadotrophins have received only limited use in the field of human medicine. However, a totally different drug (clomiphene) of synthetic origin has received widespread use in the treatment of infertility in humans. Thus, it seems of interest to look at the effect clomiphene has on the reproductive performance of sheep. Extensive literature is available pertaining to this drug, but most reports are concerned with laboratory animals or clinical studies with humans. The general interpretation is that, at low level, this material acts as an estrogen and has a stimulating action on the gonadotrophin producing fraction of the pituitary. At higher levels, it tends to have the opposite effect of inhibiting pituitary secretion of gonadotrophins. Thus, dose level is very critical, and little information is available on which to base studies with sheep. The drug, as normally used, consists of a mixture of two optical isomers (A and B), and at the time of initiation of these studies, it was not clear which was physiologically active.

Experimental Procedure

Trial 1. The first trial was designed to evaluate the effect of the two isomers on certain reproductive phenomena of ewes. This first trial was initiated June 1, 1967, and involved mature fine-wool ewes which had been purchased at a local auction. At that time of the year, the majority of the ewes involved appeared to be in a lactation or seasonal anestrus. The treatments consisted of daily intramuscular injections for a period of 16 days. The drug levels employed and some of the results obtained are shown in Table 9. This table contains a number of points of interest. The ewes involved were in poor condition, and all gained weight during the treatment period. However, it appeared that the two higher levels of both isomers tended to reduce animal gains. During the progress of the study, it appeared that some degree of udder development was occurring, and at the end of the injection period, the degree of udder development was scored on a 0-3 basis (4 score units). These data show that isomer B caused some increase in

TABLE 9. INFLUENCE OF ISOMER A AND B OF CLOMIPHENE ON CERTAIN REPRODUCTIVE PHENOMENA OF EWES[1]

Treatment	Number ewes	Body weight change during treatment, (pounds)	Udder score, (0-3 basis)	Number in estrus during treatment	Number in estrus 21 days post treatment	Number lambing	Average lambing date
Control	12	+ 12.3	0.4	0	7	9[2]	12-2-67
.03 mg/kg Isomer A	5	+ 16.0	0.4	0	5	4	11-18-67
.09 mg/kg Isomer A	5	+ 12.8	0.4	1	4	4	12-9-67
.27 mg/kg Isomer A	5	+ 12.2	0.6	0	3	4	12-17-67
.81 mg/kg Isomer A	5	+ 9.6	1.8	0	1	5	12-16-67
.03 mg/kg Isomer B	5	+ 14.8	1.2	2	2	5	12-20-67
.09 mg/kg Isomer B	5	+ 13.8	2.0	3	1	3	12-25-67
.27 mg/kg Isomer B	5	+ 15.4	1.4	1	0	3	1-20-68
.81 mg/kg Isomer B	5	+ 7.6	1.0	0	1	1	2-2-68

[1]All injections were made for a period of 16 days beginning June 1, 1967. Control sheep received a sham injection of sterile diluent. Vasectomized rams were run with ewes during injection period followed by fertile intact rams beginning on the date of last injection. Estrual periods were checked for only 21 days after treatment was terminated, but intact rams remained with ewes throughout summer and early fall.

[2]One ewe in the control group was lost prior to lambing.

TABLE 10. ISOMER A OF CLOMIPHENE INFLUENCE ON REPRODUCTIVE EFFICIENCY OF CYCLING FINE-WOOL EWES

Treatment	Number ewes	Body weight change during treatment, (pounds)	Udder score[1]	Percent showing estrus		Lambing results		
				During treatment	6 weeks post treatment	Percent lambing	Lambing rate[2]	Lambing date
Control	19	+ 9.8	.47	60	89.4	76.5	1.18	3-19-68
0.17 mg Isomer A	19	+ 11.8	.34	55	85.0	80.0	1.31	3-26-68
0.50 mg Isomer A	20	+ 11.6	.50	70	100.0	83.3	1.47	3-21-68
1.50 mg Isomer A	20	+ 10.9	.50	60	90.0	73.7	1.36	3-24-68
4.50 mg Isomer A	18	+ 10.6	.61	45	90.0	77.8	1.29	3-26-68

[1]Udder scores were assigned as in the previous trial.
[2]Number of lambs born per ewe lambing.

udder development at each level employed, but isomer A appeared to cause udder development only at the higher levels. Six of the 20 ewes receiving isomer B were marked by vasectomized rams during the injection period. These ewes were laparotomized, and none were found to have ovulated. This, along with the udder development which occurred, indicated that this material was acting as an estrogen at the level employed. The occurrence of post-treatment estrus along with the number of ewes lambing and the lambing date indicate that isomer B definitely adversely affected reproductive performance. The only suggestion of a beneficial influence is the earlier lambing date for the animals receiving a low level of isomer A, but with the small number involved, these differences are not statistically significant. Essentially, all parturitions involved single births (both control and treatment groups); thus no influence on lambing rate was indicated.

Trial 2. Due to the generally adverse results obtained with isomer B, this drug was dropped from subsequent trials. However, it seemed of interest to take a further look at the influence of isomer A. In the second trial, this was done by using cycling mature fine-wool ewes during the breeding season. The ewes involved had been checked with a vasectomized ram, and approximately 90 percent were cycling prior to the start of the experiment. A 16-day injection period was employed from October 1 to 15, inclusive. The drug levels employed were the same as used in the first trial with the exception that all dose calculations were based on the mean weight of the groups and were not calculated for each individual ewe. The treatments employed and some of the results obtained are shown in Table 10. These results do not show marked evidence of an effect on body weight gains or udder development. Likewise, there is no clearcut evidence that isomer A affected cycling, since most ewes continued to cycle during and subsequent to treatment. There is a thread of evidence seen throughout all the variables studied that the 0.50 mg. level employed favorably affected reproductive performance. This is shown in a larger percent of the ewes cycling, a larger number lambing and a higher lambing rate. However, these differences are not statistically significant.

Trial 3. Trial 3 was conducted to investigate further the suggestion from Trial 1 that isomer A of clomiphene was beneficial in stimulating mating of anestrual ewes. This trial was initiated May 29, 1968, utilizing crossbred yearling ewes (Suffolk or Columbia sired lambs out of fine-wool ewes). These had been checked by vasectomized rams for approximately 30 days prior to the initiation of the trial. Approximately only one-third were found to be cycling prior to start of injection. Treatment consisted of daily injections of isomer A for 16 days. The dosage employed and some results obtained are shown in Table 11. Fertile rams were placed with the ewes on the last day of injection and remained with them throughout the summer. Lambing data have been calculated for only a 6-week breeding season.

Treatment differences as shown in Table 11 are not statistically significant. However, it is clearly evident that no favorable response was obtained from the treatments employed. From these limited data, it is not clear whether an adverse effect is evident.

TABLE 11. INFLUENCE OF ISOMER A OF CLOMIPHENE ON REPRODUCTIVE BEHAVIOR OF ANESTRUAL YEARLING EWES

Treatment	Number ewes	Body weight change, (pounds)	Percent in estrus in 30 days post treatment	Percent lambing from 6-week mating period
Control	10	+0.9	80.0	60.0
Isomer A .003 mg/kg	10	—2.3[1]	70.0	50.0
Isomer A .01 mg/kg	9	+1.3	77.8	55.6
Isomer A .03 mg/kg	11	+0.8	54.5	50.0
Isomer A .09 mg/kg	10	+0.5	60.0	44.4

[1]One ewe in this lot lost 31 pounds apparently as a result of some unobserved illness.

Summary

Three experiments have been conducted to study the influence of isomer A and B of clomiphene on reproductive performance of ewes. These studies have clearly shown that the two isomers act differently in sheep. The primary evidence of this is a marked estrogenic effect of isomer B resulting in an unfavorable influence on reproductive performance. These limited studies have failed to show any consistent beneficial results from the use of clomiphene with sheep.

Acknowledgment

These studies were partially supported by Hess and Clark, Ashland, Ohio.

PR-2634

Fringed Tapeworm Control In Market Lambs

J. W. Menzies, W. T. Hardy
and L. B. Merrill

It has long been thought by the lamb feeding industry that fringed tapeworms *(Thysanosoma actinoides)* cause death losses and losses in production and production efficiency in market lambs. It is also theorized that fringed tape worms will block the bile duct, causing an abnormal environment to be set up in the intestines and thereby contributing to lowered efficiency and possibly to entero-toxemia losses.

There is a definite economic loss at the slaughter level due to fringed tape worms contaminating the liver and resulting in liver condemnations and, consequently, in lowered income.

Experimental Procedure

Two hundred thirty-one lambs from a known infested area were divided at random into 3 groups of 77 head each. Group 1 (control) did not receive any medication. Group 2 received 1 ounce of Di-Phenthane 70[1] at the recommended level, following a 24-hour fasting period. The lambs were not given feed for an additional 3 hours after dosage. Group 3 received the same treatment as did Group 2, plus a vaccination of *Clostridium perfringens* Type D bacterin 4 days later.

The three groups of lambs were self-fed three rations, ending with a 63 percent milo ration, and all environmental conditions were kept as even as possible with the exception of the treatments.

The lambs were self-fed until they reached market weight, 90 to 100 pounds. They were then taken to Armour and Company, Inc., San Angelo, where they were slaughtered and liver condemnations were recorded.

Results

Table 12 reveals that there was a non-significant reduction (2.6 percent combining Groups 2 and 3) in fringed tapeworm infestations due to the recommended treatment with Teniatol.

Price and Hardy's (1953) results correspond with this trial's results in that there was little to no reduction in fringed tapeworm populations at the currently recommended dosage. Some diarrhea was noted in both trials at the recommended dosages.

Price and Hardy (1953) also found that a dosage rate of 0.25 gram per pound body weight (sufficient to partially eliminate fringed tapeworms) produced moderate to severe diarrhea, some death loss and liver damage. The dosage level recommended on the label and given in this trial was at the rate of 0.128 gram per pound of body weight. Therefore, it appears that an increase in the dosage rate will not be feasible due to increased toxicity and lack of a sufficient reduction in the infestation.

This trial indicated significant reduction in average daily gain and, consequently, in feed efficiency in the treated groups. This was probably caused by a combination of factors rather than by the Di-Phenthane-70 alone. These factors would include the fasting period (total of 27 hours), the toxicity of the Di-Phenthane-70 and the slight diarrhea caused by

[1]This drug is marketed by Pitman Moore Company under the trade name Teniatol and contains 15 percent Di-Phenthane-70 (2,2' methylene bis (4-chloraphenal)). The product was used in these studies at the rate of 1 ounce per 70-pound lamb (4.5 grams of active ingredient).

TABLE 12. INFLUENCE OF TREATMENT FOR FRINGED TAPEWORMS ON DRYLOT PERFORMANCE OF MARKET LAMBS

	Number of lambs	Average daily gain	Feed per 100 pound gain	Percent liver infes-tations at slaughter	Entero-toxemia	Losses, calculi
Group						
1 (Control)	77	.460	6.59	48.7	3	1
2 (Teniatol)[1]	77	.388	8.13	41.6	3	2
3 (Teniatol + vaccine)[2]	77	.388	8.06	50.6	0	2

[1]Each animal (70 pounds average) was treated with 1 ounce of Teniatol.

[2]Each animal was treated with 1 ounce of Teniatol plus an entero-toxemia Type D bacterin vaccination.

the Teniatol and/or possibly by the fasting period followed by full feeding.

In this trial, there appeared to be no interaction between fringed tapeworm infestation and entero-toxemia losses. The results, Table 12, reveal that a vaccination of *Clostridium perfringens* Type D bacterin completely eliminated losses from entero-toxemia (even though the lambs carried a 50 percent infestation of tapeworms) compared to a 4 percent death loss in the two unvaccinated groups.

Summary

The recommended dose (1 ounce per 70-pound lamb) of Di-Phenthane-70 did not significantly reduce fringed tapeworm infestation in market lambs. The dosage level apparently cannot be safely raised because of the toxic effects on the animal. The Teniatol-treated lambs gained slower and less efficiently than did the non-treated lambs. This was possibly due to three factors: the fasting period, the Teniatol and the resulting slight diarrhea. Vaccination against entero-toxemia resulted in freedom from death losses from this disease.

Acknowledgment

The contribution by Armour and Company, San Angelo, of both facilities and assistance in obtaining the needed slaughter information is gratefully acknowledged.

Literature Cited

Price, D. A. and W. T. Hardy. 1953. Activity of certain drugs against the fringed tapeworm. J. of the Amer. Vet. Med. Assn. 122:912, p. 216.

PR-2635

Coccidiosis in Angora Goats

Maurice Shelton

Most Angora goats at some time show evidence of coccidia infections and seem to be more susceptible to this parasite than other species of farm or ranch livestock. Under most conditions, these chronic infections are not considered to adversely affect the animal to a degree to justify treatment. However, the continued presence of a low level of oocysts in the droppings provides an ever present source of infection, and acute coccidiosis can develop in times of stress. This more commonly occurs with kid goats at or near weaning age in early fall. The primary route of infection is through contamination of feed or water with fecal material. Thus, prevention of this contamination is an important sanitary measure. However, as most producers are aware, this is difficult with kid goats especially when they are confined to drylot or to small areas. In commercial practice, goats are seldom confined to drylot, but even though they may be in large pastures, they may spend a large part of their time around water, shade or feed troughs and thus in effect approach confinement conditions. This is especially true when they may be unthrifty for a reason such as coccidiosis.

Symptoms

The symptoms of acute coccidiosis are commonly unthrifty appearance, poor performance, some evidence of fever and abdominal pain and diarrhea (usually dark in color). Goats seldom have bloody discharge in natural infections. At autopsy, some enteritis may be present along with yellowish-white spots on the surface of the intestines. It is not unusual to see 20 - 40 percent of kid goats showing evidence of coccidiosis with mortality rates in the range of 10-20 percent.

Treatments

It has been recognized for some time that the sulfa drugs (especially sulfaquinoxaline) are effective in combating coccidia. The generally recommended methods of administration have been to add the drugs to the drinking water (½ ounce of sulfaquinoxaline per gallon of drinking water) or repeat daily drenching for a period of 3 to 5 days. It should be realized that no treatment will result in dramatic early recovery in cases of severe or prolonged infections because the animals may be off feed or the lining of the intestines may be sufficiently damaged to interfere with nutrient absorption or utilization.

Experimental Procedure

Those facts suggest that prevention may be of more importance than treatment, and as previously suggested, sanitation is apparently an important means of prevention. When treatment becomes necessary, the addition of medication to the drinking water or repeat daily drenchings are difficult to apply under commercial range conditions. Thus, the present series of studies were undertaken to determine if low-level feeding or a single drenching of a coccidiostat might be an effective means of preventing acute coccidiosis. Evaluations were based on oocyst counts in the feces along with any observations or animal performance, death losses or clinical coccidiosis.

Two feeding trials have been conducted with kid goats at weaning to test the effectiveness of low-level feeding of potential coccidiostats on the development of the disease. In order to control feed intake and to enhance the likelihood of clinical coccidiosis, both studies were conducted in drylot. The following ration was fed in both trials:

	Percent
Sorghum hay	40
Alfalfa hay	10
Sorghum grain	30
Cottonseed meal	17
Urea	1
Bone meal	1
Trace mineral salt	1

The following treatments were imposed:

Lot 1—Basal ration only

Lot 2—Basal + sulfaquinoxaline at rate of .015 percent (136 grams per ton)

Lot 3—Basal + amprolium at rate of 200 milligrams per pound of feed (400 grams per ton)

Lot 4—Basal + sulfur at 0.75 percent of ration (15 pounds per ton)

The choice of drugs and level of use, somewhat empirically chosen, were based on limited information available. The same treatments were applied to recently weaned billy kids in both trials. One trial was conducted from July 21 to August 10, 1966, and the second from August 23 to October 19, 1968. The results are shown in Tables 13 and 14.

