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RESEARCH REPORTS

Sheep and Angora Goat, Wool and Mohair---1972

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Foreword

Sheep and goat numbers in Texas have generally followed the trend in other states and declined substantially in recent years. Texas continues, however, to have approximately 20 percent of the nation's sheep and 97 percent of the Angora goats. Sheep and goats are produced in all areas of the State but are concentrated primarily in those areas of Texas where they can more efficiently harvest the range and pasture forages. However, large portions of Texas range and pasture lands can be utilized efficiently by grazing with more than one species of livestock; this emphasizes the desirability of maintaining a viable sheep and goat industry.

The decrease in sheep and goat numbers is the result of a variety of factors, not all of which are economic. The Texas Agricultural Experiment Station is dedicated to developing and conducting effective research programs which will give solutions to all types of problems of the sheep and goat industry. This publication reports some of the research efforts in the field of animal science. Other research efforts which apply directly or indirectly to problems of the sheep and goat industry are conducted by the Departments of Range Science, Agricultural Economics, Entomology, Biochemistry and Biophysics, Soil and Crop Sciences and Agricultural Engineering and the College of Veterinary Medicine.

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PR-3017

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Relationship of Body Weight To Ovulation Rate In Mature Fine-Wool Ewes

J. R. Gallagher and Maurice Shelton

SUMMARY: To determine the relationship of body weight to ovulation rate, data on 530 ewes which had been laporatomized or slaughtered in various seasons over a period of 8 years were analyzed. Season of the year significantly affected ovulation rate. However, in these analyses the differences between season were much less marked than those reported in earlier studies. This can be explained largely by the fact that only ewes which had shown estrus were included in this study. The major effect of season was in the number of ewes which exhibited estrus. Ovulation rate was significantly related to body weight with the heavier ewes having more multiple ovulations. On the basis of studies showing a higher relationship between body weight and number of lambs born, this relationship was less than expected. A partial explanation may be that body weight affects other components of reproductive efficiency in addition to ovulation rate.

Introduction

The potential number of young which can be born from a particular mating is dependent upon the number of ovum released from the ovary (ovulation rate) and may vary from one to three under natural conditions. Higher values than this occur only very rarely. The number of lambs actually born is dependent not only on ovulation rate but is influenced by fertilization and embryo survival as well.

It is generally known that large ewes produce more twin lambs (Coop, 1962; Shelton, Morrow and Butler, 1966) whereas the influence of weight on the percentage of ewes which produce lambs is variable, being lower at both ends of the spectrum. The components which contribute to this relationship are not fully known. Edey (1968) has shown a high correlation between body weight and ovulation rate in Australian Merino over the range of 77 to 121 pounds. These values tend to be below or on the lower end of the range in body weight for most well-developed

Rambouillet ewes. This investigation was undertaken to determine the relationship of size to ovulation for fine-wool ewes in Texas.

Procedure

In studies on reproductive performance, numerous ewes were laporatomized to record ovulation rate. Control groups in these investigations provided an essentially normal population for use in studying factors affecting ovulation rate. In the period 1962-70, 530 ewes which received no hormones to stimulate or alter ovulation rate were laporatomized following estrus. Body weights were recorded within a few days of laporatomy. The ewes were mature fine-wool ewes, and most could be more properly classified as aged, grade Rambouillet ewes. Observations were collected throughout the year, but for the purpose of analysis, the data were grouped into spring (March 21-June 20), summer (June 21-September 20), fall (September 21-December 20) and winter (December 21-March 20). These analyses involved only ewes which were recorded in estrus; thus zero values resulting from ewes which failed to cycle due to seasonal anestrus or to underdevelopment are not included. This is in contrast to many studies involving season or body weight in which zero values are included.

This study provides a more direct look at variability in ovulation rate but requires some caution in relating it to potential lamb drop. The regression of ovulation rate on body weight was calculated using both linear and quadratic functions. The data were analyzed separately for the four seasons and for the pooled data. Thus information on the effect of season on ovulation rate was provided.

Results and Discussion

The mean values for the seasons and the regression equations showing the relation of body weight and ovulation rate are shown in Table 1. The effect of season follows the pattern shown in earlier work (Barrett, Reardon, and Lambourne, 1962; Shelton and Morrow, 1965). However, the variation due to season is much less marked than might have been predicted from previous work. Using the values adjusted for differences in body weight, a difference of 0.42 ovulation per ewe was recorded between spring and fall whereas Shelton and Morrow (1965) reported a difference of 0.61 between spring and fall for similar ewes. One possible explanation is that approximately 14 percent of the ewes in the spring group involved in the earlier study had been silent ovulators (no active estrus), and there may be a difference in the ovulation rate of the ewe which shows a silent as compared to an active estrus.

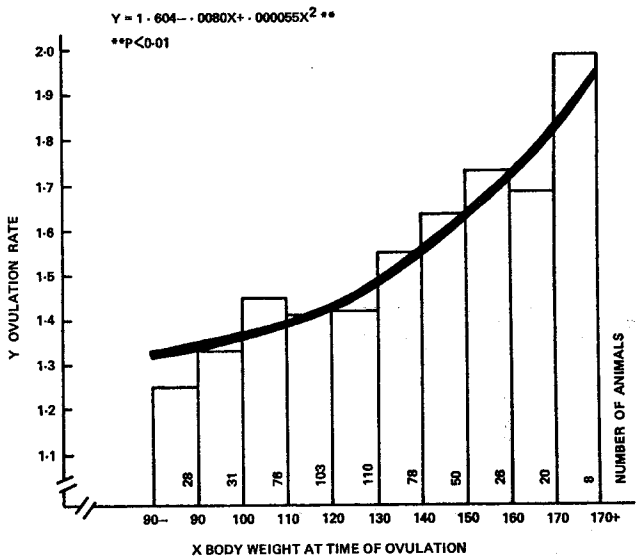

Figure 1. The relationship between ovulation rate and body weight.

In studying the relation of size to ovulation, the linear and quadratic functions were both included in all analyses without reference to the statistical significance of each. When the variance due to regression was fractioned in this manner, the individual coefficient was not significant in either case. However, the total variance due to regression was highly significant for the fall and winter seasons and for the total body of data. The actual observed ovulation rate for various body weights and the calculated values using the regression equation calculated from the entire body of data are plotted in Figure 1.

TABLE 1. RELATION OF SEASON AND BODY WEIGHT TO OVULATION RATE

Season	No. ewes	Mean body wt.	Mean ovulation rate	Ovulation rate adjusted to mean body wt.[1]	Regression equation (Ovulation rate on body wt.)	Significance of regression
Spring	78	118.6	1.282	1.225	$3.513 - .0378X + .000156X^2$	NS[2]
Summer	159	125.6	1.484	1.478	$1.026 + .00253X + .000009X^2$	NS[2]
Fall	179	121.4	1.575	1.645	$-.880 + .0340X - .000110X^2$	P ≦ .01
Winter	114	129.6	1.465	1.369	$2.613 - .0264X + .000132X^2$	P ≦ .01
Overall	530	124.0	1.481	1.481	$1.604 - .0080X + .000055X^2$	P ≦ .01

[1]Adjustment made by use of the regression equation calculated for each individual season.

[2]Not statistically significant.

TABLE 2. EXPECTED PERCENTAGE INCREASE IN OVULATION RATE WITH EACH 10-POUND INCREASE IN BODY WEIGHT

Body weight range, lb.	Expected % increase in ovulation rate
80 - 90	1.03
90 - 100	1.88
100 - 110	2.62
110 - 120	3.34
120 - 130	4.00
130 - 140	4.58
140 - 150	5.08
150 - 160	5.51
160 - 170	5.86

The expected increase in ovulation per unit increase in body weight over certain ranges is shown in Table 2. The rate of increase is greater at the heavier weights. At the lower range of this series of weights, an increase in body weight results in an increase in the number of ewes showing estrus whereas at the heavier weights the major effect is an increase in the ovulation rate. The direction of this increase is the same as that shown in earlier studies. However, the slope of the regression line is much less marked than that reported by Edey (1968) for ovulation rate or the value reported by Shelton *et al.* (1966) for the total effect of ewe weight on lamb production.

Ovulation rate is only one component of the overall effect of size on the total lamb production. Other components may be number of ewes showing estrus, conception rate, ability of the ewe to carry multiple embryos and survival and growth rate of the lamb produced. It is known that increases of body weight up to approximately 100 pounds result in marked increase in the percent of the ewes showing estrus and conceiving. At extremely heavy weights the percent of ewes lambing is reduced. The influence of body weight on the ability of the ewe to carry multiple embryos seems not to have been investigated.

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Lambing Interval in Ewes Run Continuously With Rams

Maurice Shelton

SUMMARY: Two small flocks of ewes were run continuously with rams for 3 years. The average lambing interval was 240.8 days or approximately 8 months. A lambing interval of this magnitude was obtained only by allowing those ewes which would do so to lamb at shorter intervals in order to make up for the group which lambed at considerably longer intervals. This suggests that in order to obtain the maximum lamb production, some scheme of continuous lambing may be required. Such a scheme is possible, but the management techniques required are considerable. Consequently, the scheme should be worked out by the individual producer as it can be adapted to his own resources.

Most of the ewes in this study were aged fine-wool ewes given minimal care. Some improvement over these results might be expected from use of younger but mature ewes or appropriate crossbred ewes and from management of ewes according to nutritional needs. Season of the year had a major effect on time interval from lambing to remating. Ewes lambing in the summer or fall had the shortest interval to remating, and those lambing in the winter had the longest. Lactation appeared to have only a limited effect on remating as 43.5 percent of the ewes rebred before their lambs were weaned.

Introduction

An increased level of lamb production seems to offer a means of survival, or revival, of the sheep industry in Texas. More frequent lambing (multiple or accelerated lambing) offers one promising technique to accomplish this goal. It is important to determine the potential for accelerated lambing in order that management schemes can be devised to take advantage of this potential.

Materials and Methods

Two small flocks of mature Rambouillet ewes were established at Texas A&M University Agricultural Research Center at McGregor in June 1967 and were run with rams continuously for 3 years. Each flock initially consisted of approximately 30 ewes, but this number was not maintained exactly as ewes died or were removed for various causes. The two flocks differed in that one was run under pasture conditions and the other was maintained throughout the period in drylot. The ewes in drylot were self fed on a mixture of sorghum grain, sorghum hay and cottonseed meal with Vitamin A and salt added. The level of

roughage in the ration was varied from time to time between 65 and 85 percent of the ration depending on the quality of the hay used and the condition of the flock. The pasture group was grazed on the forage available which tended to be small grains in the winter and spring seasons and sorghums or native pasture in summer. Supplemental feeding was used as necessary to maintain condition of the flock in general. The management system in each flock was designed to maintain the group as a whole; consequently, the condition of individual ewes fluctuated depending on stage of gestation or lactation. The ewes in both flocks ranged from solid mouths to aged ewes and tended to be in the terminal phase of their productive life.