No cases of clinical coccidiosis occurred in any of the lots involved in either of these trials. However, the oocyst counts indicate that a substantial level of infection was present. The differences in body weight gains were not statistically significant and were not consistent between the two trials. Some trends in level of oocyst discharge were evident. The first of these was that the numbers or concentrations of oocysts being discharged were initially markedly reduced as a result of putting the animals on feed in dry lot. After the animals had been in the pens for a time, the counts of oocysts per gram began to increase, and both trials appeared to have been terminated before the peak oocyst discharge was reached. This was clearly a case of experimental error, but in each case the final count and data tabulation occurred only after the animals had been removed from experimental lots. It appears from these data that all the drugs employed had some effect in limiting the build-up of coccidia, and this effect would appear to be adequate to prevent clinical coccidiosis. In the first trial, all three drugs appeared to be of value in reducing oocyst counts. However, in the second trial, sulfaquinoxaline at the level used appeared to be somewhat less satisfactory than either sulfur or amprolium. It is evident from these studies that none of the drugs adversely affected the animals. At the present time, the cost of the drugs in question might prohibit their routine use with kid goats, but when prices for mohair or replacement goats are more favorable, the use of these drugs should be considered when coccidiosis outbreaks are to be anticipated. The drug levels (on percentage basis) utilized in this study would be suggested only where complete ration control was possible as in drylot. When fed only as a part of a supplement, the levels should be increased accordingly. In this study, the kids consumed and wasted the ration at the approximate rate of 4 percent of their body weight.

The drug levels utilized here are suggested only as potential preventive measures. In one limited trial, the same ration additives were utilized with kids that were already in very poor or weak condition and showing obvious symptoms of clinical coccidiosis. The drugs used appeared to have no marked effect on rate of recovery.

Certain anthelmintics have been advertised or suggested as a possible treatment for coccidiosis. In several instances, as a part of other studies, oocyst counts were made before and after drenching with various anthelmintics. Some of the results are shown in Tables 15 and 16. From these there is no real evidence that any of the commonly used anthelmintics

TABLE 13. RESULTS OF FEEDING COCCIDIOSTATS TO BILLY KIDS AT WEANING (TRIAL 1), 1966

Lot number	Treatment	Number kids	Initial weight, July 21	Final weight, Aug. 10	Body weight, change	Oocyst counts (per gram)		
						July 21	Aug. 1	Aug. 10
1	Control	12	46.9	51.7	+4.8	31,500	4,150	17,700
2	Sulfaquinoxaline	12	51.5	51.6	+0.1	33,450	4,625	6,436
3	Amprolium	12	50.0	52.8	+2.8	39,666	2,225	7,560
4	Sulfur	12	45.2	49.3	+4.1	54,200	4,100	7,260

TABLE 14. RESULTS OF FEEDING COCCIDIOSTATS TO BILLY KIDS AT WEANING (TRIAL 2), 1968

Lot number	Treatment	Number kids	Initial weight, Aug. 23	Final weight, Oct. 19	Body weight, change	Oocyst counts (per gram)			
						Aug. 23	Sept. 12	Oct. 2	Oct. 19
1	Control	10	43.2	54.7	+11.5	2,500	1,760	14,410	7,560
2	Sulfaquinoxaline	10	42.9	54.6	+11.7	1,025	370	9,900	41,800[1]
3	Amprolium	10	43.0	59.6	+16.6	1,012	344	820	1,060
4	Sulfur	10	43.2	60.7	+17.5	2,067	410	3,600	4,400

[1]The high value in this lot is due to one individual animal which had an unusually high count (159,000). On the last two dates for this second trial fecal oocyst counts were made for only one-half the kids in each lot.

TABLE 15. INFLUENCE OF DRENCHING WITH CERTAIN ANTHELMINTICS ON OOCYST COUNTS OF DOE KIDS

	TRIAL 1			TRIAL 2		
		Oocysts per gram			Oocysts per gram	
Treatment	Number animals	Prior to drench	After drench	Number animals	Prior to drench	After drench
Control	10	13,200	16,860	5	1,288	9,750
Tox-I-Ton	9	10,267	11,056	4	975	3,833
Rulex	9	10,500	12,771	5	1,100	14,800

had any significant effect on coccidia as indicated by oocyst discharge.

As pointed out earlier, the standard recommendation for treatment for coccidiosis consists of repeated daily drenching (3 to 5 days) with sulfaquinoxaline. However, the question is occasionally asked whether a single drench has any value and whether it can be mixed with or done at the same time as drenching with commonly used anthelmintics. Two studies along this line have been conducted using amprolium and sulfaquinoxaline in combination with various drenches. The first study involved a small number of doe kids which were showing signs of clinical coccidiosis. The results are shown in Table 17. With the small numbers involved, the results are erratic and nonsignificant. However, there appears to be some suggestion that both treatments affected oocyst discharge, and based on the limited data available, the amprolium appeared to exert a greater beneficial influence.

TABLE 16. INFLUENCE OF DRENCHING WITH CERTAIN ANTHELMINTICS ON OOCYST COUNTS OF DOE KIDS

Treatment	Number animals	Oocyst per gram: Pre-drench	Oocyst per gram: After drench
Control	7	3,767	1,067
Phenothiazine	7	1,517	3,100
Thiabenzole	8	1,721	3,331
Loxon	8	3,271	1,956

TABLE 17. INFLUENCE OF A SINGLE DRENCH WITH SULFAQUINOXALINE OR AMPROLIUM ON OOCYST DISCHARGE OF KID GOATS

Treatment	Number animals	Oocysts per gram: Initial	Oocysts per gram: Final	Change
Control	2	20,700	88,200	+ 67,500
Sulfaquinoxaline[1] 2.5 grams	6	52,950	60,550	+ 7,600
Amprolium[1] 2.5 grams	6	111,900	53,640	— 58,260

[1]Each coccidiostat was used in combination with phenothiazine, Tox-I-Ton and Thiabenzole drench with two animals per subgroup. There appeared to be no interaction between the various drugs, and thus the results are grouped for presentation.

TABLE 18. INFLUENCE OF DRENCHING WITH COCCIDIOSTATS ON OOCYST DISCHARGE OF KID GOATS

Treatment	Number animals	Oocysts per gram: Initial	Oocysts per gram: Final
None	26	2,563	2,428
Sulfaquinoxaline	14	2,068	327
Amprolium	12	2,308	519

In one additional trial, a group of weaning age doe kids were drenched with various combinations of anthelmintics (phenothiazine, thiabenzole and Loxon) and coccidiostats (sulfaquinoxaline and amprolium). Again there appeared to be no interaction between the two classes of drugs, and thus only data relating to the coccidiostats are reported. Because of limited evidence of effectiveness in the previous trial, increased dosage was employed in the second. Initially 6 grams of sulfaquinoxaline per head were used in the form of a 20 percent solution. This level proved toxic as five of 18 goats so treated died. The level was subsequently reduced to 4 grams. Amprolium was used throughout at the rate of 50 milligrams of a 20 percent solution. The results are shown in Table 18. It will be evident from these data that this group of animals did not apparently harbor a heavy load of coccidia. However, both treatments markedly and significantly reduced oocyst discharge. It should be remembered that some toxicity problems were encountered with the sulfaquinoxaline at the levels employed, and further work needs to be done to determine appropriate dosage of both drugs. There was no evidence of a harmful effect from amprolium, but the large volume employed makes it impractical to administer as a part of the same operation as drenching with a regular anthelmintic. From these data it appears that a single drenching does have an effect on coccidia in the alimentary tract, but it is not clear from this if the single drench would prevent the development of clinical coccidiosis.

Acknowledgment

These studies were partially supported by Merck, Sharp and Dohme Research Laboratories, Rahway, New Jersey.

PR-2636

Cutability of Lamb Carcasses Grouped According To Proposed Yield Grades

Z. L. Carpenter and W. M. Oliver

Several earlier studies of lamb carcass cutout have shown that there is approximately $10 per hundredweight of carcass difference in the value of the yield of retail cuts from US Choice and US Prime carcasses. It is recognized that the present carcass grade standards are questionable in reflecting differences in quality and cutability attributes. Previous data have confirmed that carcasses possessing the same weight and grade differed widely in their yields of trimmed retail cuts. Therefore, it was logical to assume that yield grades, based upon cutability concepts, would make a definite contribution to more efficient marketing. These previous studies have shown conclusively that differences in cutability resulted primarily from differences in fatness on the outside of the carcass and from fat deposited in the body cavity, mainly around the kidneys and in the pelvic area. It was also found that variations in leg conformation affected the yields of the salable cuts and that, among lambs of the same degree of fatness, those that had higher conformation grades had slightly higher yields of retail cuts. On the basis of these findings, an equation for predicting the yields of major boneless, closely trimmed retail cuts was developed. This was subsequently adapted to a system of experimental yield grades. It was, therefore, the purpose of this study to carefully appraise the merit of the proposed lamb carcass yield grade system.

Experimental Procedure

The proposed yield grades were developed on the basis of the following equation:

Estimated percent yield of boneless closely trimmed retail cuts from leg, loin, rack and shoulder = 47.80 − (11.8 × adjusted fat thickness over center of ribeye, inches)

+ (0.09 × leg conformation grade code, 1-15, with high Prime coded 15, Prime 14, and so on)

− (0.44 × percent kidney and pelvic fat)

Based upon this equation, a system was developed which included five yield grades. The proposed formula for yield grade is as follows:

Yield grade = 1.66 − (0.05 × leg conformation grade code)

+ (0.25 × percent kidney and pelvic fat)

+ (6.66 × adjusted fat thickness over center of ribeye, inches)

TABLE 19. ESTIMATES OF BONELESS MAJOR CUT YIELDS FOR EACH PROPOSED YIELD GRADE

Yield grade	Yield of boneless major cuts, percent
1	47.3 and over
2	45.5 to 47.2
3	43.7 to 45.4
4	41.9 to 43.6
5	less than 41.9

Each yield group is determined in such a manner that a range of 1.77 percent major boneless cut yield is available for each of the yield grades. Table 19 lists the expected yield of boneless major cuts for each yield grade.

Based upon the preceding studies and proposed standards, a test was designed for evaluation of the proposed standards. One hundred lambs were randomly selected and identified for slaughter. Three evaluators independently scored each lamb for estimated yield grade. Following live evaluation, the lambs were slaughtered and subsequently graded according to the yield standards. Fifty of the carcasses were then selected for retail cutting tests following normal retail fabrication procedures.

An additional 69 lambs were evaluated alive by four evaluators. The carcasses were yield graded. However, cutting tests were not performed on this particular group of carcasses.

Results

A comparison of the live yield grade estimates with actual yield grade data is presented in Table 20. It should be pointed out that 65 to 75 percent of the carcasses were assigned the correct yield grade. Some improvement in accuracy was attained in the second test. In fact, over 80 percent of the lambs were assigned within ± 0.3 of the correct yield grade. This means that some lambs considered to be borderline carcasses were not assigned the correct yield grade and that 94 - 98 percent of the lambs were assigned within one entire grade of the correct carcass yield grade designation. These data substantiate the fact that live lambs can be rather accurately evaluated for estimated cutability when identified according to these criteria.

TABLE 20. COMPARISON OF LIVE ESTIMATES WITH LAMB CARCASS YIELD GRADES

Evaluator	Simple correlation coefficients Test 1 number, 100	Test 2 number, 69
1	0.77	0.79
2	0.65	0.70
3	0.61	0.74
4		0.64

TABLE 21. MEANS FOR VARIOUS TRAITS FOR EACH YIELD GRADE

Yield grade	Carcass weight, pounds	Major bone-in cuts, percent	Fat trim, percent	Retail carcass value per hundred-weight, dollars	Estimated yield grade	Actual yield grade
1	43.1	71.5	6.7	84.19	1.8	1.6
2	45.8	69.3	10.0	81.77	2.8	2.4
3	50.6	66.8	13.3	79.92	3.6	3.3
4	53.5	63.8	16.0	76.00	4.6	4.5
5	65.0	61.5	19.8	73.08	5.3	5.3

The yields of salable cuts for each of the yield grades are presented in Table 21. This cutting test confirmed previous findings that indicated wide differences in yields of retail cuts, in trimmable fat and in retail value among carcasses. For instance, a difference of $13 per hundredweight in retail value was found between the highest and lowest yielding carcasses within the US Choice grade. It should be noted that only four carcasses were observed in yield grade 5 in this test; therefore, there is some possibility of bias in this particular yield group. An evaluation of the differences between the means of various yield grades is included, Table 22. These data indicate that differences in retail cut yields and retail carcass value can be rather accurately reflected by the yield groups utilized in this study. This is especially true if carcasses are quite variable in contributory traits. There exists a need for a detailed study of carcasses possessing narrow limits of these important cutability factors.

Summary

It has been suggested that a single method will probably not be completely acceptable for estimating cutability of lamb carcasses differing in physiological growth, conformation and general carcass characteristics. However, for a marketing system, a rather uniform single method must be utilized. It is certainly felt that only minor emphasis should be given to previously used subjective measures of conformation and quality.

It seems that the possibility of yield grading could emphasize the very important measure of weight of edible meat per day of age as a reasonable goal for the producer. This trait should be emphasized since it combines production and cutability and, consequently, should improve palatability and consumer attitudes toward lamb. Information relative to physiological growth, genetic antagonisms, palatability, heritabilities and merchandising will undoubtedly lead to changes in the specifications for the lamb carcass that will be most desirable for all segments of the industry including the consumer.

The main advantage of this type of grading system is that it provides a more accurate method for market identification of lamb carcasses. The ultimate goal of this identification would be to transmit proper values to the producer or feeder of lambs which will be difficult to achieve. The packing industry will be able to incorporate these particular standards into its operations and can accurately appraise live lambs for their cutability grades.

TABLE 22. DIFFERENCES BETWEEN THE MEANS OF VARIOUS TRAITS FOR THE YIELD GRADES

Between yield grades	Percent major bone-in cuts	Percent trim fat	Retail carcass value hundred-weight, dollars
1 and 2	2.22	3.23	2.42
2 and 3	2.46	3.38	1.85
3 and 4	3.06	2.62	3.92
4 and 5	4.26	3.86	2.92
1 and 4	7.74	9.23	8.19
1 and 5	10.00	13.09	11.11

Acknowledgment

This study was conducted in cooperation with Armour and Company, Inc.; Safeway Stores, Inc.; American Sheep Producers Council, Inc.; Standardization Branch, Livestock Division, Consumer and Marketing Service, USDA; and the Texas Sheep and Goat Raisers' Association.

PR-2637

Effects of Fatness and Carcass Weight Upon Transit Shrinkage Of Lamb Carcasses

Z. L. Carpenter, G. T. King
and D. G. Koenig

Shrinkage and possible deterioration in color and appearance are of major concern in shipment of carcasses from point of slaughter to major retail distribution areas (East Coast, Great Lakes, West Coast). The effects of fatness and carcass weight upon transit shrinkage have not received a great deal of attention. It has been suggested that a moderately thick fat covering is necessary to prevent product dehydration and associated deteriorative changes that may reduce consumer acceptance and shelf-life of the product. Since excess fatness drastically reduces proportionate retail value of lamb carcasses, it is necessary to establish the relative merit of fatness in reduction of shrinkage. Therefore, the objectives of this study were as follows: (1) to obtain shrinkage values for lamb carcasses of various weight groups and various external fatness groups; (2) to visually inspect thinly finished carcasses shipped from the Southwest to the East Coast to determine the possible dehydration and surface deterioration; and (3) to obtain customer reaction to carcasses differing in finish and muscling.