All lambs were early weaned as compared to conventional practice of later weaning in range flocks in the state. Both flocks were worked at approximately monthly intervals, and all lambs which were 60 days of age and weighed 40 pounds were weaned at that time; all lambs at least 90 days of age were weaned regardless of weight. Thus, all lambs were weaned between 60 and 90 days of age.

The data were analyzed by lambing intervals, that is, time lapse between two consecutive parturitions of individual ewes while they were present in the flock. The total of 167 parturition intervals involved included from one to four for individual ewes. These data were analyzed primarily with respect to the effect of season and lactation on lambing interval.

Results and Discussion

Due to the relatively small numbers involved, the data from the two groups were combined for analyses. The ewes on pasture tended to perform more satisfactorily, but losses to predators were a problem. The ewes on pasture tended to be better nourished, especially at seasons when small grain grazing was available. The ewes in drylot performed satisfactorily, but there was a tendency for their performance to deteriorate the longer they remained in drylot. However, since this decreased performance was confounded with the length of time they had been on the multiple lambing scheme, it is not possible to isolate drylot nutrition as a cause of reduced performance. One problem frequently encountered in the drylot group was uterine prolapse at lambing. With the high labor input in harvesting and processing feeds for the drylot group, drylot maintenance was not economically sound under the conditions under which it was practiced in this study.

The overall lambing interval was 240.8 $\pm$ 4.07 days. This translates to an approximate lambing interval of 8 months or to a remating at an average of 90 days post lambing. This interpretation is not exact as lambing interval can be calculated only on those ewes which actually lamb more than once while in this flock. Thus, the actual reproductive efficiency is somewhat below this. Many producers have translated this into a program of lambing three times in 2 years which constitutes 8-month lambing intervals. However, the data suggest that this time interval may be in error in that, with an average lambing interval of 8 months, approximately one-half of the ewes had shorter and one-half longer lambing intervals — this figure was obtained as an average only by allowing one-half of the ewes to lamb at shorter intervals. The standard deviation of the lambing interval was 52.62 days. This degree of deviation shows an abnormal distribution as two standard units of standard deviation would have certain ewes mating before they had lambed. The distribution of lambing intervals graphed in Figure 1 also shows that these data do not follow a normal distribution. The major peak of ewe lambing centers around 180 to 240 days. However, there appears to be a skew to the right with a significant number of ewes showing lambing intervals of greater than 300 days. If these ewes could be made to rebreed along with the majority of the flock, the average lambing interval would be much shorter. There may be a physiological explanation for these lambing intervals of larger than 300 days; this possibility should be investigated.

The Effect of Season

Since these ewes were run continuously with rams, it is possible to study the effect of season on lambing interval (Table 1). The ewes were divided into four groups based on date of lambing: spring (March 21 to June 20), summer (June 21 to September 20), fall (September 21 to December 20) and winter (December 21 to March 20).

As expected, season of the year had a highly significant influence on interval to conception. Since the average interval from lambing to conception was 90 days, mating occurred the season following lambing. On this basis, these data follow the expected pattern with ewes lambing in the winter showing the longest lambing interval (281.1 days). These ewes also showed the greatest variability in lambing intervals probably because a few of the ewes rebred before initiation of a spring anestrus period while the majority went into an anestrual period of variable length.

TABLE 1. INFLUENCE OF SEASON OF LAMBING ON LAMBING INTERVAL

Season of lambing	No. parturitions	Avg lambing interval days	Range days	Standard error
Spring	36	241.6	196-366	6.59
Summer	21	224.8	174-329	7.87
Fall	75	226.1	161-362	6.17
Winter	35	281.1	183-390	8.65

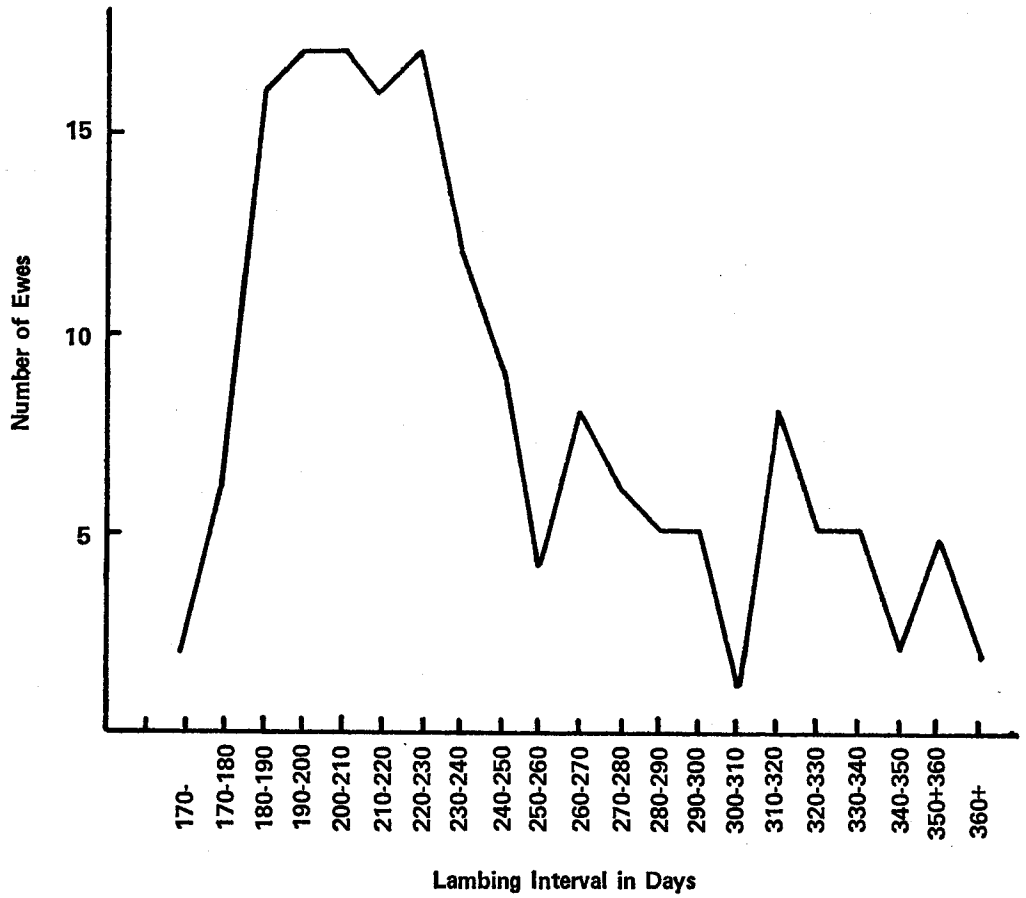

Figure 1. Distribution of lambing intervals on mature fine-wool ewes run continuously with rams.

The shortest lambing intervals were among ewes which lambed in summer and remated in the fall. However, these were only slightly shorter than those of ewes which lambed in the fall as apparently most of these remated before initiation of an anestrual period.

The Effect of Lactation

A reduction in the average lambing interval over those observed in this study is critical to obtaining the maximum reproductive performance. The condition of the ewe may have an effect on lambing interval. Although each ewe was weighed annually, this weight provides little clue to the condition of the ewe at the critical time of remating. However, lactation history provides some estimate of the condition of the ewe. The lambing interval in relation to lactation is shown in Table 2.

The differences shown are not statistically significant, but the trend of longer lambing interval with higher level of lactation seems to indicate that these differences are real; lack of significance is due to the small numbers in the groups. Since the lambs in this study were early weaned, and many of the ewes remated only after the lambs were weaned, this tabulation represents both a direct and a latent effect of lactation possibly mediated through the effect on condition of the ewe. The major difference is between ewes which did not lactate and those which did. The large difference in the standard errors of lambing intervals between the groups is somewhat surprising but probably has a physiological explanation. Possibly included among the ewes which lost their lambs were a number which became sick (mastitis, uterine infections, and so forth). That they rebred only after recovering from the infection possibly resulted in the extreme variability. Likewise, some of the ewes nursing twins apparently were milked down to the extent that a period of recovery was required.

TABLE 2. INFLUENCE OF LACTATION ON LAMBING INTERVAL

Lactation history	No. parturitions	Lambing interval days	Range days	Standard error
Lost lamb	23	227.0	176-335	9.02
Raised one lamb*	117	241.9	161-390	4.93
Raised two lambs	27	248.0	182-354	10.82

*Includes ewes giving birth to twins but in which one lamb was lost.

TABLE 3. DISTRIBUTION OF DATE OF CONCEPTION RELATIVE TO DATE OF WEANING OF PREVIOUS LAMB OR LAMBS

Date	No. conceptions	% of total
Before Weaning	50	43.48
1st month postweaning	30	26.09
2nd month postweaning	14	12.17
3rd month postweaning	5	4.35
4th month postweaning	8	6.96
5th month postweaning	4	3.48
6th month postweaning	4	3.48

Knowing the weaning date on the individual lambs makes possible an examination of conception data (150 days previous to lambing date) relative to weaning of the previous lamb (Table 3). These data considered with those in Table 2 suggest that lactation is only a relatively minor factor influencing the ability to rebreed ewes.

Conclusions

These data indicate that ewes may be expected to lamb at approximately 8-month intervals, but shortening this interval somewhat should be possible. The ewes involved in this study were aged ewes and were generally undernourished during lactation. Ewes in their prime producing years (3 to 5) generally performed better than the very young or very old ewes.

Lambing at 8-month intervals does not appear possible if ewes are allowed to mate only at 8-month intervals. An average lambing interval of this length was obtained in this study only by allowing those ewes which would do so to remate at earlier intervals to make up for those with much longer lambing intervals. This suggests some scheme of continuous lambing, but the management techniques for such must be worked out by the individual producers in relation to their own resources.

Season of the year is a distinct factor in lambing interval; where accelerated but controlled lambing is practiced, this factor should be considered in choice of mating periods.

Lactation does not appear to be a serious impediment to early remating – in this study about 43 percent of the ewes remated while still nursing lambs.