Experimental Procedure

A total of 168 lamb carcasses were selected 24 hours following slaughter. The following data were recorded for each carcass: weight, finish group, fat thickness, conformation grade, leg muscling score, USDA grade, estimated kidney fat and sex. Carcasses were selected in four weight groups (less than 36 pounds, 36-46 pounds, 46-51 pounds and over 51 pounds) and three finish groups (A, less than 0.1 inch fat thickness; B, 0.1-0.3 inch and C, 0.3 inch and over). In San Angelo, carcasses were loaded onto a refrigerated trailer-truck along with 532 regular lamb carcasses normally comprising a similar shipment. The carcasses arrived on the East Coast 4 days following slaughter and were weighed. Six days following slaughter the carcasses were evaluated for appearance and desirability. Upon arrival, the trailer temperatures were 33° F., rear; 35° F., middle; and 34° F. at the nose of the trailer. Test carcasses were individually weighed while the other carcasses were group weighed. A retail buyer (selector of carcasses) provided some verbal observations relative to the desirability of the test carcasses.

It should be kept in mind that this study was a single test and therefore should be interpreted as such. Certainly, these results cannot be interpreted to be final and unalterable, as many shipments under varied conditions must be studied and carefully analyzed.

Results and Discussion

The distribution of selected carcasses is presented in Table 23. It should be noted that equal distribution according to weight group and finish level was not attained. Therefore, trends in these data as presented will be discussed. Average shrinkage values for the test carcasses are included in Table 24. Shrinkage was determined by dividing the weight loss, computed at the end of the trip, by the weight in San Angelo. It appears that the very lightweight, thinly finished carcasses sustained greater shrinkage than other test lots. There appeared to be no large differences or trend in shrinkage for the other finish groups with the exception that the lighter weight groups tended to have somewhat higher shrinkage values. When considering the carcass population available for shipment, these data suggest little difference in shrinkage due to variations in fat thickness for weight ranges of carcasses usually demanded.

TABLE 23. DISTRIBUTION OF TEST CARCASSES ACCORDING TO WEIGHT AND FAT THICKNESS

Weight group	Finish groups A (<0.1 inch)	B (0.1-0.3 inch)	C (>0.3 inch)
1. (< 36 pounds)	20	19	1
2. (36-46 pounds)	20	20	8
3. (46-51 pounds)	20	20	10
4. (> 51 pounds)	6	20	4

TABLE 24. AVERAGE SHRINKAGE VALUES FOR TEST CARCASSES

Weight group	Finish groups A (<0.1 inch) percent	B (0.1-0.3 inch) percent	C (>0.3 inch) percent
1. (<35 pounds)	4.08	3.43	
2. (36-46 pounds)	2.08	3.56	2.01
3. (46-51 pounds)	1.93	2.41	2.04
4. (>51 pounds)	2.44	1.62	1.82

It is generally assumed that less mature carcasses have a greater proportionate amount of moisture in the tissues (lean and fat). Therefore, this possibly explains the relatively high shrinkage values for the lighter weight groups. In addition to shrinkage observations, the test carcasses were visually evaluated relative to carcass dehydration and deterioration. All carcasses were of desirable condition relative to shipability and were not discolored or dehydrated. Therefore, these limited data suggest that degree of finish is relatively minor in relation to shrinkage and deterioration of lamb carcasses.

Discussions with and observations of a chain store representative during selection of carcasses were of interest. Carcasses were selected on the basis of grade, cutability, muscling and weight. It was suggested that the maximum carcass weight allowable was 51 pounds. However, a number of trim, muscular carcasses weighing over 51 pounds were selected. It was further suggested that poorly muscled carcasses having less than 0.1 inch fat will not have a desirable length of retail shelf-life. Research evidence is not available to support or refute this suggestion. Therefore, with the knowledge that trim, muscular high-cutting carcasses are in demand, it is essential that the retail shelf-life properties be investigated.

Acknowledgment

Appreciation is extended to Armour and Company, San Angelo, Chicago and Boston, for assistance in the study.

PR-2638

A Survey of the Lamb Carcass Population—Southwest And West Coast

Z. L. Carpenter

The increasing pressure of world population and the need to raise living standards have made the production of increased amounts of acceptable quality meat an important issue. Practically all marketing agencies are reporting lower live and carcass prices for heavy weight lambs. Therefore, it seems logical that efforts should be made to determine whether there is justification for this discrimination. Possible reasons for this discrimination are that (1) traditionally, light weight lamb carcasses in the 40-51 pound range have been preferred by retail organizations, and (2) it has been suggested that heavy weight lamb carcasses generally possess excess fat and require extra trimming, thus increasing the labor costs per pound of retail cuts and reducing the retailer's price margin.

On the other hand, certain factors prove advantageous to the heavy weight lamb carcasses. Since one of the most preferred cuts of the lamb carcass is the loin, and since the relationship of carcass weight to the *longissimus dorsi* area is positive, heavier weight lamb carcasses possess a larger *l. dorsi* muscle than do lighter weight lamb carcasses. The consumer will discriminate against lamb loin cuts that possess a small area of *l. dorsi* muscle. Therefore, heavy weight lamb carcasses have an advantage in this respect. Because of the present trend for producers to select for rapid gains and efficiency of production which possibly favor the production of heavy weight lambs, the availability and merit of heavy weight lambs to the market should be carefully determined and appraised.

The goal of this study has been to determine as many of the factors contributing to determinants of carcass price as possible. To accomplish this goal, full advantage has been taken of the earlier research results that appear to be pertinent to this study.

The specific objectives of the study are (1) to determine the availability and distribution of various weights of lamb carcasses, (2) to determine the economic value of lamb carcasses available to the various marketing channels, and (3) to determine the distribution of carcasses according to proposed yield grades.

Experimental Procedure

A survey of lamb carcasses available in nine commercial plants was conducted from July 1, 1967, through June 1968. Of 75,760 carcasses available, 4,992 on the West Coast and in the Southwest were evaluated to obtain data relative to the distribution of various weight groups of carcasses. Every 5th, 10th or 20th carcass, depending upon total numbers slaughtered, shipping schedule and personnel available, was measured as a sample of the population slaughtered at that particular time. The following data were obtained for each carcass evaluated: carcass weight, sex, USDA carcass grade, subjective leg and carcass conformation scores, estimated percent kidney fat, subjective visual finish scores (by use of seven photographs ranked in degree of finish), a fat-thickness probe between the 12th and 13th rib taken directly over the midpoint of the *l. dorsi* muscle, and body wall thickness. The body wall measurements were obtained at the 12th and 13th ribs at variable increments from the midline depending upon carcass weight (4.5 inches for 40 pound carcasses; 5.0 inches for 40-50 pound; 5.5 inches for 50-60 pound; and 6.0 inches for carcasses over 60 pounds). These data provide an indication of the variation within and differences between the weight groups selected within the limits of the specific experimental design. Average yearly distribution of various weights of carcasses was obtained from the commercial firms. Actual observation of carcasses on selected days during the period of study provided information relative to the number and proportion of carcasses considered to be extremely wasty as compared with those expected to be higher in retail value.

Estimated retail value of carcasses in the individual weight groups was obtained through utilization of the following regression equations:

1. (Carpenter *et al.*, 1967) Lb. of retail leg, loin, rack and shoulder = 3.753 + 0.597 (carcass wt., lb.) + 0.61 (carcass conformation) — 6.889 (single fat thickness over *l. dorsi*, in.) — 0.908 (estimated lb. kidney fat).
2. (Johnston *et al.*, 1967) Percent total salable boneless retail cuts = 37.68 — 1.57 (percent kidney fat) — 0.90 (finish group score).
3. (Field, 1967) Kg. of major semi-boneless retail cuts in one half of the carcass from the leg, loin, rib and shoulder = 0.849 + 0.278 (carcass wt., kg.) — 0.37 (bodywall thickness, mm.) — 0.044 (fat depth ¾ across *l. dorsi*, mm.).
4. (Field, 1967) Percent yield of major semi-boneless retail cuts from the leg, loin, rib and shoulder = 63.249 — 0.3147 (bodywall thickness, mm.) — 0.378 (fat depth ¾ across *l. dorsi*, mm.) — 0.580 (kidney fat, kg.).
5. (Johnston *et al.*, 1967) Percent total salable boneless retail cuts, including lean trim = 72.30 + 0.13 (leg conformation grade) — 1.59 (percent kidney knob) — 0.95 (finish group score).
6. (Oliver, 1967) Lbs. consumer cuts = 4.65 + 0.83 (carcass weight) — 3.34 (bodywall thickness) — 0.73 (percent kidney knob).
7. Percent boneless major cuts = 47.7976 — 11.7953 (rib probe, in.) + 0.0916 (leg conformation) — 0.4425 (estimated kidney and pelvic fat, percent).

TABLE 25. DISTRIBUTION OF CARCASSES EVALUATED ACCORDING TO CARCASS WEIGHT, SOUTHWEST

Carcass weight (pound)	Total Number	Total Percent
35 and under	118	7.3
36 - 40	318	19.5
41 - 45	524	32.3
46 - 50	303	18.6
51 - 55	173	10.6
56 - 60	95	5.8
61 - 65	62	3.8
66 and over	34	2.1
Total	1627	100.0

TABLE 26. DISTRIBUTION OF CARCASSES EVALUATED ACCORDING TO CARCASS WEIGHT, WEST COAST

Carcass weight (pound)	Total Number	Total Percent
35 and under	37	1.1
36 - 40	132	3.9
41 - 45	354	10.5
46 - 50	724	21.5
51 - 55	891	26.5
56 - 60	609	18.1
61 - 65	366	10.9
66 and over	252	7.5
Total	3365	100.0

8. Yield grade = 1.66 + 6.6640 (rib probe, in.) — 0.0517 (leg conformation) + 0.2500 (estimated kidney and pelvic fat, percent).

Results and Discussion

For the cutability and weight phase of the study, data from 4,992 lamb carcasses were obtained. These carcasses were obtained from the West Coast and Southwestern regions of the United States. In selection of these regions, consideration was given to the distribution of the lamb population and the availability of lamb abattoirs. The relative distribution of carcasses according to carcass weight can be observed in Tables 25 and 26 for the Southwest and West Coast regions, respectively.

Means for the various carcass measurements and the various estimates of cutability indicate a high degree of similarity in mean values for the two regions. The data indicate an average increase in fatness and, consequently, a decrease in cutability with increases in carcass weight. However, as will be evidenced later, the heavy weight carcass groups were extremely variable in fatness. Therefore, trim, high-cutting carcasses were available in the heavy weight groups.

Carcasses evaluated in the plant survey were grouped according to fat thickness (over the center of the loin at the 13th rib) and weight group. These data emphasized the variability in fat thickness within each of the weight group categories. Based upon these data, it seemed feasible to determine the relative distribution of carcasses meeting optimum fatness levels. The system used for this stratification is as follows: carcasses with 0.08 inch or less of fat thickness were considered under-finished; those with 0.12 to 0.3 inch were considered properly finished; and carcasses with 0.3 inch or more were considered overfinished. These fat-thickness determinants were established after consideration was given to the following specifications and standards. The American Meat Science Association published "Recommended Guides for Carcass Evaluation and Contests" at the 1967 Reciprocal Meat Conference. These guides list maximum fat thickness over the *l. dorsi* for highly desirable lamb carcasses, 50 pounds and under, at 0.25 inch and maximum fat thickness for highly desirable carcasses, 50 pounds and over, at 0.30 inch. The Industrywide Lamb and Wool Planning Committee specified a fat covering of 0.20 inch over the *l. dorsi*. Standards for carcass merit in lamb prepared by a committee of Western Regional Project W-61 state that 0.10 inch is the minimum amount of fat which a lamb carcass can possess and still be highly desirable. Finally, suggestions were taken from specifications for consumer preferred lambs.

The distribution of carcasses from the three fat thickness groups (under-finished, properly finished and overfinished) was evaluated within regions as shown in Table 27. Percentages were calculated for

TABLE 27. DISTRIBUTION OF CARCASSES ACCORDING TO FAT THICKNESS DESIRABILITY

Weight groups, pounds	Underfinished Southwest Number	Underfinished West Number	Properly finished Southwest Number	Properly finished West Number	Overfinished Southwest Number	Overfinished West Number
35 and under	27	25	89	12	2	0
36 - 40	22	66	270	63	26	3
41 - 45	21	103	429	234	74	17
46 - 50	9	124	235	520	59	80
51 - 55	2	60	115	636	56	195
56 - 60	1	10	55	376	39	223
61 - 65		3	32	195	30	168
66 and over	1	1	9	102	24	149
Total percent	5.1	11.6	75.9	63.6	19.1	24.8
Total carcasses	83	392	1234	2138	310	835

TABLE 28. PERCENTAGE OF CARCASSES CONSIDERED PROPERLY FINISHED, OVERFINISHED AND UNDERFINISHED

	West	Southwest
Properly Finished		
less than 55 pounds[1]	68.5	79.3
over 55 pounds	54.9	50.3
Overfinished		
less than 55 pounds	13.8	15.1
over 55 pounds	44.0	48.6
Underfinished		
less than 55 pounds	17.7	5.6
over 55 pounds	1.1	1.1

[1]Percentage figured as a total of the carcasses in the particular weight group within region.

the number of carcasses within each fat thickness group within each region. Table 27 shows the percentages within each fat thickness group while Table 28 includes the same stratification system but only two weight categories.

The low incidence of underfinished carcasses and the high proportion of overfinished carcasses in the heavy weight groups suggests that as carcasses increased in weight they possessed more finish. The relative percentages of both underfinished and properly finished carcasses varied little between the regions. In proportions of overfinished carcasses, the West Coast region exhibited a higher percentage of overfinished carcasses than the Southwest region.

Carcasses included in the survey were distributed according to the USDA proposed yield grades. These data for the Southwest and West Coast regions are presented in Tables 29, 30 and 31. It is noted that the West Coast carcass population contained 76 percent of the population in the top three yield grades. The relative percentage for the Southwest was 81 percent. It is significant to note that a relatively large number of the heavy weight carcasses were qualified for the yield grades 2 and 3.

Table 32 includes a sample that indicates the effects of carcass weight and cutability upon the economic value of the ovine carcass. The differences in retail value are small in terms of the general market discrimination against heavy lamb carcasses.

TABLE 29. YIELD GRADE DISTRIBUTION OF ALL CARCASSES EVALUATED IN SOUTHWEST AND WEST COAST SURVEY

Yield grade	West Coast Number	West Coast Percent	Southwest Number	Southwest Percent
1	141	4.19	17	1.05
2	1168	34.71	428	26.35
3	1248	37.09	868	53.45
4	633	18.81	275	16.93
5	175	5.20	36	2.22
Total	3365		1624	

TABLE 30. YIELD GRADE ACCORDING TO WEIGHT GROUP FOR ENTIRE YEAR—SOUTHWEST

Carcass weight, pound	Yield Grade 1	2	3	4	5
35 and under	11	64	41	2	
36 - 40	3	125	165	22	3
41 - 45	2	133	324	59	5
46 - 50	1	63	176	54	6
51 - 55		24	90	52	7
56 - 60		13	38	41	3
61 - 65		5	26	29	2
66 and over		1	8	16	10
Total	17	428	868	275	36
Percent of total	1.0	26.4	53.4	16.9	2.2

Summary and Conclusions

Data from 4,992 lamb carcasses, which represented a total population of 75,760 carcasses sampled, were analyzed. These carcasses were grouped according to fat thickness for a segregation of the carcasses into desirability. The low incidence of underfinished carcasses and the higher proportion of overfinished carcasses in the heavy weight groups suggest that as carcasses increased in weight they possessed more finish. However, a surprisingly high percentage of heavy weight carcasses were properly finished (65-70 percent). Therefore, carcasses must be identified on the basis of individual merit.