The performance of individual ewes and their reaction to multiple lambing varied considerably. Several ewes produced lambs at intervals approaching 12 months while one ewe produced and raised nine lambs in 3 years. It should be possible to select individual ewes for substantially better performance. In addition, appropriate crossbred ewes might be expected to perform better than the straight fine-wool ewes used in the present study.

Influence of Cyclophosphamide (CPA) On Reproduction in Sheep

Maurice Shelton

SUMMARY: The effect of cyclophosphamide (CPA) on various reproductive processes in sheep was studied. Data combined with results of work of other researchers suggest that CPA should not be administered to the breeding male within approximately 7 weeks of commencement of the breeding season. Some reduction in libido may be expected to occur during the weeks immediately following administration of the drug, and some reduction in sperm cell count might be expected to occur 6 to 7 weeks later. In contrast to studies with laboratory animals, no evidence of fetal teratology was observed. These data provide no evidence that CPA at the levels used affects survival of the embryo or maintenance of pregnancy when ewes are treated during the first 4 months of pregnancy; the data do provide some suggestion that when used in late pregnancy, CPA may affect survival of the lamb during the early postnatal period.

Introduction

Cyclophosphamide (CPA, cytoxan or chem-shear) has been proposed as a potential agent for chemical defleecing of sheep. If or when the drug is eventually approved for this purpose, it will at times be desirable to treat animals in various stages of reproduction. Thus it is important to know the effect of this drug on the various reproductive processes. The possibility of fetal teratology or the birth of defective offspring as a result of treatment of the pregnant female deserves special attention. CPA and other related alkylating agents are known to be teratogenic in laboratory animals such as rats, mice, rabbits, amphibians and developing chicken eggs (Murphy, *et al.*, 1957; Gibson and Becker, 1968; Gibson and Becker, 1971). Its effect on other reproductive functions or possible teratogenic effects with large animal species have not been thoroughly investigated.

Effect of CPA on Male Fertility

Five pairs of rams were subjects for investigation of the effect of CPA on fertility for the period of 10 days immediately post treatment. The fleece is usually removed at approximately this time, and the animal is left very bare. It was assumed that due either to cold or heat stress or to sensitivity of the bare skin, the males would be largely ineffective as breeders until a regrowth of cover had occurred. Also it is known that a marked but transitory reduction in white cell count occurs within 10 days post treatment. Inskeep, *et al.* (1971) reported studies on the effect of this drug on fertility for the period of 7 weeks post treatment.

TABLE 1. INFLUENCE OF CYCLOPHOSPHAMIDE (30 mg/kg) ON BREEDING PERFORMANCE OF RAMS FOR 10 DAYS POST TREATMENT

Ram no.	Age & breed of rams	Treatment & date	Ewes exposed	Ewes marked		Ewes settled	% settled of those marked
				No.	%		
7786	Yearling Rambouillet	Control	15	10	66.7	7	70.0
7766	Yearling Rambouillet	9/24/69	15	11	73.3	3	27.3
3634	Mature Columbia	Control	15	12	80.0	6	50.0
3583	Mature Columbia	9/16/69	15	12	80.0	3	25.0
8841	Yearling Rambouillet	Control	18	10	55.5	2	20.0
8998	Yearling Rambouillet	6/3/70	23	2	8.7	0	00.0
8907	Yearling Rambouillet	Control	15	10	66.7	6	60.0
8862	Yearling Rambouillet	6/16/70	13	10	76.9	3	30.0
8907	Yearling Rambouillet	Control	9	6	66.7	2	33.3
8841	Yearling Rambouillet	8/10/70	10	8	80.0	1	12.5
	Summary	Control	72	48	66.7	23	47.9
		Treated	76	43	56.7	10	23.4

In the present study the rams were treated with 30 milligrams per kilogram (mg/kg) of CPA as a drench. Beginning on the day of treatment, they were exposed to a group of ewes for 10 days. Matings were recorded by markings made by painting the brisket of the rams with a mixture of lamp black in oil. These treatments were conducted from October 24, 1969, to August 10, 1970. The ewes were subsequently slaughtered to determine pregnancy. The results are shown in Table 1. Except for one treated ram, all rams marked approximately the number of ewes to be expected from an exposure of 10 days of a 17-day estrus cycle. However, in all cases the treated rams settled fewer of the ewes than the control rams. One ram (8998) failed to settle any of the ewes to which he was exposed. The difference between the treated and control rams is statistically significant when the data are combined for the five pairs of rams.

The mechanism of this reduction in fertility is not known. Inskeep, *et al.* (1971) did not find a reduction in sperm count at this time. However, the administration of CPA at this level is known to cause a transitory or temporary reduction in white cell count and some degree of anorexia. Therefore, it appears that a reduction in mating vigor is the likely explanation for the effect noted. The conception rate of ewes bred to both the control and treated rams is generally lower than might have been expected. This apparently can be explained by the fact that these matings were made in the spring and summer when conception among sheep is generally poor in the McGregor area. The work of Inskeep, *et al.* (1971) has shown that CPA at 40 mg/kg does cause a reduction in sperm count 6-7 weeks post treatment. Therefore, it would appear desirable not to treat breeding rams within 7 weeks of initiation of the breeding season. In this study one ram died, but all others were subsequently used for breeding and proved to be fertile. No abnormal lambs were found among those bred by these rams.

TABLE 2. INFLUENCE OF CYCLOPHOSPHAMIDE (30 mg/kg) ON CYCLE LENGTH IN EWES

Treatment	No. ewes	No. cycling	Estrus cycle length, days	
			Mean	Standard deviation
Control	18	17	18.4[1]	3.46
Treated 30 mg/kg	20	15[2] (19)	17.5	3.74

[1]One ewe did not return to estrus within 30 days, and three ewes had abnormal cycle lengths at the initiation of estrual cycling in June. If these three are discarded, the mean cycle length is 16.9.

[2]Five ewes were not recorded in estrus within 30 days, but these were laporatomized and four were found to have ovulated; these returned to service after two apparently normal cycles. This suggests that since these ewes had a bare skin at the time they would have returned to service, breeding marks were not observed.

Effect of CPA on Length of Estrual Cycle

A total of 38 ewes was used to study the effect of CPA on the length of the estrous cycle. The results (Table 2) do not suggest an effect on cycle length. Ewes receiving CPA were treated on days 0, 1, 3, 4, 5, 6, 7, 9, 10, 11, 13 and 14 of the cycle. Five ewes were not recorded in estrus within a normal cycle length. However, laporatomy showed that four of the five had ovulated and also returned to estrus at the equivalent of two estrual cycles. This suggests that these ewes cycled but were not recorded in estrus due to the absence of wool to hold marking pigment from ram. These data show no definite evidence of an effect on the development of the corpus luteum or a return to estrus. Ref (1968) reported that antimetabolites administered at a critical time, within 3 hours of expected peak of LH release, could block ovulation in the rat. In this study ewes were not treated in the immediate proestrual period. Thus it is conceivable that treatments administered on day 15, 16 or 17 might have an inhibitory effect on ovulation.

Effect of CPA on Embryo Survival in the Pre-Implantation Period

A total of 44 ewes was used to investigate the effect of a single oral treatment with CPA (30 mg/kg) during the preimplantation period on embryo survival. Of this number, 21 were treated and 23 served as controls. The ewes were treated on various days following mating (0 day). Ewes were treated on each day of the equivalent of one estrus period except for days 1, 2, 7 and 13. The ewes were either slaughtered, laporatomized or carried to lambing to ascertain pregnancy. The results are shown in Table 3. These data provide no evidence of an effect of CPA on embryo survival. Fourteen lambs were born of ewes allowed to lamb following treatment during this time. All lambs appeared normal in all respects.

Influence of Cyclophosphamide in the Gestating Ewe on Fetal Teratology and Lamb Survival

A critical question relating to the potential use of CPA as a chemical defleecing agent relates to its possible teratological effects when used on the gestating animal. A total of 180 ewes, treated during gestation, later lambed and produced a total of 240 lambs. These ewes had known mating dates and were treated (30 mg/kg) according to a schedule intended to provide for different ewes to be treated on at least alternate days throughout the gestation period. This was not accomplished completely due to failure of ewes to lamb, errors in recording estrus or death of some of the ewes involved. Periods of greater than one day's duration from which no lambs were born of ewes treated during these dates are 13-15, 19 and 20, 31 and 32, 35-37, 59-61, 64 and 65, 70 and 71, 73 and 74, 95 and 96, 100 and 101, 130 and 131, 133-135. Day 0 represents the date on which mating occurred. Among the 240 lambs born of treated ewes, no observable gross teratological effects were noted which could be attributed to treatment with CPA. One hermaphroditic lamb and one "bulldog" type lamb were born of treated ewes. However, neither of these is unusual. One hermaphroditic lamb was also born from ewes designated as control to the CPA group. All stillborn lambs out of the treated ewes or those which died within 24 hours of birth were frozen and dissected. Again no gross abnormalities were noted among these lambs. No histological studies were made on these carcasses. The influence of CPA on lamb birth weight and survival is reported in Table 4.

TABLE 3. INFLUENCE OF CYCLOPHOSPHAMIDE (30 mg/kg) ON EMBRYO SURVIVAL IN THE PREIMPLANTATION PERIOD

Treatment	No. ewes	No. pregnant	% pregnant
Control	23	18	78.26
Cyclophosphamide 30 mg/kg[1]	21	17	80.95

[1]Administered as a single oral drench on each day of the estrus cycle except for days 1, 2, 7 and 13, counting the day of estrus as 0 day.

TABLE 4. INFLUENCE OF CYCLOPHOSPHAMIDE AT 30 mg/kg IN THE GESTATING EWE ON BIRTH WEIGHT AND SURVIVAL OF THEIR OFFSPRING

Treatment	Type of birth	No. born	Avg birth wt[1]	No. raised	% raised	
Control	Singles	74	10.08	58	78.38	75.31
	Twins	88	7.77	64	72.73	
CPA, 30 mg/kg	Singles	114	9.56	89	78.04	73.36
	Twins	115	7.58	79	68.70	

[1]The birth weights were adjusted for sex, utilizing adjustment factors calculated from the total body of data.