TABLE 31. YIELD GRADE ACCORDING TO WEIGHT GROUP FOR ENTIRE YEAR—WEST COAST

Carcass weight, pound	Yield Grade 1	2	3	4	5
35 and under	11	26			
36 - 40	29	78	22	2	
41 - 45	34	216	89	16	
46 - 50	43	366	244	66	6
51 - 55	19	285	404	154	27
56 - 60	5	133	257	178	38
61 - 65		47	153	120	46
66 and over		17	79	97	58
Total	141	1168	1248	633	175
Percent of total	4.2	34.7	37.1	18.8	5.2

TABLE 32. THE EFFECT OF CARCASS WEIGHT UPON THE VALUE OF LAMB

Traits	Light	Medium	Heavy
Mean weight	38.4	53.1	62.8
Total salable boneless cuts, percent[1]	71.63	70.29	69.64
Retail value of carcass per hundredweight	$89.54	$87.86	$87.05

[1]Means for weight and cutability percentage were taken from populations of 334, 791 and 316 for light, medium and heavy weight groups, respectively.

It is evident that the relative percentages of both underfinished and properly finished carcasses varied little among the West Coast and Southwest regions.

Relatively high correlation coefficients existed among all cutability estimates, final grade and conformation scores and between most of the estimates and their respective variables. These data revealed a positive correlation between carcass weight and carcass conformation scores. And since, usually, an increase in carcass conformation results in an increase in carcass grade, this increase in carcass conformation is an advantage for heavyweight lambs.

The availability of heavyweight lambs to the various marketing channels was relatively low in the Southwest region when compared to the high percentage of heavyweight lambs in the West Coast.

As previously mentioned, practically all marketing agencies have reported lower live and carcass prices for heavyweight lamb carcasses. Therefore, the goal of this study has been to determine as many of the factors contributing to determinants of carcass price as possible. When considering the justification for the apparent discrimination, these data have indicated that when carcasses increased in weight they possessed more fat, and cutability decreased. However, the differences in cutability were small and inconsistent.

On the other hand, certain factors indicate inherent advantages for consideration of heavyweight lamb carcasses. Since the most preferred cut of the lamb carcass is the loin, and the relationship of carcass weight to *l. dorsi* area is positive; heavyweight lamb carcasses possess a larger *l. dorsi* muscle than do lighter weight lamb carcasses. The consumer will discriminate against lamb loin cuts that possess a small area of *l. dorsi* muscle. Therefore, heavyweight lamb carcasses have an advantage in this respect. It should also be emphasized that a high percentage of the heavyweight lamb carcasses were highly desirable, properly finished carcasses. These particular carcasses should be identified on the basis of individual merit rather than be given a lower price based on the average of all heavyweight carcasses.

These results should provide ample material to justify receiving a higher price for heavyweight lamb carcasses. Heavy selected carcasses are more efficient to merchandise due to a greater output of salable retail cuts per unit of labor time.

Based upon these studies, it appears that certain other areas of research must be accomplished. These areas include management and selection system, nutritional alternatives, proper methods of ram testing, shrinkage and shelf-life studies, alternative marketing systems, quality grading standards and implementation of cutability or yield grading standards.

Acknowledgment

This study was partially supported by the American Sheep Producers Council, Inc. The following firms generously cooperated during different phases of the study: Armour and Company, Inc.; Swift and Company; Allan Bros.; American Sheep Company; Stoeven Bros.; and Superior Packing Company.

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PR-2639

Effects of Chronological Age Upon Palatability of Lamb

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Physiological growth characteristics and their relationship to changes in mammalian body tissues are of immense importance. Maturity is of considerable importance in determining the USDA quality grade of lamb carcasses, since all of the other quality indicators are balanced in relation to the physiological maturity evaluations.

A number of investigations comparing animals of known chronological ages have been reported in the literature. Weber and Loeffel (1932) reported that roasts from weaning lambs were less pronounced in aroma and flavor of fat and lean, but more tender and juicy than roasts from lambs fed 28 days after weaning. Weller *et al.* (1962) reported that tenderness did not appear to be related to weight or age of lamb but that roasts from lambs older than 6 months were scored milder than those from younger animals and were found more often to have a "natural" lamb flavor.

Batcher *et al.*, (1962) reported that lambs 11-14 months of age exhibited greater amounts of fat in the ribs, legs and loins, more cooking drip loss, higher ether extract percentages and less tender ribs and loins than animals 4 to 5 months of age. In their study, the tenderness of muscle decreased as the age of animal from which it was taken increased, while the juiciness, aroma and flavor increased. Paul *et al.*, (1964a) concluded that cuts from lambs that were 11-12 months of age generally received higher scores for marbling, juiciness, tenderness, texture and natural flavor of lean than those cuts from lambs that were 5½ months of age. Paul *et al.*, (1964b) reported that feedlot lambs

TABLE 33. AGE DISTRIBUTION OF LAMBS

Group	Age (days)	Number
1	< 100	14
2	100 - 160	26
3	160 - 220	24
4	220 - 280	20
5	280 - 340	24
6	340 - 400	33
7	400 - 460	25
8	460 - 520	22
9	520 - 580	21
10	580 - 640	26
Total		235

received higher scores for juiciness, tenderness, texture and general acceptability than grass fattened lambs even though both groups were graded US Choice and were the same chronological ages. Cassard *et al.*, (1965) reported that the lamb preferred by family panels for juiciness of lean was from lambs significantly younger at slaughter but that age appeared to have no effect on tenderness rating. Pearson (1966) cited unpublished research conducted by Kirton who found that lambs slaughtered at 4 months of age were more tender than those killed at 6 months of age.

Maturity in lamb carcasses is presently subjectively determined through the aid of a descriptive terminology specified in Official U.S. Standards for Grades for Lamb and Mutton Carcasses.

This portion of the study was designed to determine the effects of animal age on the ultimate consumer satisfaction of the cooked product.

Experimental Procedure

Ewe and wether lambs were slaughtered at various ages as indicated in Table 33. The data were generally grouped according to the 60-day intervals. On the 9th day following slaughter, two chops from the posterior end of the rack were used for shear force determinations. One of these chops was cooked to an internal temperature of 75° C. and the other to 65° C. internal temperature. After cooling the chops to room temperature, three one half-inch cores from the *l. dorsi* were used to measure shear force with a Warner Bratzler shear. An 18-member semitrained taste panel was assembled for evaluation of legs according to a nine-point hedonic scale (9 = like extremely; 1 — dislike extremely) for tenderness, flavor, juiciness and overall satisfaction. Loin chops were evaluated by a three member trained panel according to the nine-point hedonic scale. To facilitate analyses, randomly selected wether (11 from each age group) and ewe (8 from each age group) samples were considered for this phase of the study. Shear force data for the legs were collected from each leg roast using cores taken from the four major muscles of the leg. Muscle samples were dissected from the loin for determination of the gross muscle composition.

Results

For comparison of age effects, it seemed desirable to achieve similar quality levels in all age groups. The proximate muscle composition of the ewe and wether carcasses is presented in Table 34. It is readily noted that there was no significant difference in moisture or fat content for the muscles derived from the ewe carcasses. There was a trend for the samples from the older wether carcasses to contain slightly more fat and less moisture than the younger age groups. However, there appears to be a general similarity in muscle composition of all age groups.

Taste panel (loin chops) and shear force (rib chops) results for chops from wether and ewe lambs are shown in Tables 35 and 36. Generally, there were inconsistent differences found among wether samples as age increased. For example, there was a trend for the chops from younger wether lambs to be more tender as evaluated by the taste panel and the Warner Bratzler shear. However, samples derived from older wether lambs were somewhat more desirable in flavor. This probably resulted from the fact that the chops

TABLE 34. PROXIMATE MUSCLE COMPOSITION FOR EWE AND WETHER LAMBS

Age, days	Moisture, percent		Fat-wet basis, percent		Fat-moisture free basis, percent	
	Ewe[1]	Wether[1]	Ewe	Wether	Ewe	Wether
< 100		74.86[a]		2.33[c]		9.26[d]
100-160	73.91[a]	74.00[abcd]	3.67[a]	3.15[bc]	13.72[a]	12.07[cd]
160-220	73.13[a]	73.54[bcde]	4.22[a]	4.28[a]	15.79[a]	16.00[a]
220-280	73.51[a]	73.56[bcde]	4.06[a]	3.87[ab]	14.84[a]	14.53[abc]
280-340	73.78[a]	74.45[ab]	3.83[a]	3.25[abc]	14.00[a]	12.58[abcd]
340-400	72.14[a]	74.28[abc]	5.17[a]	3.09[bc]	18.42[a]	11.96[cd]
400-460	73.44[a]	73.38[cde]	4.30[a]	4.32[a]	16.11[a]	16.19[a]
460-520	73.30[a]	73.78[bcde]	4.09[a]	3.71[ab]	15.25[a]	13.91[abc]
520-580	73.86[a]	73.34[de]	3.59[a]	3.91[ab]	14.06[a]	14.53[abc]
580-640	73.78[a]	73.05[e]	3.54[a]	4.28[a]	13.38[a]	15.77[ab]

[1]To facilitate analyses, eight ewe lambs were randomly selected from each of the indicated nine age groups. For the wethers, 11 lambs were randomly selected from each of the 10 age groups. Loin muscle was utilized for proximate analyses.

[abcde]Values bearing the same superscript are not significantly different ($P < .05$).

TABLE 35. LOIN PALATABILITY TRAITS FOR WETHER LAMBS[1,2]

Age, days	Loin flavor	Loin juiciness	Loin tenderness	Loin overall satisfaction	Rib chop shear value—75°C., pound	Rib chop shear value—65°C., pound
$<$ 100	4.76^{cde}	5.09^{ab}	5.58^{a}	4.64^{bcd}	10.8^{ab}	9.8^{ab}
100-160	4.09^{e}	4.49^{b}	5.30^{a}	3.85^{d}	11.3^{ab}	7.6^{b}
160-220	5.27^{abc}	5.79^{a}	6.00^{a}	5.12^{abc}	11.6^{ab}	9.3^{ab}
220-280	5.88^{ab}	5.30^{ab}	6.03^{a}	5.49^{ab}	10.4^{b}	8.9^{ab}
280-340	6.09^{a}	5.85^{a}	5.94^{a}	5.88^{a}	11.4^{ab}	10.0^{a}
340-400	6.00^{a}	5.76^{a}	5.40^{a}	5.33^{ab}	11.1^{ab}	10.2^{a}
400-460	6.30^{a}	6.18^{a}	5.97^{a}	6.03^{a}	11.2^{ab}	9.8^{ab}
460-520	5.82^{abc}	5.45^{ab}	5.12^{ab}	5.15^{abc}	10.1^{b}	8.4^{ab}
520-580	6.21^{a}	5.33^{ab}	5.27^{a}	5.27^{ab}	11.7^{b}	8.8^{ab}
580-640	5.15^{abcd}	4.55^{b}	3.82^{c}	4.06^{d}	13.1^{a}	10.5^{a}

[1]To facilitate analyses, 11 wether lambs were randomly selected from each of the 10 groups (n=110).
[2]Palatability was based on scores by a three-member trained taste panel. Hedonic scale ratings were on a nine-point basis (1 = dislike extremely and 9 = like extremely).
[abcde]Values bearing the same superscript are not significantly different ($P < .05$).

from the two young groups were considered to be bland in the flavor attributes. Individual palatability traits for the loin chops from ewe carcasses were quite similar for all age groups. In fact, when significant differences occurred, most values favored the older groups with the exception of the 580-640-day age group. Shear values were not significantly influenced by chronological ages in the ewe lamb carcass category.

It is of interest to note that with an increase in degrees of doneness (Tables 35 and 36), there was an increase in shear value, therefore, less tender samples. This indicates that internal temperature must be carefully controlled and that "well-done" samples are likely to be less tender than those chops that are cooked to lesser degree of doneness.

Palatability ratings for leg roasts from each sex and age group are included in Tables 37 and 38. The leg roast data disagree slightly with the loin data in that there was a definite reduction in tenderness of leg roasts with an increase in age (taste panel and shear values). Data were very similar for taste panel flavor and juiciness scores. The overall satisfaction scores for leg roasts derived from ewe lambs were not significantly different due to age groups, although the mean values indicated slightly lower scores for the older groups. Generally, there was a decrease in overall palatability for the wether lamb carcasses that were over 460 days of age.

Summary

Although these data are preliminary in nature, they indicate that minor differences in palatability existed for cuts derived from lambs that were less than 1 year of age. It seems, then, that age (in days) is not a reliable index for assessment of expected consumer satisfaction. There appears to be a slight but general decrease in tenderness with advancing chronological age.

TABLE 36. LOIN PALATABILITY TRAITS FOR EWE LAMBS[1,2]

Age, days	Loin flavor	Loin juiciness	Loin tenderness	Loin overall satisfaction	Rib chop shear force, (75°C) pound	Rib chop shear force, (65°C) pound
$<$ 160	5.96^{ab}	5.33^{a}	6.92^{a}	5.83^{ab}	9.6^{a}	6.8^{a}
160-220	5.04^{bc}	5.25^{a}	5.29^{ab}	4.79^{ab}	11.4^{a}	9.2^{a}
220-280	4.58^{c}	5.58^{a}	5.71^{ab}	4.59^{b}	11.9^{a}	9.0^{a}
280-340	6.46^{a}	5.85^{a}	5.71^{ab}	5.90^{ab}	10.3^{a}	8.9^{a}
340-400	6.25^{a}	5.88^{a}	6.50^{ab}	5.92^{ab}	10.2^{a}	8.1^{a}
400-460	6.04^{ab}	6.00^{a}	5.42^{ab}	5.54^{ab}	9.7^{a}	8.1^{a}
460-520	6.08^{ab}	5.54^{a}	6.21^{ab}	6.00^{a}	10.1^{a}	8.6^{a}
520-580	6.13^{ab}	5.83^{a}	6.17^{ab}	5.96^{a}	9.1^{a}	8.7^{a}
580-640	5.63^{abc}	5.21^{a}	4.83^{b}	4.92^{ab}	10.4^{a}	8.3^{a}

[1]To facilitate analyses, eight lambs were randomly selected from each of the nine age groups.
[2]Palatability was based on scores by a three-member trained taste panel. Hedonic scale ratings were on a nine-point basis (1 = dislike extremely and 9 = like extremely).
[abc]Values bearing the same superscript are not significantly different ($P < .05$).

TABLE 37. LEG PALATABILITY TRAITS FOR WEATHER LAMBS[1,2]

Age, days	Flavor	Juiciness	Tenderness	Overall satisfaction	Shear value, pound
< 100	5.51^{ab}	5.85^{a}	6.45^{a}	5.74^{ab}	8.1 ^{bc}
100-160	5.66^{ab}	5.53^{a}	6.34^{ab}	5.78^{ab}	8.1 ^{bc}
160-220	5.73^{a}	5.75^{a}	6.55^{a}	5.86^{a}	7.8 ^{c}
220-280	5.61^{ab}	5.76^{a}	5.65 ^{d}	5.49^{abc}	9.7^{ab}
280-340	5.76^{a}	5.74^{a}	6.24^{abc}	5.75^{ab}	8.7^{bc}
340-400	5.34 ^{b}	5.51^{a}	5.79 ^{cd}	5.31 ^{c}	8.7 ^{bc}
400-460	5.75^{a}	5.51^{a}	5.78 ^{cd}	5.72^{ab}	9.0 ^{bc}
460-520	5.53^{ab}	5.36^{a}	5.37 ^{d}	5.43 ^{bc}	9.0 ^{bc}
520-580	5.65^{ab}	5.57^{a}	5.58 ^{d}	5.55^{abc}	8.7 ^{bc}
580-640	5.54^{ab}	5.33^{a}	5.23 ^{d}	5.31 ^{c}	10.8^{a}

[1]To facilitate analyses, 11 wether lambs were randomly selected from each of the 10 age groups. (n = 110).
[2]Palatability was based on scores by an 18-member taste panel. Hedonic scale ratings were on a nine-point basis. (1 = dislike extremely and 9 = like extremely).
[abcd]Values bearing the same superscript are not significantly different ($P < .05$).

TABLE 38. LEG PALATABILITY TRAITS FOR EWE LAMBS[1,2]

Age, days	Flavor	Juiciness	Tenderness	Overall satisfaction	Shear value, pound
< 160	5.93^{a}	5.86^{a}	6.82^{a}	5.96^{a}	7.2 ^{b}
160-220	5.69^{ab}	5.98^{a}	6.28^{ab}	5.73^{a}	8.6^{ab}
220-280	5.51 ^{b}	5.69^{a}	6.11 ^{bc}	5.56^{a}	8.6^{ab}
280-340	5.77^{ab}	5.90^{a}	6.25^{ab}	5.86^{a}	7.7^{ab}
340-400	5.69^{ab}	5.90^{a}	6.09 ^{bcd}	5.72^{a}	9.8^{a}
400-460	5.80^{ab}	5.78^{a}	5.91 ^{bcde}	5.67^{a}	8.0^{ab}
460-520	5.67^{ab}	5.86^{a}	5.71 ^{bcde}	5.64^{a}	9.3^{ab}
520-580	5.69^{ab}	5.78^{a}	5.62 ^{bcde}	5.60^{a}	8.6^{ab}
580-640	5.64^{ab}	5.68^{a}	5.43 ^{e}	5.52^{a}	9.2^{ab}

[1]To facilitate analyses, eight lambs were randomly selected from each of the nine age groups.
[2]Palatability was based on scores by an 18 member taste panel. Hedonic scale ratings were on a nine-point basis (1 = dislike extremely and 9 = like extremely).
[abcde]Values bearing the same superscript are not significantly different ($P < .05$).

Acknowledgment

This research was partially supported by Cooperative Agreement 12-14-100-8418 (51), Market Quality Research Division, Agricultural Research Services, USDA.

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PR-2640

Lamb Carcass Maturity And Its Relationship To Palatability

Z. L. Carpenter, G. C. Smith, G. T. King and K. E. Hoke

Lamb carcass maturity is one of the most important factors considered in the USDA grading standards for establishing the quality grade. Maturity is also the basis of distribution for the grading standards as they apply to and separate lamb, yearling mutton and mutton carcasses. Maturity assessment is based upon the color of lean and the shape, color, size and structure of the ribs and shanks. Color of lean is evaluated by examination of the lean exposed in the flank and in the thoracic cavity. A desirable color indicative of youthfulness is an attractive, bright, light red to pink color. Generally, with an increase in chronological age, there is a darkening of the color of the lean. It is assumed that the muscle tissues from more mature carcasses are less desirable in palatability. Also, the dark red color is not as acceptable to the consumer when purchasing decisions are made at the retail counter. Very young lamb carcasses will possess narrow round ribs and a well-defined "break-joint" on the front shank. The primary point of distinction between lamb and mutton carcasses is the presence or absence of the break-joint. Yearling carcasses generally do not possess a break-joint; however, carcasses may be classed as yearling if a break-joint is present, but the clean color is slightly dark red, and the ribs are wide and flat.

Since maturity is an important ingredient in the official lamb carcass grading standards, it seemed imperative to compare palatability characteristics of carcasses from the various maturity classifications (A = young lamb; B = mature lamb; Y = yearling mutton).

Carpenter and King (1965) reported that with an increase in age of the lamb, there was an increase in maturity score as indicated by a simple correlation coefficient of −0.51. As maturity score increased, there was an increase in tenderness (r = −0.27), indicating a low relationship of the current subjective maturity scores with the tenderness of lamb carcasses. Fresh muscle color score was related to age, maturity and cooking losses but was not significantly related to tenderness.

Smith *et al.* (1964) reported that leg of lamb roasts from carcasses varying significantly in USDA maturity scores did not appreciably differ in flavor, tenderness, number of chews, cooking losses or flavor descriptions. Paul *et al.* (1964) reported that panel scores for desirability of color showed some relation to Munsell color value and chroma; however, color was not significantly related to shear force values when comparing cuts from lambs differing 6 to 7 months in age.

Acker *et al.* (1959) reported that lambs fed stilbestrol appeared to be more mature in the carcass and were found to be inferior in tenderness and flavor. Hartman *et al.* (1958) reported that stilbestrol fed lambs had 14.4 percent of the carcasses with yearling spool joints while nonstilbestrol fed lambs had only 2.3 percent incidence of spool joints.

Experimental Procedure

A total of 348 known and unknown-history ewe and wether carcasses were grouped according to maturity score. Loin chops from each carcass were evaluated by a three-member trained taste panel for tenderness, juiciness, flavor and overall satisfaction. A nine-point hedonic scoring system was utilized (1 = dislike extremely; 5 = neither like nor dislike and 9 = like extremely). Two chops from each carcass were cooked to 65° and 75° C. for tenderness evaluation by the Warner-Bratzler shear. Since these data were derived from carcasses of different sources, nutritional regimes, management practices and sex, the data were not statistically analyzed for this particular report. Rather, these data are presented for the purpose of observing any gross differences as detected by the taste panel.

TABLE 39. PALATABILITY OF LOIN CHOPS FROM LAMBS VARYING IN PHYSIOLOGICAL MATURITY

	Maturity classification			
Measurement	A	B	Yearling	Total
Number of carcasses	191	72	85	348
Shear value 75°C.	10.3	9.8	9.8	10.1
Shear value 65°C.	8.6	8.1	8.3	8.4
Flavor (taste panel)	5.7[1]	6.2	6.0	5.9
Juiciness (taste panel)	5.6	5.8	5.9	5.7
Tenderness (taste panel)	5.8	5.7	5.8	5.8
Overall satisfaction (taste panel)	5.4	5.7	5.7	5.5

[1]Taste panel attributes represent an average of scores assigned by a three-member taste panel. Scores were based on a hedonic scale (1 = dislike extremely, 9 = like extremely, 5 = neither like nor dislike).

Results

The results of this view of the effects of maturity upon palatability are summarized in Table 39. There appear to be no significant differences among maturity groups for the shear force values. This is confirmed by the similar taste panel tenderness scores. Since other data have indicated a trend for chops from younger lambs (younger in chronological age, days) to be more tender, it is obvious that physiological maturity is, in fact, a different measure and may vary from chronological age.

Since the A maturity lamb carcasses provided chops that were not as intense in flavor (bland), this particular panel rated these samples somewhat lower than the B and Yearling maturity groups. Caution should be exercised in interpretation of these data, since the panel members were regular consumers of lamb and obviously preferred the more intense flavor of the more mature carcasses. Data from other phases of the lamb quality study have tended to indicate that new lamb consumers or those that seldom eat lamb may favor the less intense flavor of the younger carcasses. In the present study, because of the lower flavor scores, the A maturity carcasses were rated slightly lower than the B or Yearling maturity groups in overall satisfaction.

Summary

Lamb carcass maturity scores, as used in USDA quality standards, do not completely differentiate differences in loin chop palatability. These data, when compared to those of other phases of the study, suggest that the maturity scores are not necessarily indicative of chronological age. The significance of these data is difficult to assess since there is a definite and variable preference for different degrees of flavor intensity of lamb loin chops.

Acknowledgment

This research was partially supported by the Cooperative agreement 12-14-100-8418 (51), Market Quality Research Division, ARS, USDA.

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PR-2641

Relationship of Chronological Age To Physiological Maturity Of Ewe and Wether Lambs

Z. L. Carpenter, G. C. Smith,
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and K. E. Hoke

Maturity is of considerable importance in determining the USDA quality grade of lamb carcasses since all of the other quality indicators are balanced in relation to the physiological maturity evaluation. Many research studies have indicated that as animals reach maturity as measured by maximum muscled development, increased rate of fat deposition occurs. It has also been reported that ewe lambs likely reach maturity at an earlier chronological age than wethers and rams. At similar carcass weights, ewe lamb carcasses normally possess greater amounts of external fat.

Under USDA grading terminology, maturity is subjectively evaluated on the basis of meat color and size, shape and structure of the ribs and shanks. The point of distinction between a lamb and a yearling carcass is the presence of a well-defined "break-joint." In dressing sheep, the foot and pastern are removed at the ankle (between the proximal sesamoids and the metacarpal bone). There is a "round" or "spool joint" on the lower end of the cannon bone (metacarpal). In sheep under 12-14 months of age (lamb), the foot and pastern are removed at the "break-joint," the junction of the epiphysis and diaphysis located at the lower end of the cannon bone. Growth in this location ceases when the cartilage ceases to regenerate, and this joint ultimately is fused into solid bone. Until the sheep is 12-14 months old, it is generally easy to remove the foot at the break-joint; after 14 months the foot generally must be removed at the spool-joint. Thus, these two types of joints are used to differentiate between lamb and mutton carcasses. Generally, older yearling carcasses also have a spool-joint. However, a youthful yearling carcass may have a break-joint. In this case, the break-joint may be partially broken or the lean may be extremely dark in color and therefore will not qualify for classification as lamb.

There are also distinguishable differences in age among those carcasses classified as lambs. Young carcasses ("A" maturity) show considerable redness in the break-joint, have narrow, round ribs that possess a considerable amount of redness and have a distinct redness in the shank bones. In lamb carcasses approaching the yearling stage ("B" maturity) the shank bones are whiter, the ribs are broad and flat with little red color in them, and the break-joint is whiter and drier than that found on a young lamb carcass. Also, there are distinguishable differences in the characteristics of the flesh. In young carcasses the lean is generally a bright reddish-pink color, whereas the lean of those approaching the yearling stage is darker or more purple in color. Since younger lambs possess a milder flavor and are thought to be more tender than the more mature ones, they are rated higher in maturity evaluations.

The purpose of the study was to compare chronological age of ewe and wether lambs with the maturity scores.

Experimental Procedure

Ewe and wether carcasses were derived from 238 known-history lambs from the Texas A&M University Research Center at McGregor. The lambs were fed at different nutritional levels to assure variability in level of fatness-associated quality characteristics. After slaughter, carcasses were scored for the following maturity related characteristics: break-joint condition, rib structure, flank lean color, diaphragm lean color, thoracic lean color, loin color, leg color and overall maturity. Since lambs varied in age up to 540 days of age, it seemed reasonable to examine relative maturation of bone and lean tissue across the age groupings. A distribution of maturity level for each sex and age group was determined. Percentages classified in each maturity within each age group were calculated.

Results

A number of different criteria have been suggested as indicators of maturation. For the purposes of this study, lean color and break-joint maturity were considered for a comparison of various age groups of ewe and wether lambs. The maturity level data as assigned by evaluation of the lean in the upper flank muscle are summarized in Table 40. Up to 340 days, all lambs, regardless of sex, were observed to represent A (young) maturity. There was a definite trend for some of the ewe lambs to be designated as B or yearling maturity at approximately 60 days younger age than the wethers. However, it is interesting to note that all ewe lambs in the 520-580 day age group were in the A maturity group for color of flank muscle.

TABLE 40. PERCENTAGE OF LAMBS IN EACH AGE AND SEX GROUP ACCORDING TO FLANK LEAN COLOR MATURITY[1]

Age group	A Wether Percent	A Ewe Percent	B Wether Percent	B Ewe Percent	Yearling Wether Percent	Yearling Ewe Percent
1 (< 100 days)	100	100				
2 (100 - 160)	100	100				
3 (160 - 220)	100	100				
4 (220 - 280)	100	100				
5 (280 - 340)	100	100				
6 (340 - 400)	100	92		8		
7 (400 - 460)	92	77	8	15		8
8 (460 - 520)	72	50	28	38		12
9 (520 - 580)	46	100	46		8	
10 (580 - 640)	44	30	51	70	5	

[1]Maturity refers to score assigned by the USDA Meat Grading Service.

Table 41 shows a summary of the maturity levels as determined by observation of the break-joint or spool joint. There was a definitely greater percentage of the ewe lambs classified as yearling maturity. This occurred even at 280-340 days of age. In the most advanced age group, 580-640 days, 32 percent of the wethers were classed as yearlings while 100 percent of the ewes were in the yearling category.

TABLE 41. PERCENTAGE OF LAMBS IN EACH AGE AND SEX GROUP ACCORDING TO BREAK-JOINT MATURITY[1]

Age group	A Wether Percent	A Ewe Percent	B Wether Percent	B Ewe Percent	Yearling Wether Percent	Yearling Ewe Percent
1 (< 100 days)	100	100				
2 (100 - 160)	100	100				
3 (160 -)220)	100	100				
4 (220 - 280)	91	100	9			
5 (280 - 340)	92	36	8	45		19
6 (340 - 400)	81	33	19	33		34
7 (400 - 460)	41	8	59	39		53
8 (460-520)	28	14	58		14	86
9 (520-580)	38	14	56		6	86
10 (580-640)	13		55		32	100

[1]Break-point or spool-joint maturity as evaluated by the USDA Meat Grading Service.

TABLE 42. PERCENTAGE OF LAMBS IN EACH AGE AND SEX GROUP ACCORDING TO OVERALL MATURITY[1]

Age group	A Wether Percent	A Ewe Percent	B Wether Percent	B Ewe Percent	Yearling Wether Percent	Yearling Ewe Percent
1 (< 100 days)	100	100				
2 (100 - 160)	100	100				
3 (160 - 220)	100	100				
4 (220 - 280)	100	100				
5 (280 - 340)	100	81				19
6 (340 - 400)	100	42		25		33
7 (400 - 460)	41	16	59	31		53
8 (460 - 520)	50		35	13	15	87
9 (520 - 580)	38	13	54		8	87
10 (580 - 640)	19		32		49	100

[1]Overall maturity refers to final maturity score assigned by the USDA Meat Grading Service.

All indicators of maturity were combined into the USDA maturity designation for each carcass. These data are presented in Table 42. At 340-400 days of age, all wether lambs were in the A maturity classification while, at the same age, 42 percent of the ewes were in A maturity, 25 percent in B and 33 percent in the yearling category. In the 580-640 day age group, 100 percent of the ewes possessed yearling maturity characteristics while for the wethers, 19 percent were A, 32 percent were B and 49 percent were yearling maturity. Based upon these data, it appears that ewe lambs mature 60 to 120 days earlier than do the wether lambs. It should be recognized that these observations are based only on the characteristics of flesh and bone.

Other characteristics of bones from these animals of similar breeding are being determined. These data include: plasticity of bone, hardness, size and resiliency. Perhaps certain parameters of bone maturity will provide estimates that will be helpful in various studies using animals of unknown age and genetic background.