Death losses were somewhat heavy in both groups, but not necessarily higher than would have been expected from aged, range fine-wool ewes in which more than 50 percent of the lambs were twin born (Campbell, 1962; Giles, 1968; and Obst and Day, 1968). Differences in birth weight and lamb survival between the treated and control groups were not statistically significant. However, the CPA treated ewes were below the control in all comparisons, with the largest difference being in the lower survival of twin born lambs out of CPA treated ewes. This difference was particularly marked among lambs born of ewes treated during the last 10 days of gestation in which only 6 of 16 (37.5 percent) lambs survived.

Toxicity of CPA

No losses occurred as a result of acute toxicity of CPA among the large number of animals treated during this study. However, the use of this drug appeared to contribute to increased death losses under certain conditions. Several ewes were lost from cold stress directly traced to defleecing with CPA. Although not unexpected, the possibility of such loss needs to be considered in the use of this drug. Some losses also appeared to occur when CPA was administered at times of other forms of stress on the animal such as mastitis, pregnancy disease and so forth. In addition, the use of this drug late in gestation appeared to compound the stress of multiple pregnancies. Twin lambs out of the treated ewes had a 4 percent lower survival rate than twin lambs out of control ewes; this difference was particularly marked when ewes carrying multiple births were treated within the last few weeks of gestation. Of two sets of triplets born to treated ewes, none survived.

Discussion

Although the management considerations involved are considerable, the results of these studies suggest that CPA can be utilized as a defleecing agent

for sheep with certain precautions. Only heathly vigorous animals should be treated. Provision should be made to protect animals from temperature stress for at least 2 weeks following defleecing. Breeding males should preferably not be treated within 7 weeks of the breeding season, and ewes should not be treated within 30 days of expected parturition. This drug has not yet been approved by the Food and Drug Administration for use as a chemical defleecing agent, and until this occurs, it should not be used except under experimental conditions. Although more than 300 animals have been used in these studies, it is still possible that when the drug is used on a larger population, some side effects will appear which have not been evident. A more detailed treatment of the prospects and precautions involved in chemical shearing has been reported by Shelton (1971).

Acknowledgments

The assistance of C. W. Livingston in autopsy of the dead lambs out of treated ewes is gratefully acknowledged.

Appreciation is expressed to Bristol Laboratories, Syracuse, N.Y., for providing the cyclophosphamide used in these trials.

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PR-3020

Effect of Chlortetracycline And Sulfamethazine on the Performance Of Lambs Fed a High Concentrate Diet

M. C. Calhoun and Maurice Shelton

SUMMARY: Supplementation with chlortetracycline and sulfamethazine, either alone (25 mg/lb) or in combination, significantly increased live weight gain and feed consumption of lambs fed a high concentrate diet, in drylot, for a 56-day period. Chlortetracycline increased daily gain 0.056 pound and feed consumption 0.16 pound. Similar statistics for sulfamethazine were +0.066 and +0.12 pound. Feeding the combination produced an additive response, increasing daily gain 0.120 pound and feed consumption 0.28 pound. The effects on feed conversion were less consistent, however; the average effect of feeding the combination was to decrease by 1.40 pounds the feed required per pound of gain. Although, the combination of chlortetracycline and sulfamethazine gave a positive live weight gain response throughout the 56-day trial, the major response was obtained early in the feeding period. Supplementation with chlortetracycline and/or sulfamethazine appeared to be without effect on reducing the stress associated with adaptation to a high concentrate ration, as evidenced by the marked decrease in feed consumption accompanying increases in the concentrate level of the diet.

Introduction

Antibacterial feed additives such as the antibiotics, chlortetracycline and oxytetracycline have made an important contribution to the lamb feeding industry by reducing losses from enterotoxemia and promoting growth and improving feed efficiency (Ott, 1968). In recent years, the feeding of combinations of antibacterial agents has received increased attention because of the possibility for an additional improvement in animal performance over that obtained with drugs used alone. One such combination, chlortetracycline and sulfamethazine, shows promise for use in drylot feeding of lambs on high concentrate rations. (Calhoun and Shelton, 1970; Embry *et al.*, 1970; Calhoun and Shelton, 1971; Byers *et al.*, 1971; Ternus *et al.*, 1971).

This report describes continuing research on chlortetracycline and sulfamethazine in the diet of feeder lambs during 1970-71.

Experimental Procedure

Animals and Feeding

Experiment 1: Forty spring lambs, mostly black-faced crossbred lambs of mixed sex, were purchased at a central Texas auction May 9, 1970. They were trucked to Texas A&M University Agricultural Research Center at McGregor on the day purchased and placed in experimental pens and fed a 40-percent roughage ration but without vitamin A (Table 1). This ration was fed for a 7- to 14-day period (uniformity period) during which time the lambs were ear tagged, weighed and drenched (thiabendazole)[1].

[1]Thiabendazole: Merck and Company, Rahway, New Jersey, Thibensole®, 2 grams per lamb in aqueous suspension. (Lambs were drenched after fecal samples were obtained from 24 of the lambs selected at random for assessment of coccidial oocysts and gastrointestinal nematode load).

TABLE 1. COMPOSITION OF EXPERIMENTAL DIETS

Ingredient	Roughage, %		
	40	25	10
Grain sorghum (dry rolled)	40.0	55.0	70.0
Alfalfa hay (ground)[1]	20.0	12.5	5.0
Cottonseed hulls	20.0	12.5	5.0
Cottonseed meal	7.0	7.0	7.0
Feather meal[2]	3.0	3.0	3.0
Urea	1.0	1.0	1.0
Calcium Carbonate	1.5	1.5	1.5
Trace mineralized salt[3]	1.5	1.5	1.5
Molasses	6.0	6.0	6.0
Vitamin A palmitate	to provide 1,000 IU/lb. of feed		

[1]Hammermill ground through a ½-inch screen.

[2]Hydrolzed poultry feathers, 85 % crude protein.

[3]Guaranteed to contain between 91 and 95 % salt, as NaCl, and not less than the following percentages of mineral elements: manganese as MnO, 0.30; zinc as ZnO, 0.25; iron as either Fe_3O_3 or $Fe_2(CO_3)_3$, 0.15; copper as CuO, 0.015; cobalt as $CoCO_3$, 0.01 and iodine as Ca $(IO_3)_2$, 0.01.

Upon completion of the uniformity period, the lambs were weighed and allotted to treatment groups at random, but balanced with respect to live weight, sex and breed. The treatments were as follows: (1) control; (2) chlortetracycline[2] 25 milligrams per pound (4) chlortetracycline and sulfamethazine, both at 25 mg/lb. Two groups of five lambs were fed each of the above treatments. Initially, (7 days) they continued to receive the 40-percent roughage ration. At 8 days, the roughage level was reduced to 25 percent, and finally, on the 15th day, the roughage level was reduced to 10 percent. The composition of the experimental rations is given in Table 1. Adjustment of the roughage level was accomplished by removing equal parts of ground alfalfa hay and cottonseed hulls and adding an equivalent weight of sorghum grain to the ration. The three rations with markedly different roughage levels and the rapid changing from one ration to the next were used in an attempt to increase the stress of adaptation to the highest concentrate level and possibly to provide a more sensitive evaluation of the imposed treatments.

All lambs were weighed initially and at 7, 14, 28 and 56 days. For the first 21 days, feed consumption was determined daily and, thereafter, at weekly intervals.

Rectal temperatures, obtained by using a 5-inch veterinary thermometer left *in situ* for a minimum of 3 minutes, were recorded twice a week for the first 28 days.

Experiment 2: Forty lambs consisting of approximately equal numbers of black-and white-faced cross-bred lambs of mixed sex were purchased at a central Texas auction July 18, 1970. The experimental procedure followed was the same as that for experiment 1.

Experiment 3: Forty white-faced wether lambs were purchased at a central Texas auction October 10, 1970. The experimental procedure was essentially the same as that for experiment 1 with the exception that fecal samples were not taken for assessment of coccidial oocysts and gastrointestinal nematode load.

Statistical Design and Analysis of Data

The experimental design was a 2 x 2 factorial with two levels each of chlortetracycline and sulfamethazine, 0 and 25 mg/lb. of feed. The data from each experiment were analyzed separately according to standard procedures (Steel and Torrie, 1960) to test the main effects of the two feed additives and their interaction. Since the experimental design and procedures followed were identical for the three experiments, an analysis of variance was carried out on the combined data (Cochran and Cox, 1957).

Results and Discussion

The average initial weight, live weight gains, feed consumption and feed efficiency data for the 56-day feeding period are summarized for each experiment in Table 2. The pooled results of the three experiments are summarized in Table 3 and presented graphically in Figure 1.

TABLE 2. EFFECT OF CHLORTETRACYCLINE AND/OR SULFAMETHAZINE ON PERFORMANCE OF FEEDER LAMBS IN DRYLOT (56-DAY DATA)[1]

Criterion	Treatments[2]			
	Control	CTC	S	CTC+S
(Experiment 1)				
Initial weight, lb.	69.0	69.6	66.7	70.3
Live weight gain, lb./day	0.525	0.520	0.562	0.623
Feed consumption, lb./day	2.94	3.02	3.08	3.37
Efficiency, lb. feed/lb. gain	5.69	5.82	5.47	5.41
Rectal temperature, ° F	105.2	105.5	105.2	105.1
(Experiment 2)				
Initial weight, lb.	61.0	62.1	59.5	59.1
Live weight gain, lb./day	0.384	0.416	0.425	0.443
Feed consumption, lb./day	2.65	2.92	2.70	2.76
Efficiency, lb. feed/lb. gain	6.98	7.03	6.36	6.24
Rectal temperature, ° F	104.9	105.2	105.1	105.1
(Experiment 3)				
Initial weight, lb.	70.4	71.3	71.3	71.2
Live weight gain, lb./day	0.309	0.450	0.428	0.512
Feed consumption, lb./day	2.90	3.03	3.08	3.21
Efficiency, lb. feed/lb. gain	9.44	6.76	7.22	6.26
Rectal temperature, ° F	104.0	103.6	104.0	103.7

[1]Each value represents the average of 10 lambs.

[2]CTC, Chlortetracycline, 25 mg/lb. of diet; S, Sulfamethazine, 25 mg/lb. of diet.

[2]Chlortetracycline: American Cyanamid Company, Princeton, New Jersey, Aureomycin 50®, 50 grams aureomycin per pound. (mg/lb.) of feed; (3) sulfamethazine[3], 25 mg/lb. and

[3]Sulfamethazine: American Cyanamid Company, Princeton, New Jersey, Sulmet®, 7.7 percent sulfamethazine.

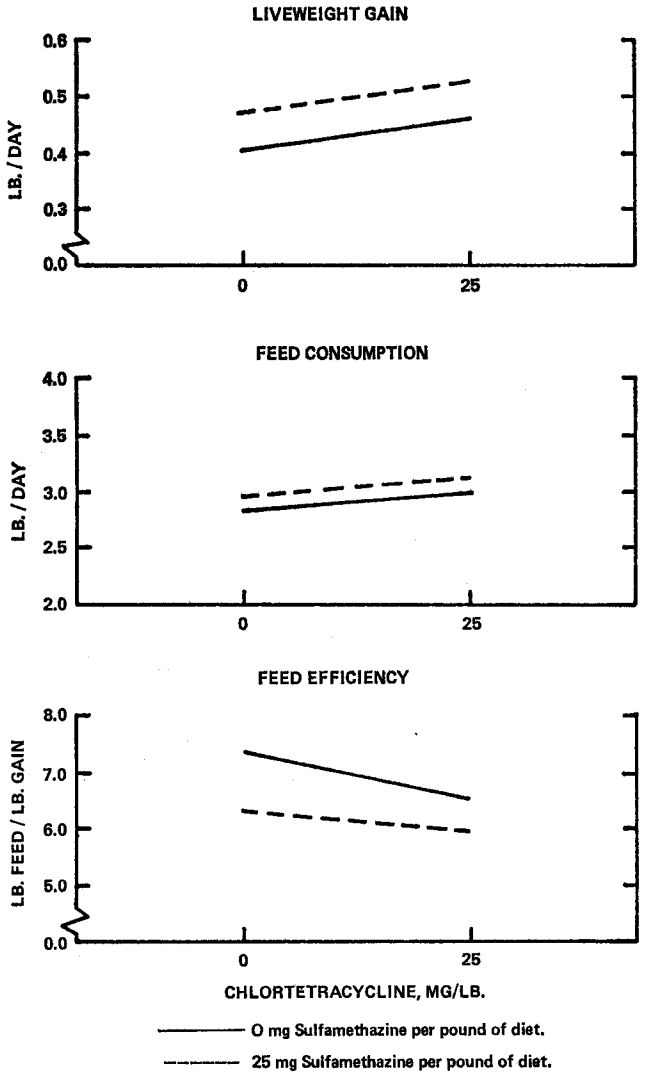

Figure 1. Feeder lamb response to chlortetracycline and sulfamethazine fed alone or in combination.

Supplementation of the diet with either chlortetracycline or sulfamethazine at the level of 25 mg/lb. significantly increased the live weight gain and feed consumption of lambs fed a high concentrate diet, in drylot, for a 56-day period. The main effect of chlortetracycline on average daily live weight gain was + 0.056 pound, $P < 0.05$, and feed consumption was increased 0.16 pound per day, $P < 0.05$. Sulfamethazine produced about the same response, increasing live weight gain by 0.066 pound per day, $P < 0.025$, and feed consumption by 0.12 pound per day, $P < 0.10$.

The combination of chlortetracycline and sulfamethazine (both at 25 mg/lb. of diet) was additive and resulted in an increase of 0.12 and 0.28 pound per day in live weight gain and feed consumption, respectively.

In both live weight gain and feed consumption, there was a significant difference in the performance

TABLE 3. EFFECTS OF CHLORTETRACYCLINE AND/OR SULFAMETHAZINE ON PERFORMANCE OF FEEDER LAMBS IN DRYLOT: POOLED 56-DAY DATA: EXPERIMENTS 1, 2 AND 3

Criterion	Treatments[1]				
	Control	CTC	S	CTC S	SD
Initial weight, lb.	66.8	67.7	65.8	66.9	
Live weight gain, lb./day	0.406	0.462	0.472	0.526	0.054
Feed consumption, lb./day	2.83	2.99	2.95	3.11	0.17
Efficiency, lb. feed/lb. gain	7.37	6.52	6.34	5.97	0.50
Rectal temperature, ° F	104.7	104.8	104.8	104.6	0.5

[1]CTC, Chlortetracycline, 25 mg/lb. of diet;
S, Sulfamethazine, 25 mg/lb. of diet.

of the lambs from one experiment to the next. This was not unexpected in view of the fact that the lambs were purchased from several sources and fed at three different times of the year. However, the absence of a significant experiment-times-treatment interaction indicated that the response to chlortetracycline and sulfamethazine was similar in all experiments.

For feed efficiency (pound feed required per pound of gain), there was a significant experiment-times-treatment interaction – $P < 0.025$ for this criterion. On examination, this appeared to be due to the fact that in experiments 1 and 2, chlortetracycline alone slightly increased the amount of feed required per pound of gain, whereas in experiment 3, there was a marked reduction in the feed-gain ratio. This hypothesis is substantiated by the presence of a significant experiment times chlortetracycline interaction, $P < 0.005$, whereas the interaction for experiments times sulfamethazine was not significant.

Although the interpretation of the feed efficiency data is not as straight-forward as live weight gain and feed consumption data, it appears that supplementation of the diet with 25 mg/lb. of sulfamethazine or the combination of chlortetracycline and sulfamethazine significantly decreases the feed required per pound of gain. The average effect of sulfamethazine was to decrease the feed per pound of gain by 1.03 pounds. The combination decreased feed requirements 1.40 pounds per pound of gain.

The results obtained in this series of experiments are similar to those previously reported for lambs (Calhoun and Shelton, 1970; Termus *et al.*, 1971; Byers *et al.*, 1971). The addition of a combination of chlortetracycline and sulfamethazine (both at 25 mg/lb. of diet) consistently increased average daily gain and decreased the amount of feed required per pound of gain. The response to either chlortetracycline or sulfamethazine alone was less consistent.

The response to sulfamethazine alone is somewhat unexpected. However, sulfa drugs have been used in the control of coccidiosis (McGowan, 1968; Hammond *et al.*, 1959; Salisbury *et al.*, 1953) and in

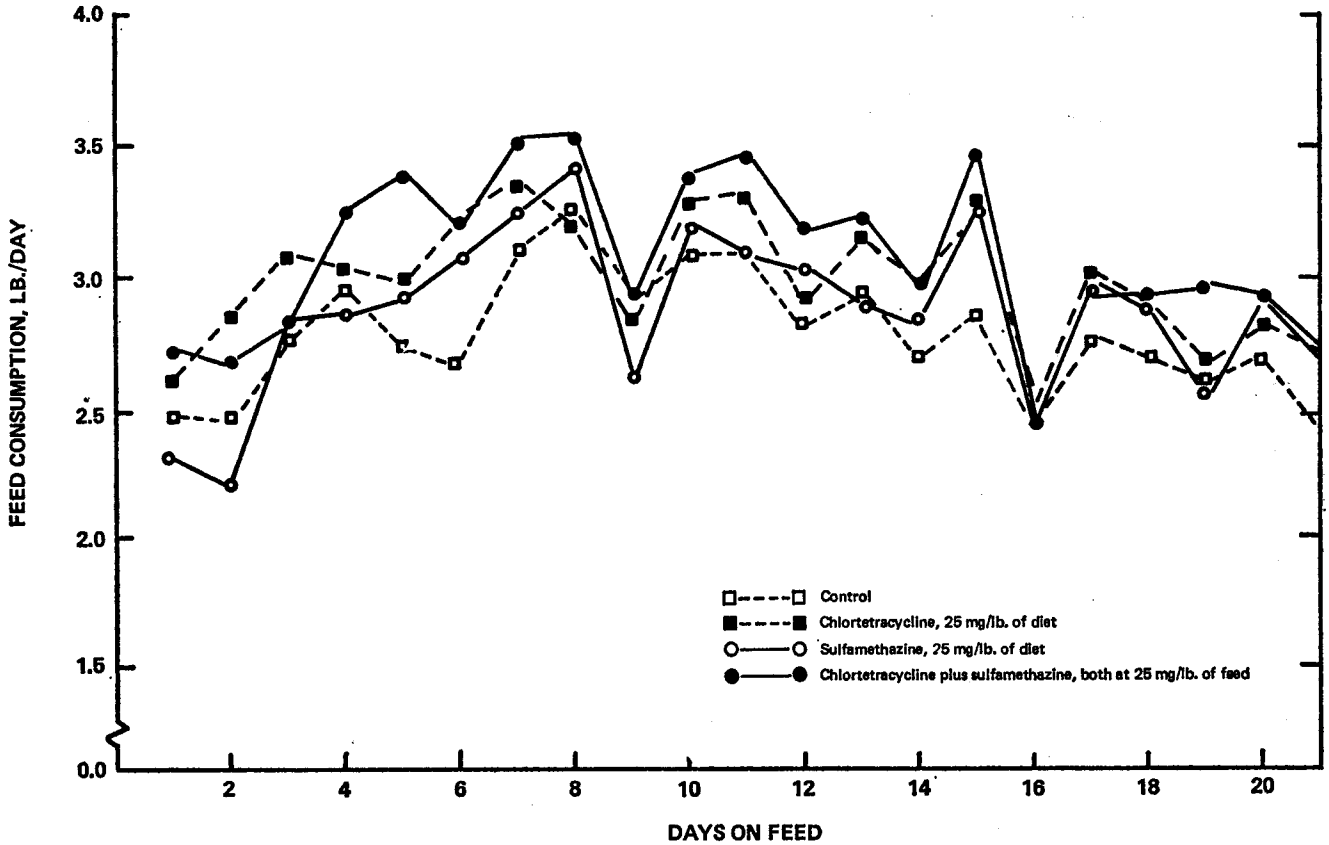

Figure 2. Effect of chlortetracycline and sulfamethazine on average daily feed consumption (pounds per day) during the first 21 days of the feeding period. Each point on the graph is the average of 30 lambs.

the treatment of pneumonia after shipment of lambs (McGowan, 1968). In these studies, no evidence of clinical pneumonia was apparent, and no lambs became sick or died. Examination of fecal samples from lambs used in experiments 1 and 2 revealed some coccidial oocysts, but actual numbers present were far below a level which would indicate clinical coccidiosis (Calhoun and Shelton, 1971).