Summary

These data provide comparisons of various ages of ewe and wether lambs for maturity factors that are currently utilized in the industry for grade determination. It is obvious that the subjective maturity score is not necessarily related to the chronological age of the animal, especially if sex is not considered. The bone of ewe lambs becomes mature at 60-120 days earlier than for wether lambs. This study provides some evidence to support the reasoning that increased fat deposition and reduced muscle growth occurs at a younger age for ewe lambs. It should be emphasized that these data were derived from predominantly finewool X mediumwool crossbred lambs that were reared under similar environmental and management conditions. Other breeds could reach maturity at different chronological ages.

Acknowledgment

This research was partially supported by Cooperative Agreement 12-14-100-8418 (51), Market Quality Research Division, ARS, USDA.

PR-2642

Flock Differences In Mohair Production

J. W. Bassett and G. R. Engdahl

Five Texas mohair producers cooperated in a study to determine the influence of age and season on fiber characteristics of mohair. Some of the results have been previously reported in Texas Agricultural Experiment Station PR-2526. This present report shows flock differences in the same trials.

Experimental Procedure

Angora does were selected within each of four age groups, ½, 1½, 2½ and 3½ years. These does were individually identified, and records were obtained for six consecutive shearings. Some of the animals died before completion of the project, but no substitutions were made. Grease fleece weights and shorn body weights were obtained at the time of shearing. The fleeces were taken to the Animal Science Department Wool and Mohair Laboratory, Texas A&M University, where samples were measured for lock length, clean yield and fiber diameter, and clean fleece weights were calculated. Lock length, grease fleece weight and clean fleece weight were adjusted to a 6-months basis when shearing dates did not fall exactly 6 months apart. Specific shearing dates were determined by each producer in accordance with his usual practice.

Results

Combined data for all ages and all flocks are given in Table 43.

These data show no consistent pattern for body and fleece weights. Over the 3-year period, the does averaged 58.1 pounds shorn body weight and produced an average of 5.4 pounds of grease fleece each 6 months or 10.8 pounds per year. This mohair production is in addition to the kids that these does will produce. This is outstanding production when the small body size of the Angora does is considered. This represents approximately 1 pound of mohair per 5 pounds of body weight. Clean yield varied between 79.6 and 76.8 percent with an average of 78.3 which gave a clean fleece weight average of 4.2 pounds.

Lock length showed a distinct seasonal variation with the spring mohair being from 0.5 to 1.0 inch shorter than that of the preceding fall. The lock length showed a consistent decrease with age, dropping from 5.3 inches at the fall 1964 shearing to 3.7 inches at the spring 1967 shearing. The overall average lock length of 4.6 inches in 6 months falls short of the desired 1 inch per month of growth. The period of longest growth, 5.3 inches shorn in fall 1964, also fails to meet the desired standard of 1 inch of growth per month.

Fiber diameter showed a large increase from the first to the third shearing. This is due in large measure to the increase in diameter of the kid mohair during this period. After this initial period, however, a seasonal trend appeared with the spring diameter finer than that of the previous fall in spite of the increase in age. Average fiber diameter of 34.8 microns is in the 26's spinning count according to proposed USDA mohair top standards.

Average measurements and weights can be misleading. Figure 3 shows shorn body weights for the five flocks represented in the study. Flock 5 shows a distinct seasonal trend which is not found in the other four flocks. Body weights for three flocks overlap at different shearing seasons while the other two flocks are consistently higher or lower than the others. Body weights were not available for flock 5 at the first shearing period, and neither body weight nor fleece data were available for flock 1 at the last shearing. Some flocks show a large variation in body weights over the period of this study while others show little variation. The flocks with the heaviest does were those showing the greatest variation between shearings.

TABLE 43. BODY AND FLEECE DATA FOR ALL ANGORA DOES

	Fall 1964	Spring 1965	Fall 1965	Spring 1966	Fall 1966	Spring 1967	Average
Body weight, pounds	50.2	57.1	57.4	62.2	61.6	62.2	58.1
Grease fleece weight, pounds	5.2	5.5	5.4	5.1	5.5	5.3	5.4
Clean yield, percent	78.5	76.9	78.4	79.1	79.6	76.8	78.3
Clean fleece weight, pounds	4.1	4.2	4.2	4.0	4.4	4.0	4.2
Lock length, inches	5.3	4.3	4.7	4.2	4.6	3.7	4.6
Fiber diameter, microns	30.5	33.0	37.1	36.1	37.9	36.9	34.8

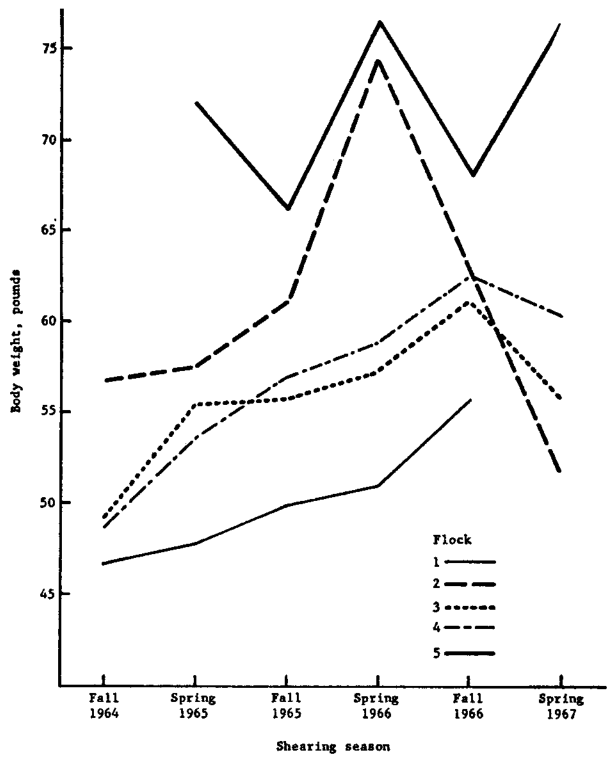

Figure 3. Body weights after shearing.

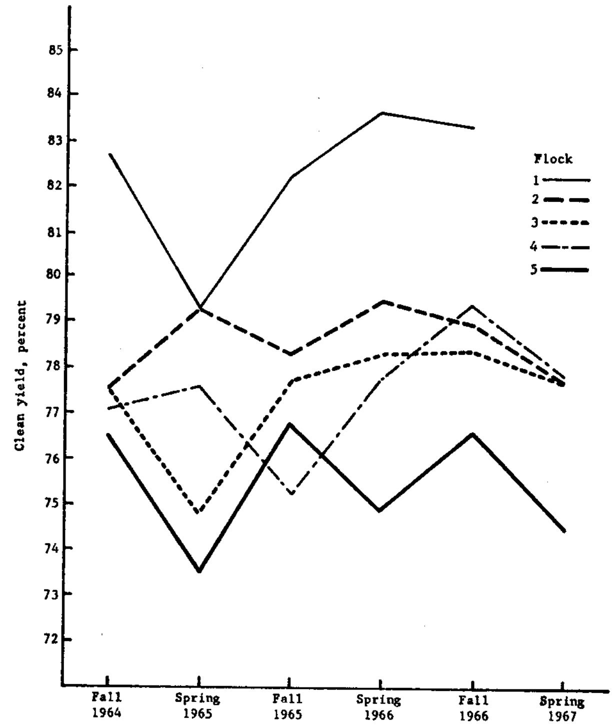

Figure 5. Clean yield.

The heavier doe flocks had the heavier grease fleece weights as shown by Figure 4. However, the heaviest grease fleece weights within individual flocks were more often associated with the lighter body weights. Part of this can probably be explained by the fact that the body weights tend to be heavier in the spring when the does are heavier because of pregnancy, while the lighter fleece weights are showing effects due to season and nutrition. No distinct pattern is shown by all flocks although there is an apparent trend toward lighter spring grease fleece weights which does show up in the overall averages of Table 43.

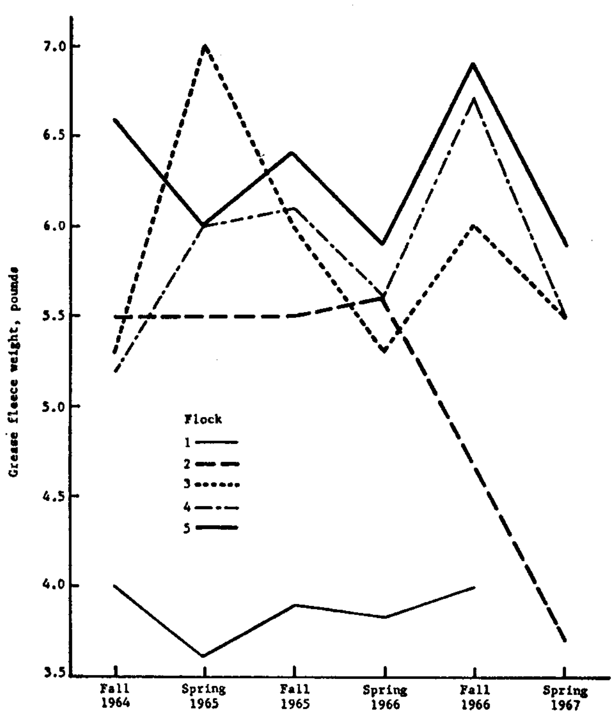

Figure 4. Grease fleece weights.

The flocks with the heaviest does and heaviest grease fleece weights had the lowest yield while the light bodied does had the highest yielding fleeces, Figure 5. Differences in yield, however, were not sufficiently large to significantly change the relative grease fleece weight curves. Other than in flocks 1 and 5, yields fluctuated and overlapped in no apparent order.

Lock length for the five flocks are shown in Figure 6. Of all the measurements, lock length measurements show the smallest between-flock variation and the most consistent seasonal variation. Length shows a definite decrease for spring shearing as compared to the fall-shorn fleeces in all flocks. There is also a decrease in length with increasing age in all five flocks.

Fiber diameters also show similar growth patterns for all flocks as indicated in Figure 7. The spring mohair at the later shearings is not only shorter but also finer. All flocks showed a very large increase in fiber diameter from the first shearing to the third, but seasonal fluctuations were identifiable after this time.

Summary

A look at the body weight measurements and mohair fleece data from the five Angora doe flocks

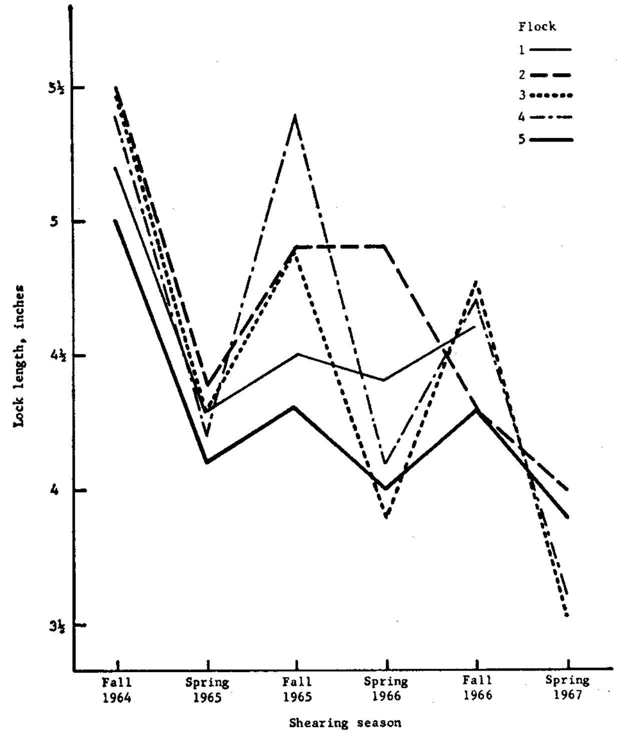

Figure 6. Lock lengths.

indicate that there are some growth patterns and relationships which are consistent in all flocks. Lock length showed a distinct seasonal influence in all flocks at all shearings, and there was less variation between flocks for this trait. The flocks with the heaviest average body weight tended to have the heaviest grease and clean fleece weights but had the shortest and

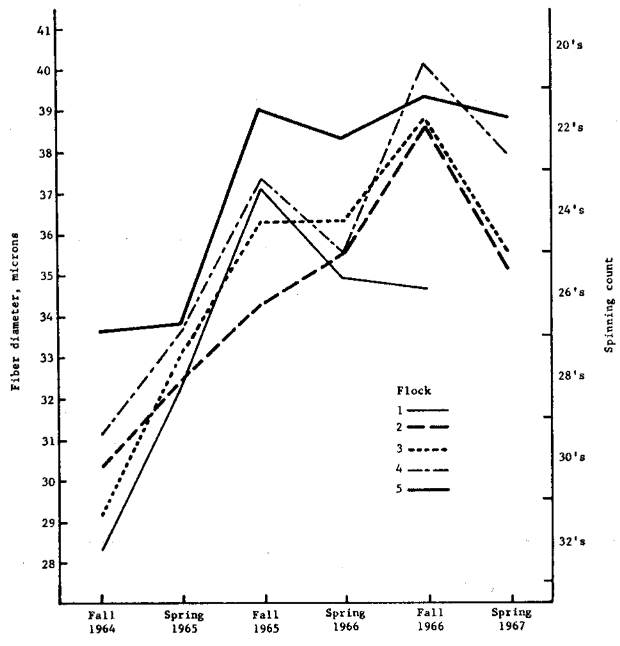

Figure 7. Fiber diameter.

coarsest fibers and lower clean yields. These growth patterns were not consistently true and were not true for individual goats, indicating that selection should be possible for large Angora does with heavy grease fleece weight, adequate lock length and an acceptable fiber diameter.

PR-2643

Performance of Lambs Fed High Concentrate Rations Containing Different Alkali Supplements

M. C. Calhoun, Maurice Shelton and J. E. Huston

In Texas, the trend in recent years in commercial lamb feeding has been toward rations based heavily on grain sorghum and with only limited roughage. This has occurred because of the availability of grain sorghum at a price competitive to alternative feedstuffs as an energy source and the limited supply of good quality roughage. Comparison of these high concentrate rations with conventional rations or feeding systems shows that the quantity of feed necessary per pound of gain is reduced. In addition, this trend takes advantage of the highly mechanized production and handling of grains and the generally favorable cost of nutrients from grains when compared to roughages, especially when the latter must be purchased and transported.

One of the problems associated with the use of increasing amounts of grain sorghum in lamb rations arises from the marked alteration in rumen metabolism which occurs when large quantities of readily fermentable carbohydrates are introduced into the rumen. The pH of the rumen decreases markedly, microbial lactic acid production increases and undigested starch spills over into the small intestine. As a result, the animal often goes off feed with acute acid indigestion. The combination of the above factors, particularly the presence of undigested starch granules in the small intestine generally accompanied by ruminal stasis resulting from the acid condition in the rumen, may predispose the animal to enterotoxemia. The above described metabolic disturbances markedly limit the more effective utilization of high concentrate rations and are the reason for the current practice of gradual introduction of increasing amounts of grain sorghum into the ration.

In recent years, research with various alkali supplements has been carried out in an attempt to maintain a near normal rumen pH and prevent the animal's going off feed. In theory, these would appear to have merit, but research results with cattle and sheep are quite variable, and, as yet, it is not possible to select an alkali supplement which will predictably enhance animal performance.

TABLE 44. PERFORMANCE OF LAMBS FED A HIGH CONCENTRATE RATION[1] CONTAINING VARIOUS ALKALI AGENTS[2] (EXPERIMENT I. NOVEMBER 1967)

Treatment	Lambs, number	Death loss, number	Initial weight, pound	Average daily gain, pound	Feed consumption, pounds per day	Feed efficiency, pounds feed per pound gain
Control	11	1	60.3	0.420	2.70	6.43
2 Percent mixed hydroxides[3]	11	1	60.0	0.412	2.49	6.04
2 Percent mixed bicarbonates[4]	11	0	59.8	0.485	2.90	5.98
2 Percent calcium hydroxide	11	0	60.2	0.292	2.54	8.70
2 Percent calcium hydroxide (initially)[5]	11	1	60.3	0.375	2.47	6.59

[1]The composition of the control ration in percent was as follows: Sorghum grain (ground), 77; alfalfa hay (ground), 5; cottonseed meal, 10; molasses, 5; urea, 1; calcium carbonate, 1 and trace mineralized salt, 1. Vitamin A palmitate and aureomycin were added to the ration at a level to provide respectively, 1,000 I.U. per pound and 15 milligrams per pound.

[2]The various alkali agents were added at 2 percent of the diet and replaced sorghum grain.

[3]A mixture containing equal parts of $Al(OH)_3$, $Mg(OH)_2$ and $Ca(OH)_2$.

[4]A mixture containing equal parts of $NaHCO_3$ and $KHCO_3$.

[5]Two percent $Ca(OH)_2$ fed initially for 14 days and then removed from the diet and replaced with sorghum grain.

Because of this, three trials were carried out at McGregor from November 1967 to December 1968 to further evaluate the feasibility of using various alkali agents to prevent off-feed in situations where lambs are placed immediately on high concentrate rations.

Trial 1 (November 1967)

Fifty-five ewe and wether lambs (blackface crosses) purchased through the auction at Lampasas during November 1967 were placed on an experiment consisting of five treatments, 11 lambs per treatment, as follows: (1) high concentrate control, 77 percent ground grain sorghum; (2) mixed hydroxides, 1:1:1 mixture of aluminum hydroxide, $Al(OH)_3$, magnesium hydroxide, $Mg(OH)_2$ and calcium hydroxide, $Ca(OH)_2$; (3) mixed bicarbonates, 1:1 mixture of sodium bicarbonate, $NaHCO_3$ and potassium bicarbonate, $KHCO_3$; (4) $Ca(OH)_2$ and (5) $Ca(OH)_2$ initially (14 days) and then the control ration. The duration of the feeding period was 59 days. Weights of animals were obtained initially and at 2-week intervals thereafter. Performance data for these lambs are given in Table 44.

Trial 2 (June 1968)

Thirty-three late winter ewe and wether lambs were assigned at random to three treatments with 11 lambs per treatment and balanced with respect to weight and sex. The treatments consisted of a control group receiving a high concentrate ration (81.4 percent grain sorghum, ground) and two groups receiving alkali supplements as follows: (1) a 1:1 mixture of $Ca(OH)_2$ and $Mg(OH)_2$ and (2) $NaHCO_3$. The alkali supplements were fed for the first 5 days at a level of 2 percent which was subsequently reduced to 1 percent for the remainder of the trial. The duration of the feeding period was 48 days.

The results of Trial 2 are presented in Table 45.

Trial 3 (October 1968)

One hundred and twenty feeder lambs (wethers) were obtained from the auction at San Angelo and transported to the Agricultural Research Center at McGregor. On arrival, they were unloaded for a short time into pasture with free access to water.

TABLE 45. PERFORMANCE OF LAMBS FED A HIGH CONCENTRATE RATION[1] CONTAINING VARIOUS ALKALI AGENTS[2] (EXPERIMENT 2. JUNE 1968)

Treatment	Lambs, number	Death loss, number	Initial weight, pound	Average daily gain, pound	Feed consumption, pounds per day	Feed efficiency, pounds feed per pound gain
Control	11	1	60.0	0.498	2.60	5.23
Mixed hydroxides[3]	11	1	64.6	0.523	2.99	5.71
Sodium bicarbonate	11	0	66.7	0.473	2.82	5.96

[1]The composition of the control ration in percent was as follows: Sorghum grain (ground), 81.4; alfalfa hay (ground , 10.0; blood meal, 2.0; cottonseed meal, 4.0; urea, 0.7; calcium carbonate, 0.7 and trace mineralized salt, 1.0. Vitamin A palmitate and aureomycin were added to provide, respectively, 1,000 I.U. and 25 milligrams per pound in the mixed ration.

[2]The various alkali agents replaced sorghum grain and were added initially (first 5 days) at a level of 2 percent. This was subsequently reduced to 1 percent for the remainder of feeding period.

[3]A mixture containing equal parts of $Mg(OH)_2$ and $Ca(OH)_2$.

Subsequently, they were sheared, weighed, ear tagged, drenched (Thiabenzole) and allotted to treatment groups at random but balanced with respect to weight. The experiment consisted of five treatments, replicated twice, with 10 lambs per pen. The treatments were as follows: (1) high concentrate control, 68 percent dry rolled sorghum grain; (2) high roughage control, 30 percent ground alfalfa and 30 percent cottonseed hulls; (3) calcium hydroxide, 2 percent; (4) potassium bicarbonate, 2 percent and (5) calcium hydroxide, 2 percent initially (first 7 days) reduced to none thereafter. Live weights were obtained initially, at the end of the first 7-day period and at 28 and 56 days. Daily feed consumption of each pen was recorded for the first 7-day period and thereafter on a weekly basis. Since it is assumed that the major advantage to the feeding of alkali supplements in the diet should be apparent during the initial portion of the feeding period, in reporting the performance data for these lambs, the experimental period has been broken down to show weight gains, feed consumption and feed efficiency after 7, 28 and 56 days of feeding (Table 46).

Results and Discussion

With the exception of the lambs continuously receiving 2 percent calcium hydroxide supplementation, the drylot performance, that is, weight gain, feed consumption and feed efficiency, of all groups in Trials 1 and 2 was quite good, Tables 44 and 45. In Trial 1, the group receiving mixed bicarbonates performed best, whereas, those getting the hydroxide mixture were about equal in performance to the high concentrate control group. The markedly poorer performance of those lambs receiving 2 percent hydroxide, either initially (14 days) or continuously, was apparently related to the adverse effect of this level of calcium hydroxide supplementation on metabolic processes and not to its effect on palatability as their feed consumption was comparable to that of the group receiving mixed hydroxides.

In Trial 2, weight gains and feed consumption were greater for the group supplemented with the mixture of calcium and magnesium hydroxides. However, feed efficiency was best for the high concentrate control group, Table 45.

In Trial 3, some difficulty was encountered in getting the lambs to accept mixed feeds in drylot. This was not entirely unexpected as these were West Texas range lambs unaccustomed to any of the imposed experimental conditions, that is, confined spaces and harvested feeds. In one aspect, this was advantageous as, with one exception (one lamb maintained on the control ration died during the first week, apparently from overeating), no difficulty was encountered with lambs overeating initially and then going off feed. During the initial 7-day period, the high roughage ration was more readily consumed. As a result, the roughage group was the only group exhibiting weight gains for the period. Poorest performance was shown by the lambs receiving 2 percent calcium hydroxide.

Although feed consumption was still greater at the end of 28 days for the roughage group, live weight

TABLE 46. COMPARISON OF THE PERFORMANCE OF LAMBS FED A HIGH CONCENTRATE RATION[1] WITH THOSE RECEIVING A HIGH ROUGHAGE RATION[2] OR A HIGH CONCENTRATE RATION SUPPLEMENTED WITH VARIOUS ALKALI AGENTS[3] (EXPERIMENT 3, OCTOBER 1968)

	Experimental Group				
Feeding period	1 High concentrate control	2 Roughage control	3 2 Percent $Ca(OH)_2$	4 2 Percent $KHCO_3$	5 2 Percent $Ca(OH)_2$ initially
7 days					
Initial weight (pounds)	61.5	61.1	62.0	62.0	61.9
Death loss (number)	1	0	0	0	0
Weight gain (pounds per day)	–0.221	0.237	–0.625	–0.330	–0.475
Feed consumption (pounds per day)	1.11	1.98	0.71	1.06	0.88
Feed efficiency (pounds of feed per pound gain)		8.35			
28 days					
Weight gain (pounds per day)	0.390	0.384	0.248	0.422	0.440
Feed consumption (pounds per day)	2.23	3.12	1.78	2.20	2.22
Feed efficiency (pounds of feed per pound gain)	5.72	8.12	7.18	5.21	5.04
56 days					
Weight gain (pounds per day)	0.516	0.464	0.331	0.520	0.533
Feed consumption (pounds per day)	2.71	3.58	2.28	2.58	2.72
Feed efficiency (pounds of feed per pound gain)	5.25	7.72	6.89	4.96	5.10

[1]The composition of the high concentrate control ration in percent was as follows: Sorghum grain (dry rolled), 68; alfalfa hay (coarse grind), 10; cottonseed meal (solvent), 7; feather meal (hydrolized), 3; urea, 1; calcium carbonate 1.5; trace mineralized salt, 1.5 and molasses, 8. Vitamin A palmitate, aureomycin and diethylstilbestrol were added at a level calculated to provide, respectively, 1,000 I.U., 15 milligrams and 1 milligram per pound in the mixed ration.

[2]The high roughage control contained 30 percent alfalfa hay (coarse ground) and 30 percent cottonseed hulls added to the ration at the expense of sorghum grain.

[3]The alkali supplements replaced sorghum grain.

gain and feed efficiency were better for the high concentrate control group, as well as for those lambs receiving potassium bicarbonate or calcium hydroxide initially. Feed consumption was markedly less for the group receiving calcium hydroxide continuously.

At the completion of the 56-day feeding trial, the drylot performances of the high concentrate control group and those groups supplemented with either potassium bicarbonate or initially with calcium hydroxide were quite good and roughly comparable. Thus, in this study, there did not appear to be a distinct advantage in the use of either of these alkali treatments. Performance of the high roughage lambs was less than the high concentrate controls, and performance of the lambs continuously supplemented with 2 percent calcium hydroxide was markedly inferior to all other treatments. In contrast to Trial 1, it appears that in this trial 2 percent calcium hydroxide decreased the palatability of the ration.

Summary

A series of feeding trials with lambs was carried out at McGregor to evaluate the effect on drylot performance of adding various alkali agents to high concentrate rations. The inclusion in the ration of a 2 percent mixture of sodium and potassium bicarbonate (1:1 mixture, Trial 1) resulted in a marked improvement in drylot performance, that is, increased gains, feed consumption and feed efficiency. The addition of 2 percent calcium hydroxide, continuously, to high concentrate rations decreased feed consumption and consequently weight gains. With the exception of the above two treatments, all other alkali supplemented diets were roughly comparable in performance to the high concentrate control rations employed.

PR-2644

Causes of Variation In Lamb Carcass Cutability

W. M. Oliver and Z. L. Carpenter

Research has revealed that the weight of major retail cuts (leg, loin, rack and shoulder) or the weight of consumer cuts obtained from a lamb carcass are among the most desirable measures of cutability. When only carcasses within the USDA Choice and Prime grades were considered, either of these yields was a highly efficient measure of lamb carcass merit [Oliver, 1967]. Oliver *et al.* (1968) and Oliver (1967) have shown that the weight of retail cuts from a lamb carcass can be estimated with more accuracy than the weight of these cuts expressed as a percent of carcass weight. These studies showed that the influence of differences in carcass weight could be most efficiently removed by including carcass weight as an independent variable in regression analyses. They further indicated that the estimated weight of retail cuts resulting from such regression analyses could then be converted to a percentage of carcass weight with out introduction of additional error (Oliver and Carpenter, 1968; Oliver, 1969).

Studies reported in the literature have utilized several carcass traits in attempting to explain the causes of variation in carcass cutability. It has been learned that excessive carcass fat has a negative effect on cutability (Hoke, 1961; Field *et al.*, 1963; Judge and Martin, 1964; Spurlock *et al.*, 1966; Riley, 1967; Oliver, 1967). Some workers have shown that the area of the *l. dorsi* at the 12th rib was positively related to cutability (Hoke, 1961; Field *et al.*, 1963; Spurlock *et al.*, 1966). Johnston *et al.*, (1967) reported that both leg conformation score and carcass conformation score were related to cutability. Other workers have reported a strong relationship between carcass weight and lamb carcass cutability (Judge *et al.*, 1966; Riley, 1967; Oliver, 1967).

Experimental Procedure

Data were available on 144 lamb carcasses selected from packing plants in Texas and the Midwest to be widely variable in weight, fatness and conformation. The carcasses were reduced to boneless, closely trimmed retail cuts in the Animal Science Department Meat Laboratory of Texas A&M University. The selection and cutting procedures have been described by Johnston *et al.*, (1967) and Carpenter *et al.*, (1966). These data were utilized in a study to determine the influence of various carcass traits on the yield of major retail cuts.

Results

First, the carcass traits shown as independent variables in Table 47 were considered one at a time

TABLE 47. PARTIAL REGRESSION COEFFICIENTS FROM EQUATIONS FOR ESTIMATING WEIGHT OF MAJOR RETAIL CUTS FROM LAMB CARCASSES (LINEAR REGRESSION EQUATIONS)

Independent variable	Equation number[a]				
	1	2	3	4	5
Y intercept	2.42	25.97	25.70	5.22	26.43
Carcass weight, pounds	0.57**				
Leg conformation score[b]		0.41[N.S.]			
Carcass conformation score[b]			0.42[N.S.]		
L. dorsi area, square inches				14.04**	
Total trim fat weight, pounds					1.05**
R^2	93.22	2.06	1.92	62.50	29.46
S[c]	1.68	6.44	6.44	3.96	5.40

**P < .01, [N.S.]Nonsignificant.

[a]Dependent variable—weight of major retail cuts.

[b]Good = 7, 8, 9; Prime = 13, 14, 15.

[c]Standard error of estimate.

in linear regression analyses to determine their effect on variation in the dependent variable, weight of major retail cuts. The regression coefficients shown for the various equations in Table 47 indicate the actual change in the weight of major retail cuts which accompanies a one-unit change in the independent variable. For example, the regression coefficient of 0.57 for carcass weight in equation 1 means that an increase of 1 pound of carcass weight results in an increase of 0.57 pound in weight of major retail cuts. The measure of the efficiency with which a change in an independent variable measurement accounts for change in the dependent variable is called the coefficient of determination and is designated at the lower portion of Table 47 as R^2. The R^2 values are percentages that may range from zero to 100 percent. Using equation 1 again as an example, the R^2 value of 93.22 percent means that a change in carcass weight was associated with 93.22 percent of the change in the weight of major retail cuts in the lamb carcasses in these data. Inspection of the various R^2 values for the five linear regression equations shown in Table 47 indicates that carcass weight was associated with a major portion of the variation in the dependent variable while the two conformation scores were associated with almost none. In fact, tests for statistical significance of the partial regression coefficients for leg and carcass conformation scores indicated that their difference from zero was due only to chance. The R^2 values for carcass trim fat and *l. dorsi* area were 29.5 percent and 62.5 percent respectively. These R^2 values show that differences in the weight of major retail cuts were best indicated by differences in carcass weight, were indicated to a much smaller degree by differences in carcass trim fat or *l. dorsi* area and differences in leg or carcass conformation scores were associated with essentially none of the variation in weight of major retail cuts.

When two or more independent variables are considered in multiple regression analyses, the influence of one variable on the variation in the dependent variable may be determined with the influence of the other independent variable or variables held constant. In multiple regression analyses, the magnitude of the coefficient of determination (R^2) will also indicate the portion of the variation in the dependent variable considered to be associated wtih the independent variables. Since the results observed in Table 47 indicated a strong positive influence of carcass weight, the study continued by considering carcass weight in combination with each of the other independent variables. These analyses measured the influence of the remaining independent variables with the variation caused by variation in carcass weight removed. The results of these analyses are presented in Table 48.