Average daily feed consumption, by days, for the first 21 days, is presented in Figure 2. In general,

TABLE 4. SUMMARY OF AVERAGE DAILY LIVE WEIGHT GAIN BY PERIODS

Criterion	Treatments			
	Control	CTC	S	CTC + S
1-7 day period				
Live weight gain, lb./day	.314	.638	.576	.714
Gain relative to control, ± %		+103	+83	+127
Gain relative to control, ± lb.		+ 2.3	+ 1.8	+ 2.8
8-14 day period				
Live weight gain, lb./day	.371	.343	.433	.457
Gain relative to control, ± %		− 8	+17	+ 23
Gain relative to control, ± lb.		− 0.2	+ 0.4	+ 0.6
15-28 day period				
Live weight gain, lb./day	.397	.438	.460	.481
Gain relative to control, ± %		+ 10	+16	+ 21
Gain relative to control, ± lb.		+ 0.6	+ 0.9	+ 1.2
29-56 day period				
Live weight gain, lb./day	.442	.459	.461	.519
Gain relative to control, ± %		+ 4	+ 4	+ 17
Gain relative to control, ± lb.		+ 0.5	+ 0.5	+ 2.2

decreasing the roughage level by 15 percent, days 8 and 15, resulted in a marked decrease in feed consumption on the second day after the ration was changed. On the basis of these data, chlortetracycline and sulfamethazine fed either alone or in combination appeared to be without effect in reducing the stress associated with a rapid change in the concentrate level of the ration.

Comparison of the average daily gains for the periods, 0 to 7, 7 to 14, 14 to 28 and 28 to 56 days, indicates that the major response was obtained at the beginning of the feeding period (Table 4). However, the combination of chlortetracycline and sulfamethazine appeared to give a positive live weight gain response throughout the 56-day trial.

No significant effects of any of the treatments on rectal temperatures was shown by any individual experiment.

Acknowledgments

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Sorghum Grain Processing Methods— Comparison of Whole, Dry Rolled And Ground Sorghum Grain For Feeder Lambs

M. C. Calhoun and Maurice Shelton

SUMMARY: Two experiments, using 144 lambs, were conducted during spring and summer 1971 to evaluate the use of whole, dry rolled and ground sorghum grain in a high concentrate diet for lambs. There was no advantage from processing sorghum grain for lambs by either dry rolling or grinding the grain when compared with feeding it whole in a 76.5 percent grain, high concentrate diet. This result supports previous research at the Texas A&M University Agricultural Research Center at McGregor reporting no performance advantage from processing sorghum grain for lambs by steam flaking, popping or reconstitution over that obtained with dry rolled grain. These results indicate that lambs can effectively utilize the nutrients from whole sorghum grain; thus, lamb feeders are not dependent upon expensive processing methods to increase the availability of grain sorghum energy for lambs.

Introduction

Texas produces annually about 1.5 million head of feeder lambs. Because of range conditions and available forage, a large percentage of these often must be fed in drylot to obtain sufficient weight and finish for slaughter. In recent years, grain sorghum has provided the cheapest source of energy for feeding lambs in drylot, quite often making up 60-80 percent of the finishing diet. Previous studies at the Texas A&M University Agricultural Research Center at McGregor (Calhoun and Shelton, 1971) indicated no advantage from processing sorghum grain by such means as popping, steam flaking or reconstitution (30 percent water in anaerobic storage for greater than 10 days) when these methods of processing were compared with dry rolling the grain. On the basis of these experiments, the efficient utilization of energy and other nutrients from sorghum grain by lambs appeared to require only that the hard seed coat be cracked. However, there is some indication that processing method, as it influences the physical form of the ration, can affect feed consumption and, thus, rate of gain and feed efficiency (Shelton, 1965; Calhoun and Shelton, 1970). Two experiments were conducted to compare the effect of feeding whole, dry rolled and ground sorghum grain on the drylot performance and carcass characteristics of lambs fed a 76.5-percent sorghum grain ration during spring and summer in Texas.

Experimental Procedure

Experiment 1

Animals and Feeding: Approximately equal numbers of black-faced crossbred and white-faced feeder lambs of mixed sex were purchased at a central Texas auction February 8, 1971, and transported via truck to the Center at McGregor, Texas. On arrival, they were placed in experimental pens and fed a 60-percent roughage ration (Table 1) with free access to water for a 14-day standardization period, during which they were weighed, ear tagged and drenched.[1]

Subsequently, they were reweighed, and 72 assigned at random to 12 pens (six lambs per pen) but balanced with respect to sex, weight and breed, such that three ewes and three wether lambs were placed in each pen.

To obtain a shrunk weight at the beginning of the experimental period and minimize errors associated with variable gut fill (Myer, 1962), the lambs were weighed after 48 hours without feed and 24 hours without water. On the same day the lambs were started on the experiment within each pen one lamb of each sex was given either a 3 milligram (mg) diethylstilbestrol[2] implant, a 12 mg implant of zearalanol[3] or no implant.

Assignment of pens to treatments (one of the three processing methods, dry rolled, whole or ground) was at random with four pens of six lambs assigned to each treatment.

Initially, the lambs were fed the 60-percent roughage ration. They were then changed, in a stepwise manner, over an 8-day period onto their respective 10-percent roughage-high concentrate ration (Table 1).

Lambs were weighed without shrink at 14, 28, 42 and 56 days, the end of the experiment. However, lambs were weighed off the experiment, using the same conditions as for placing them on the experiment, except that water was not withheld, as they reached 100 pounds live weight on any weigh day after 28 days on feed. All remaining lambs were then sent to slaughter upon completion of the 56-day feeding period.

Observation and Analyses: All feeds fed and refused were weighed to the nearest 0.1 pound and recorded. Feed was weighed out and fed each day in sufficient amount to insure that the lambs had all the feed they wanted. Feed residues were weighed back at 7-day intervals or sufficiently often so that feed refusals would not adversely affect feed consumption. Live weights of lambs were obtained to the nearest 1.0 pound. Minimum and maximum ambient temperatures were recorded daily to the nearest 1.0° F.

TABLE 1. PERCENT COMPOSITION OF EXPERIMENTAL DIETS

Ingredient	Roughage Level 60% Starter diet	10% Finishing diet
Sorghum grain[1]	24.0	76.5
Alfalfa hay, ground ½-inch screen	30.0	10.0
Cottonseed hulls	30.0	
Cottonseed meal	8.0	4.0
Urea		1.0
Carbotex, $CaCO_3$	1.0	1.5
Trace mineral salt	1.0	1.0
Molasses	6.0	6.0
Vitamin A palmitate	Added at a level to provide 1,000 IU vitamin A/lb of diet	
Chlortetracycline	Added at a level to provide 15 mg/lb. of diet	
Calculated Nutrient Composition		
Crude protein, %	12.0	13.7
Digestible protein, %	8.3	11.2
Digestible energy, Mcal/lb.	1.20	1.50
Ratio: g digestible protein/Mcal digestible energy	45.5:1	33.8:1
Calcium, %	0.89	0.82
Phosphorus, %	0.28	0.30
Potassium, %	1.25	0.69

[1]Dry rolled through a Davis, Krimper Kracker (R) Mill; Hammermill ground through a ½-inch screen.

Upon completion of the experiment, lambs were slaughtered in the Brownwood plant of Swift and Company. A representative of the Meats Laboratory, Animal Science Department, Texas A&M University, provided assistance in obtaining carcass data on the lambs at time of slaughter.

The carcass information collected was as follows: warm carcass weight, maturity grade, USDA quality grade, USDA final grade, leg conformation score, estimated percent kidney and pelvic fat, measurement of fat thickness over the *l. dorsi,* fat color and fat firmness.

Experiment 2

Ninety-seven black-faced crossbred lambs of mixed sex were purchased at a central Texas auction May 15, 1971. They were transported to McGregor via truck on the day purchased and placed on pasture with free access to water for 3 days. Subsequently, they were sheared, ear-tagged, drenched, weighed and placed on feed essentially as described for experiment 1. The experimental procedures followed were the same as for experiment 1 with the exception that none of the lambs reached 100 pounds live weight

[1]Tramisol®, American Cyanamid Co., Princeton, New Jersey, levamisole hydrochloride, (mixed 52 gm per gallon of water and dosed 1 ounce per 100 pounds).

[2]Diethylstilbestrol (DES), Pfizer Agricultural Division, Chas. Pfizer & Company, Stimplants®, 3 mg DES per implant (Lot 90561).

[3]Zearalanol, Commercial Solvents Corp., Ralgro®, 12 mg of Zearalanol per implant (Lot 80121).

prior to the 56-day weigh period. Thus, all lambs were slaughtered at the same time upon completion of the 56-day feeding period.

Results and Discussion

A summary of the drylot performance and carcass data are presented in Table 2 (experiment 1) and Table 3 (experiment 2). Data from these two experiments indicate no advantage from processing sorghum grain for lambs by either dry rolling or grinding the grain when compared with feeding it whole in a 76.5 percent grain, high concentrate diet. Previous studies conducted at McGregor (Calhoun and Shelton, 1971) and elsewhere (Buchanan-Smith *et al.*, 1968; Calhoun and Shelton, 1970) indicated no advantage from processing sorghum grain for lambs by steam flaking, popping or reconstitution. The results of these studies indicate that lambs can effectively utilize the nutrients from whole grain; thus lamb feeders are not dependent upon expensive processing methods to increase the availability of grain sorghum energy for lambs.

Acknowledgments

Appreciation is expressed to Russell Cross, Animal Science Department, for assistance in obtaining carcass data at slaughter; W. W. Collins, American Cyanamid Co., Princeton, N. J., for the Tramisol®; R. C. Crum, Jr., Pfizer Agricultural Division,, Chas Pfizer and Company, for the Stimplants®; and Jess Henson, Commercial Solvents Corp., for the Ralgro®.

TABLE 2. SUMMARY OF DRYLOT PERFORMANCE AND CARCASS CHARACTERISTICS OF LAMBS FED A HIGH CONCENTRATE DIET CONTAINING WHOLE, GROUND OR DRY ROLLED SORGHUM GRAIN. EXPERIMENT 1. SPRING 1971

Criterion	Sorghum grain processing method		
	Whole	Dry rolled	Ground
Lambs, no.	22[1]	24	24
Days on experiment	46	47	47
Initial live weight, lb.	67	68	69
Final live weight, lb.	93	93	92
Live weight gain, lb./day	0.574	0.541	0.494
Feed consumption, lb./day	3.74	3.40	3.48
Efficiency, lb. feed/lb. gain	6.53	6.29	7.06
Dressing percent	51.0	51.6	52.0
USDA final grade[2]	11	11	11
Fat thickness over *l.dorsi*, inches	0.28	0.28	0.27
Kidney and pelvic fat, estimated %	4.1	3.7	3.8
USDA yield grade[3]	3.97	3.91	3.88
Fat color score[4]	3.2	3.3	3.5
Fat firmness score[5]	4.4	4.6	4.6

[1]Two lambs were removed from one of the pens receiving whole sorghum grain at 28 days because they were losing weight.

[2]USDA (1960): Avg prime = 14; Avg Choice = 11; Avg good = 8.

[3]USDA (1969).

[4]Fat color score: 4 = white, 3 = creamy white, 2 = slightly yellow, 1 = yellow.

[5]Fat texture and firmness scores: 6 = firm and dry, 5 = moderately firm and moderately dry, 4 = slightly firm and slightly dry, 3 = slightly soft and slightly dry, 2 = moderately soft and moderately oily, 1 = soft and oily.

TABLE 3. SUMMARY OF DRYLOT PERFORMANCE AND CARCASS CHARACTERISTICS OF LAMBS FED A HIGH CONCENTRATE DIET CONTAINING WHOLE, GROUND OR DRY ROLLED SORGHUM GRAIN. EXPERIMENT 2. SUMMER 1971

Criterion	Sorghum grain processing method		
	Whole	Dry rolled	Ground
Lambs no.	24	24	24
Days on experiment	56	56	56
Initial live weight, lb.	56.3	55.6	55.7
Final live weight, lb.	82.5	82.0	82.8
Live weight gain, lb./day	0.469	0.471	0.485
Feed consumption, lb./day	2.91	3.03	3.17
Efficiency, lb. feed/lb. gain	6.20	6.44	6.54
Dressing percent	50.6	50.6	50.6
USDA final grade[1]	11	11	11
Fat thickness over *l. dorsi*, inches	0.35	0.34	0.39
Kidney and pelvice fat, estimated %	3.9	3.9	4.0
USDA yield grade	4.42	4.39	4.69
Fat color score[3]	3.7	3.5	3.8
Fat firmness score[4]	4.7	4.4	4.8

[1]USDA (1960): Avg prime = 14, Avg Choice = 11, Avg good = 8.

[2]USDA (1969).

[3]Fat color score: 4 = white, 3 = creamy white, 2 = slightly yellow, 1 = yellow.

[4]Fat texture and firmness scores: 6 = firm and dry, 5 = moderately firm and moderately dry, 4 = slightly firm and slightly dry, 3 = slightly soft and slightly dry, 2 = moderately soft and moderately oily, 1 = soft and oily.

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PR-3022

Comparison of the Effect Of Zearalanol and Diethylstilbestrol Implants on Lamb Weight Gains And Carcass Characteristics

M. C. Calhoun, Maurice Shelton and H. R. Cross

SUMMARY: Two experiments, involving 144 feeder lambs, were conducted during 1971 to compare the response of ewe and wether lambs fed in the spring and summer to implants of either 3 milligrams (mg) diethylstilbestrol (DES) or 12 mg zearalanol. The first experiment was initiated February 26 and the second May 28. The average daily minimum and maximum ambient temperatures, respectively, for the two experiments were experiment 1, 44.0° F. and 79.7° F. and experiment 2, 69.8° F and 96.9° F.

Implanting with either DES or zearalanol increased the live weight gains of both ewe and wether lambs in both experiments. In general, the response was greater for wether than for ewe lambs, and the 3-mg DES implant was slightly superior to the 12-mg zearalanol implant. In the second (summer) experiment, the live weight gain response was 33.6 and 44.4 percent less, respectively, for DES and zearalanol than in the spring experiment. However, factors other than temperature may have been involved in the observed difference in response.

Introduction

The combination of seasonal lambing schedules and range conditions generally results in a large movement of lambs from the range areas of Texas during late spring and early summer.

Some of these lambs have sufficient weight and finish to go to market as milk-fat spring lambs; however, depending upon the availability of grass during the spring pasture season, a variable percentage of the lambs must be continued on feed prior to being sold for slaughter purposes. It is common practice to feed these lambs in drylot, on high concentrate rations during the hot summer months. Lambs fed at this time of year have been reported to gain about 25 percent slower and require 23 percent more feed per pound of gain than comparable lambs fed during the cooler season of the year (Shelton and Calhoun, 1971a).

Ray *et al.* (1969) studied the effect of season (temperature) on the response of beef cattle to a variety of hormonal growth stimulants. Diethylstilbestrol (DES), melengestrol acetate (MGA), Synovex-H® and Rapigain - 1® were found to be ineffective during the hot summer months, even though significant responses were obtained during the moderate winter months.

Two hormonal growth stimulants, DES and zearalanol, are currently approved for use with lambs. Both of these have been demonstrated to increase the rate of live weight gain and improve feed efficiency with ewe and wether lambs (Ott, 1968; Shelton and Calhoun, 1971b; Brown, 1970; Jordan and Hanke, 1969; Hohenboke and Landers, 1971). Information is lacking on the effects of summer temperatures on the response of feeder lambs to either DES or zearalanol.

Experimental Procedure

Comparisons of either a 3-mg DES[1] or a 12-mg Zearalanol[2] implant with a nonimplanted control were superimposed in a split plot arrangement of treatments for the two experiments (PR-3021) in which whole, dry rolled and ground sorghum grain were evaluated. Since sex and hormone treatments were balanced out within pens, feed consumption and feed efficiency data were not available for these comparisons.

Two experiments were conducted during spring and summer 1971. Experiment 1 was initiated February 26 and completed April 22. The second experiment was started May 28 and terminated July 22. Seventy-two feeder lambs (36 ewe and 36 wether lambs) were used in each experiment. The source of lambs, experimental rations and procedures were those described in PR-3021.

Results and Discussion

The average daily minimum and maximum ambient temperatures with their standard deviations (in parenthesis) for experiments 1 and 2, respectively, were 44.0° F (8.3), 79.7° F (9.2) and 69.8° F (3.4), 96.9° F (4.4).

The effects of implanting with either DES or zearalanol on live weight gain and carcass traits of ewe and wether lambs fed a high concentrate ration in drylot are summarized in Tables 1 and 2, respectively, for experiments 1 (spring) and 2 (summer).

Implanting with either 3 mg DES or 12 mg zearalanol increased the live weight gains of ewe and wether lambs in both experiments. In general, the response was greater for wether than for ewe lambs, and the 3 mg DES implant was superior to the 12 mg zearalanol implant. In the summer experiment, the live weight gain response was 33.6 and 44.4 percent less, respectively, for DES and zearalanol than in the experiment in the cooler spring months. Factors other than temperature were undoubtedly involved in the difference in response. Of interest is the fact

[1]Diethystilbestrol (DES), Pfizer Agricultural Division, Chas. Pfizer and Co. Stimplants®, 3 mg DES per implant (Lot 90561).
[2]Zearalanol, Commercial Solvents Corp. Ralgro®, 12 mg of zearalanol per implant (Lot 80121).

TABLE 1. EFFECT OF RALGRO AND DIETHYLSTILBESTROL IMPLANTS ON LIVE WEIGHT GAIN AND CARCASS CHARACTERISTICS OF EWE AND WETHER LAMBS FED A HIGH CONCENTRATE RATION IN DRYLOT. EXPERIMENT 1. SPRING 1971

Criterion	Control			3 mg DES			12 mg Ralgro		
	Ewe	Wether	Avg	Ewe	Wether	Avg	Ewe	Wether	Avg
Lambs started, no.	12	12	24	12	12	24	12	12	24
Lambs finished, no.[1]	11	12	23	11	12	23	12	12	24
Feeding period, days	51	46	48	47	41	44	50	46	48
Initial live weight, lb.	67.5	71.2	69.5	67.3	68.3	67.8	64.9	67.3	66.1
Live weight gain, lb./day	.479	.517	.499	.526	.657	.594	.518	.641	.580
Dressing percent[2]	53.0	51.2	52.0	51.9	49.5	50.7	52.7	51.2	51.9
USDA final grade[3]	11	11	11	11	11	11	11	11	11
Fat thickness, *l.dorsi*, inches	0.31	0.27	0.29	0.31	0.21	0.26	0.34	0.22	0.28
Kidney and pelvic fat, estimated %	5.3	3.9	4.6	3.8	2.5	3.1	5.0	2.9	4.0
USDA yield grade[4]	4.49	3.88	4.17	4.12	3.14	3.60	4.63	3.33	3.98
Fat color score[5]	3.5	3.0	3.3	3.7	3.1	3.4	3.7	3.0	3.4
Fat firmness score[6]	4.8	4.4	4.6	4.7	4.2	4.5	5.2	4.1	4.6

[1]Two lambs were weighed off the experiment because they were losing weight after the 14-day period. This was felt to be related to the lambs' initial overeating and then becoming sick, a condition unrelated to the treatments imposed.

[2]Dressing percent was calculated from the warm carcass weight at slaughter and the unshrunk live weight at the time lambs were removed from the experiment.

[3]USDA (1960).

[4]USDA (1969).

[5]Fat color score (Calhoun and Shelton, PR-3021).

[6]Fat firmness score (Calhoun and Shelton, PR-3021).

that seasonal temperatures recorded at McGregor during the course of these experiments were comparable to those reported by Ray *et al.*, (1969) for Tucson, Arizona, except that the average maximum daily temperature during June and July was slightly higher in Tucson, 102.5°, compared with 96.9° F at McGregor.

DES decreased the dressing percent in both experiments. The effect was much greater in experiment 1 than in experiment 2, roughly corresponding to the effect of DES in improving live weight gain. The decrease in dressing percent was apparently due in part to a reduction in the percent of kidney and pelvic fat. Zearalanol had no consistent effect on dressing percent. However, kidney and pelvic fat were decreased by 25.6 and 17.9 percent for wethers implanted with zearalanol in experiments 1 and 2, respectively. Similar statistics for ewe lambs were −5.7 and −2.2 percent. Thus, there appeared to be a sex difference in response to zearalanol.