Equation 1 in Table 48 shows that the partial regression coefficient for leg conformation score was not significantly different from zero. The R^2 value for this equation was identical to that shown in equation 1 in Table 47 where carcass weight was the only independent variable. The same conclusion was drawn for the results obtained for equation 2 in Table 48 where carcass conformation score was the second independent variable. These results revealed that the conformation scores added nothing to the accuracy in estimating differences in the yield of retail cuts from lamb carcasses when the differences caused by carcass weight were removed. This indicated that the conformation scores are of no value as indicators of differences in yield of retail cuts in a carcass grading system if a measurement of carcass weight is available. It implied that conformation evaluations were poor estimators of yield of retail cuts in live lamb evaluation.

Equation 3 in Table 48 simultaneously considered the influence of carcass weight and the area of the *l. dorsi*. The regression coefficients for both variables were significantly different from zero and showed that both had a positive influence on weight of major retail cuts. The standard partial regression coefficients show the relative influence of the two variables by expressing the coefficients in the same unit of measure. These standard partial coefficients in equation 3 revealed that the influence of carcass weight was far greater than the influence of the *l. dorsi* area on the dependent variable. This fact was further

TABLE 48. PARTIAL AND STANDARD PARTIAL REGRESSION COEFFICIENT FROM EQUATIONS FOR ESTIMATING WEIGHT OF MAJOR RETAIL CUTS FROM LAMB CARCASSES (MULTIPLE REGRESSION EQUATIONS)

Independent variable	Equation number[a] 1	2	3	4
Y intercept	2.47	3.00	0.70	—.72
Carcass weight, pounds	0.57[b]**	0.57**	0.50**	0.72**
	0.96[c]	0.96	0.84	1.21
Leg conformation score[d]	—.006[N.S.]			
	—.002			
Carcass conformation score[d]		—.06[N.S.]		
		—.02		
L. Dorsi area, square inches			2.95**	
			0.16	
Total trim fat weight, pounds				—.66**
				—.34
R^2	93.22	93.25	94.47	98.77
S[e]	1.68	1.68	1.54	0.72

**P < .01, [N.S.]Nonsignificant.

[a]Dependent variable—weight of major retail cuts.

[b]First value shown for each independent variable is the partial regression coefficient.

[c]Second value shown for each variable is the standard partial regression coefficient.

[d]Good = 7, 8, 9; Prime = 13, 14, 15.

[e]Standard error of estimate.

demonstrated when the R^2 value of 94.5 for this equation was compared with the R^2 value of 93.22 for equation 1 in Table 47 where carcass weight alone was considered. The addition of the *l. dorsi* area increased the precision of the estimation of the weight of major retail cuts by only slightly more than 1 percent.

The combined influence of carcass weight and carcass trim fat on weight of major retail cuts was demonstrated by equation 4 in Table 48. The R^2 value for this equation was 98.77 percent showing that these two variables accounted for all but 1.23 percent of the variation in the weight of major retail cuts in these data. The partial regression coefficients indicated that the influence of carcass weight was positive and the influence of carcass trim fat weight was negative. This meant that when the influence of the difference due to carcass weight was removed, an increase in weight of carcass trim fat resulted in a decrease in the weight of major retail cuts. By the same token, this meant that when the influence of differences in carcass trim fat weight was removed, an increase in carcass weight resulted in an increase in weight of major retail cuts. This equation was the most efficient of all equations considered in this study because it accounted for a greater portion of the variation in weight of major retail cuts. It was also more efficient than any equation reported in the literature for estimating either weight or percent of major retail cuts.

Summary

It was concluded from this study that the weight of the major retail cuts obtained from a lamb carcass was determined more completely by carcass weight and the weight of the carcass trim fat than by any other variables considered. An increase in carcass weight caused an increase in the weight of major retail cuts. An increase in carcass trim fat caused a decrease in weight of major retail cuts. Thus, if the goal of sheep improvement is to increase the weight of the retail cuts obtained from the lamb carcass, it can be best attained by selecting breeding animals that have the heaviest body weight at the age their slaughter lamb offspring are marketed with no more fat than is necessary to give the carcass adequate shipping protection and retail shelf life and to give the meat satisfactory eating quality.

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PR-2645

More Efficient Utilization Of Winter Grain Pastures

Maurice Shelton and M. C. Calhoun

Winter grazing from small grain fields represents one of the better nutrient sources available to farm or ranch livestock in the Central Texas area. If such grazing were available in quantity, most of the livestock producer's problems would be solved. However, because of a shortage of moisture or limited acreage, available forage from small grain grazing is usually in short supply. Since young growth of small grains, such as wheat or oats, is an excellent source of protein (often as high as 20 percent), vitamins and some minerals, it would appear that in many cases winter grazing from small grains should be managed as a supplemental source of these important nutrients for many classes of animals instead of the total ration provided. Oats provide the primary small grain of interest in this area. Periodic protein determinations were made on one pasture (Alamo-X oats planted in early September and fertilized at the rate of 25-25-0) in the fall and winter 1968 with protein content 19.6 percent, October 23; 19.9 percent, November 6; 18.9 percent, November 21 and 14.3 percent, December 10. These determinations are expressed on an air dry basis (calculated to 10 percent moisture). The low protein for the December 10 collection date apparently represents, in part, method of sampling as the latter sample was collected by a different individual.

The protein content of the above forage is higher than that required by any class of sheep or goats except possibly the very young animal. As evidence of this, the suggested protein level expressed as a percent of the complete ration (*ad libitum* intake) for certain classes of sheep and goats are:

	Protein level, percent
Young lambs (40 pounds or less)	16.0
Feeder lambs	12.0
Dry ewes and gestating ewes (first 3 months)	6.5
Gestating ewes (last 6 weeks)	8.0
Lactating ewes	10.0
Dry does	8.8
Gestating does (last 6 weeks)	10.0
Lactating does	12.0
Developing young does or billies	14.0

The above values represent the authors' interpretation of available research information. It will be noted that the protein content of oat forage is above the requirement of any of the classes outlined above, but especially that of mature animals. By contrast, the energy content of the oat forage may be somewhat below that required for maximum performance because of the high moisture content. This would be primarily applicable to animals with limited digestive capacity, such as young lambs or kids, which are being fed for maximum performance. When the animal requirements and forage content are known, it should be possible to calculate the optimum ration for both animal performance and most efficient utilization of small grain forage. In the case of animals, such as feeder lambs, with high energy requirements, this would require provision of supplemental energy feeds. However, in the case of an excess of protein in the oat forage, it would require intermittent grazing such as a few hours per day or a few days per week.

Experimental Procedure

Utilization of Oat Forage as a Supplement

Two short-term trials were conducted in fall 1968 to investigate the use of the practice of intermittent grazing in the utilization of oat pastures. The first trial was conducted with Angora billy kids beginning October 19, 1968, and continued for a period of 6 weeks. The treatments were:

Lot 1—run on bermudagrass with a supplement of 0.4 pound per day of a mixture containing one-half sorghum grain and one-half cottonseed meal fed twice weekly.

Lot 2—run on bermudagrass but grazed 2 days per week (Tuesday and Friday) for 24-hour period on oat forage.

Lot 3—run continuously on oat forage.

The results in terms of animal performance are shown in Table 49. This study is of short duration and thus should be limited in interpretation. However, it shows that periodic grazing of oat forage did not adversely affect animal performance and that twice-weekly grazing of oat forage more than equals 0.4 pound daily of a high concentrate supplement in contributing to performance. It also shows, as could have been predicted, that bermudagrass (mostly dry in late fall), even with supplement, is not an adequate ration for development of kid goats. Gains at least on the order of those made on oat pasture are required for maximum or optimum development of billy kids during their first season.

TABLE 49. A COMPARISON OF INTERMITTENT GRAZING OF OATS AND A PROTEIN CONCENTRATE FOR KID GOATS

Six weeks (beginning October 19, 1968) Treatment	Number animals	Average initial weight	Body weight change during trial	Number lost from Freezing[1]
Bermuda and supplement	26	40	+ 1.0 lb.	5
Bermuda and oat grazing	26	41	+ 2.0 lb.	2
Continuous oats	12	45	+ 5.7 lb.	1

[1]These goats had approximately a 6-week hair growth at the time this experiment was initiated. During the trial, a cold storm (prolonged rain, wind and temperatures as low as 30° F.) resulted in loss of eight goats from freezing. These animals were in open fields with no protection.

A second trial was conducted with yearling ewes (approximately 1 year of age) beginning in November 1968. This trial was identical to that with the kid goats except that the ewes were fed one-half pound of supplement per day. Supplemental feed or oat grazing was provided on Tuesday and Friday. At other times, the ewes were run on dry bermudagrass with sorghum hay fed at the rate of approximately 1 pound per head per day. The results are shown in Table 50. Again there is no evidence that periodic grazing of oat forage adversely affected animal performance, but in this case 2 days grazing on oat forage

TABLE 50. RESULTS OF PERIODIC GRAZING OF OAT FORAGE BY YEARLING EWES

Treatment	Number	Average initial weight	Total 30-day gain per ewe, pounds	Death losses
Roughage[1] + one-half pound supplement	20	75.5	+ 1.8	1[2]
Roughage[1] + twice weekly grazing of oat forage	22	76.8	— .03	0
Continuous oats	10	73.9	9.1	0

[1]The roughage used was low-level feeding of sorghum hay (approximately 1 pound per head per day) fed on dry bermudagrass pasture.

[2]This animal's death was caused by a wolf and was not related to treatments imposed.

TABLE 51. SOME RESULTS OF PROVIDING SUPPLEMENTAL ENERGY TO FEEDER LAMBS ON OAT FORAGE[1]

Treatment	Number lambs per acre	Average daily gain, pounds	Feed intake per day	Feed intake per pound gain	Lamb gains, per acre	Calculated gross value of lamb gains per acre less cost of feed, Situation[2] 1	2	3	4
Fed[3]	7.6	.33	1.16	3.50	243.5	42.91	33.21	56.30	46.60
Control	4.5	.33	0.00	0.00	133.9	33.48	28.12	41.46	36.11
Difference (fed-control)	3.1	.00	1.16	3.50	109.6	9.43	5.09	14.84	10.49

[1]Performance data were collected on two 10-acre pastures grazed from November 22, 1961 to March 26, 1962. Not all lambs were in the pasture for the entire period as lambs were added as needed to utilize available forage and sold as they reached desirable market finish. The pastures were fertilized (150 pounds 16-20-0) oats (Suregrain) under good moisture conditions and thus producers should not generally expect a carrying capacity this great.

[2]Situation 1—Sale value of lambs = 25 cents per pound with no margin and no death losses.
Situation 2—Sale value of lambs = 21 cents per pound with no margin and no death losses.
Situation 3—Sale value of lambs = 25 cents per pound with a 3 cent positive margin and no death losses.
Situation 4—Sale value of lambs = 21 cents with a 3 cent positive margin and no death losses.

[3]Lambs were self-fed a mixture of 80 percent ground sorghum grain and 20 percent cottonseed hulls. Feed prices used were $23 per ton for cottonseed hulls and $46 per ton for sorghum grain.

per week did not quite equal one-half pound of supplement daily in contributing to performance. Also, this level of feed intake did not provide for adequate development of yearling ewes, but the continuous oats provided more gain than would be desirable for ewes if continued for a long period of time. This suggests that something less than full-time utilization of small grain forages by yearling ewes in the fall and winter would provide for optimum development and also extend the supply of winter forage.

Extending the Use of Small Grain Pastures

Over a period of years, several trials have been conducted with feeder lambs to study methods of extending limited quantities of small grain grazing. These have generally taken the form of feeding lambs on oat pasture to improve animal performance or increase carrying capacity. During the fall and winter months when oat forage is of high quality and an adequate quantity is present, the provision of supplemental feed has not consistently improved animal gains, although in most cases it is apparent that animals receiving high energy supplements are fatter. However, the provision of supplemental energy feeds will invariably increase carrying capacity, and since the more expensive nutrients are supplied by the forage, the adoption of this practice will generally be found to be economical with animals being fed for market. This is especially true where a positive margin is expected and quantity of small grain forage is a limiting resource. An example of this is shown in Table 51. These data primarily illustrate the possibilities of supplemental feeding to increase the carrying capacity and returns when calculated on a per-acre basis. Similar calculations made on a per-head basis would obviously show an advantage for not feeding. Thus, a critical question relates to which is the limiting resource, and this report is predicated on the assumption that the limiting resource is quantity of small grain forage. It should be noted that these data represent utilization of forage only to early March with much of the production from this crop to be utilized in other ways.

Where the quantity and quality of small grain grazing are good, it may be necessary to force animals to take grain feed by penning them near the feeders for a few hours daily or overnight. In most studies at the Research Center at McGregor, pure sorghum grain has been used as a supplement for old-crop lambs, although in some cases, a small amount of dry roughage such as cottonseed hulls or sorghum hay has been used, Table 51. In the case of young early weaned lambs, a more complete ration has been used. No studies have been conducted at the McGregor Center to determine the type of ration to be used as a supplement to oat forage.

Some Suggestions

Some possible suggestions for utilization of a limited quantity of small grain grazing with various classes of sheep and goats are presented in Table 52.

TABLE 52. SUGGESTIONS FOR UTILIZING A LIMITED QUANTITY OF SMALL GRAIN GRAZING WITH VARIOUS CLASSES OF SHEEP AND GOATS

Class of animals	Amount of small grain grazing	Additional feed source	Comments
Dry ewe and ewes in early gestation	One day per week	Dry range or pasture forage or nonlegume hays	Small grain used only as a source of supplemental protein and vitamins
Ewes in late gestation	Two days per week	Dry range or pasture forage or nonlegume hay plus one-half pound energy supplement per day	Small grain used as a source of supplemental protein and vitamins
Lactating ewes with baby lambs	Full time	Supplemental energy (sorghum grain) and/or dry roughage may be fed to increase carrying capacity	Small grain forage to provide the primary nutrient source for both ewes and lambs
Early weaned lambs	Full time	Supplemental energy may be used to advantage to improve or to insure good performance.	Limited digestive capacity of small lambs may prevent them from ingesting adequate high moisture forage to insure good gains
Feeder lambs	12 hours daily or full time	Sorghum grain or other energy source may be used to increase carrying capacity or to improve condition of lambs.	Half-time grazing of small grain forage will more than provide any mineral or vitamins required to supplement cereal grains
Dry does or does in first 3 months gestation	Two days per week	Range forage	Infrequent grazing as contrasted to full-time use of small grains may also help prevent photosensitization
Does in last 60 days gestation	Two days per week	Range forage plus energy supplementation for small or weak does	Infrequent grazing as contrasted to full-time use of small grains may also help prevent photosensitization
Lactating does and young kids	One-half to full time	Supplemental energy or dry roughage may be used to increase carrying capacity	Lactating does with young kids are well adapted to efficient utilization of small grain grazing; however, other species (cattle or sheep) may be better income producers than goats, and thus the latter would not often be indicated as a means of utilizing this important resource
Developing young does and billies	Full time	Supplemental energy (grain) may be used to maximize performance, but this would not generally be economical in a commercial program	Photosensitization may develop when full-time grazing of small grain is practiced

WOOL AND MOHAIR FIBER FINENESS GRADE STANDARDS

The following wool and mohair grade standards for fiber fineness are listed for information purposes. These are the standards used to identify wool and mohair grades as listed in these progress reports or as may be listed in market news reports.

Micron is the unit of measurement used and is equal to 0.000039 inches. Spinning counts are considered to be the number of hanks of yarn which can be spun from 1 pound of scoured wool or mohair. A hank of yarn is 560 yards in length.