TABLE 2. EFFECT OF RALGRO AND DIETHYLSTILBESTROL IMPLANTS ON LIVE WEIGHT GAIN AND CARCASS CHARACTERISTICS OF EWE AND WETHER LAMBS FED A HIGH CONCENTRATE RATION IN DRYLOT. EXPERIMENT 2. SUMMER 1971

Criterion	Control			3 mg DES			12 mg Ralgro		
	Ewe	Wether	Avg	Ewe	Wether	Avg	Ewe	Wether	Avg
Lambs started, no.	12	12	24	12	12	24	12	12	24
Lambs finished, no.	12	12	24	12	12	24	12	12	24
Feeding period, days	56	56	56	56	56	56	56	56	56
Initial live weight, lb.	55.6	57.1	56.3	54.8	57.5	56.1	53.7	56.6	55.2
Live weight gain, lb./day	.409	.476	.443	.467	.531	.499	.438	.528	.483
Dressing percent[1]	51.7	49.8	50.8	50.8	50.0	50.4	50.9	50.4	50.6
USDA final grade[2]	11	11	11	11	11	11	11	11	11
Fat thickness, *l.dorsi*, inches	0.35	0.31	0.33	0.36	0.39	0.38	0.39	0.37	0.38
Kidney and pelvic fat, estimated %	4.5	3.9	4.2	4.0	3.5	3.7	4.4	3.2	3.8
USDA yield grade[3]	4.59	4.18	4.39	4.49	4.57	4.53	4.83	4.34	4.59
Fat color score[4]	3.8	3.5	3.6	3.8	3.7	3.8	3.8	3.5	3.7
Fat firmness score[5]	4.7	4.0	4.3	5.2	4.8	5.0	4.7	4.3	4.5

[1]Dressing percent was calculated from the warm carcass weight at slaughter and the unshrunk live weight at the time lambs were removed from the experiment.

[2]USDA (1960).

[3]USDA (1969).

[4]Fat color score (Calhoun and Shelton, PR-3021).

[5]Fat firmness score (Calhoun and Shelton, PR-3021).

TABLE 3. PERFORMANCE OF EWE AND WETHER LAMBS FED A HIGH CONCENTRATE DIET IN DRYLOT. EXPERIMENT 1. SPRING 1971

Criterion	SEX	
	Ewe	Wether
Lambs started, no.	36	36
Lambs finished, no. [1]	34	36
Feeding period, days	49	44
Initial live weight, lb.	66.5	69.0
Live weight gain, lb./day	.508	.605
Dressing %[2]	52.6	50.6
USDA final grade[3]	11	11
Fat thickness, *l. dorsi*, inches	0.32	0.24
Kidney and pelvic fat, estimated %	4.7	3.1
USDA yield grade[4]	4.42	3.45
Fat color score[5]	3.7	3.1
Fat firmness score[6]	4.9	4.2

[1]Two lambs were weighed off the experiment because they were losing weight after the 14-day period. This was felt to be related to the lambs' initial overeating and then becoming sick, a condition unrelated to the treatments imposed.

[2]Dressing percent was calculated from the warm carcass weight at slaughter and the unshrunk live weight at the time lambs were removed from the experiment.

[3]USDA (1960).

[4]USDA (1969).

[5]Fat color score (Calhoun and Shelton, PR-3021).

[6]Fat firmness score (Calhoun and Shelton, PR-3021).

DES and zearalanol produced a marked effect on the fat thickness, measured over the *l. dorsi,* of wethers; however, the effect was opposite for the two experiments. In experiment 1 (spring) back fat thickness was decreased by 22.2 and 18.5 percent, respectively, for DES and zearalanol implanted wethers. Similar statistics for experiment 2 (summer) were +25.8 and +19.4 percent, respectively. The effect of DES or zearalanol on the fat thickness of ewe lambs was less and not consistent.

TABLE 4. PERFORMANCE OF EWE AND WETHER LAMBS FED A HIGH CONCENTRATE DIET IN DRYLOT. EXPERIMENT 2. SUMMER 1971.

Criterion	SEX	
	Ewe	Wether
Lambs started, no.	36	36
Lambs finished, no.	36	36
Feeding period, days	56	56
Initial live weight, lb.	54.7	57.0
Live weight gain, lb./day	0.438	0.512
Dressing %[1]	51.1	50.1
USDA final grade[2]	11	11
Fat thickness, *l.dorsi*, inches	0.37	0.36
Kidney and pelvic fat, estimated %	4.3	3.5
USDA yield grade[3]	4.64	4.36
Fat color score[4]	3.8	3.6
Fat firmness score[5]	4.8	4.4

[1]Dressing percent was calculated from the warm carcass weight at slaughter and the unshrunk live weight at the time lambs were removed from the experiment.

[2]USDA (1960).

[3]USDA (1969).

[4]Fat color score (Calhoun and Shelton, PR-3021).

[5]Fat firmness score (Calhoun and Shelton, PR-3021).

There was some effect of treatment on the USDA Yield Grade; for the most part this reflected the changes in fat thickness over the *l. dorsi* and estimated percent kidney and pelvic fat, both of which enter into the calculation of USDA Yield Grade (USDA, 1969). Final USDA Quality Grade, and fat color and firmness scores were not affected by the implants of DES or zearalanol.

Live weight gains and carcass traits of ewe and wether lambs for both experiments were compared by pooling and averaging the data for all treatments (Tables 3 and 4). The results are consistent with previously reported information for ewe and wether lambs (Oliver *et al.,* 1967; Shelton and Carpenter, 1971). Wethers gain faster and deposit less internal and external fat at comparable live weights resulting in a leaner carcass with a lower USDA Yield Grade. However, ewe lambs have more desirable external fat color and firmness characteristics.

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PR-3023

Determination of the Alkali Discrimination Threshold in Sheep

M. C. Calhoun and Maurice Shelton

SUMMARY: A two-choice preference test was used to determine the ability of sheep to detect the presence of either calcium hydroxide or magnesium oxide when offered at concentrations of 0, 0.25, 0.50, 1.0 and 2.0 percent of the ration. Response was measured as the amount of alkali-containing ration consumed as a percent of total feed consumption. The pattern of response was similar for both calcium hydroxide and magnesium oxide with the sheep beginning to discriminate against the alkali-containing feed when the alkali level reached 1.0 percent of the ration.

Introduction

In recent years, various alkali supplements have been investigated in an attempt to maintain a near normal rumen pH, prevent off-feed and improve performance of feeder lambs and cattle receiving high or all-concentrate rations (Wise *et al.*, 1965; Wise *et al.*, 1968; Bhattacharya and Warner, 1968; Calhoun *et al.*, 1969; Calhoun and Shelton, 1969; Shelton and Calhoun, 1970). Results have been quite variable and, in general, it is difficult to arrive at any definite conclusions as to the value of alkali supplements fed either alone or in combination on feedlot performance of ruminants receiving high or all-concentrate rations. Bhattacharya and Warner (1968) suggested that age of the animal and buffer level might be important factors in determining response to buffer supplementation. However, age apparently would not explain variability in data from lamb feeding experiments in which age differences would be minimal (Shelton and Ellis, 1965; Woolfitt *et al.*, 1964; Kromann and Meyer, 1966; Lassiter, 1968; Calhoun *et al.*, 1969). However, the amount and type of acid neutralizing compound used, as well as the type of ration and the relative stress placed on the ruminant during either adaptation to or maintenance on high concentrate rations, have been shown to influence the response to alkali supplementation (Calhoun and Shelton, 1969; Shelton and Calhoun, 1970).

TABLE 1. PERCENT COMPOSITION OF HIGH CONCENTRATE CONTROL EXPERIMENTAL RATION

Ingredient	Percent
Sorghum grain, dry rolled	77.5
Alfalfa hay, hammermill ground ½-inch screen	10.0
Cottonseed meal	7.0
Calcium carbonate	1.5
Trace mineralized salt	1.0
Molasses	3.0
Vitamin A palmitate	To provide 1,000 IU/lb. of feed

TABLE 2. INCORPORATION OF ALKALI INTO HIGH CONCENTRATE CONTROL RATION[1]

Alkali, %	Control, lb.	Sorghum grain, lb.	Alkali, lb.
0.00	49.0	1.00	0.00
0.25	49.0	0.88	.12
0.50	49.0	0.75	.25
1.00	49.0	0.50	.50
2.00	49.0	0.00	1.00

[1]Fifty-pound batch mixed in cement mixer.

The effect of various alkali compounds on the palatability of high concentrate rations has not been examined. Since variations in palatability might be contributing to the variability in response to the inclusion of alkali compounds in lamb rations, an experiment was designed to measure the effect of calcium hydroxide and magnesium oxide on palatability and possibly relate this effect to feed intake.

Experimental Procedure

The lambs used were obtained from the ewe flock at the Texas A&M Agricultural Research Center at McGregor and at a local central Texas auction. They were adapted to the high concentrate control ration (Table 1) prior to being used to measure the relative palatability of the alkali-containing rations.

Subsequently, they were placed in individual pens with raised, expanded metal floors and provided with a feeder with two compartments. A procedure similar to that described by Goatcher and Church (1970) was employed to measure the relative palatability of alkali-containing feeds and to determine the levels at which sheep discriminate either for or against the alkali in the ration. The procedure essentially consisted of a two-choice preference test with the alkali materials offered in a series of ascending concentrations – 0, 0.25, 0.50, 1.0 and 2.0 percent.

Each comparison consisted of an 8-day feeding period during which each sheep was offered a choice between a control (0 percent) and an alkali-containing feed. Response was measured as the amount of alkali-containing ration consumed as a percent of the total ration eaten. The positions of the feeders were reversed each day to balance out possible position effects or preferences.

Alkali was incorporated into the ration, essentially as outlined in Table 2, by use of a concrete mixer.

The design of the experiment was a 5 x 5 Latin square (Cochran and Cox, 1964) replicated two times. It was anticipated that as the concentration of alkali in the ration increased above the 0-percent level, a

point would be reached at which the sheep would begin to discriminate, either for or against further increases. This would be reflected in a significant deviation of the percent consumption of the alkali-containing ration from 50 percent of the total feed consumption. The lambs were offered water two times per day at about 7:00 a.m. and 4:00 p.m. for about 30 minutes each time.

Results and Discussion

The effect of increasing the concentration of either calcium hydroxide or magnesium oxide on the consumption of a 77.5-percent sorghum grain, high concentrate ration is shown in Figure 1. Each point on the graph represents the average response of 10 lambs.

The pattern of response was similar for both calcium hydroxide and magnesium oxide. The sheep apparently began to discriminate against the alkali-containing feed at levels around 1 percent of the ration. Results support those of the previously reported research on calcium hydroxide supplementation of high concentrate lamb rations by Shelton and Calhoun (1970) who reported that at levels of 1 percent, or greater, the presence of calcium hydroxide in the ration markedly reduced the rate of gain and increased the amount of feed required per pound of gain. These results differ markedly from those of Bhattacharya and Warner (1968) who reported that palatability was not a problem in a pelleted, 80-percent corn diet, containing 2.5 percent calcium hydroxide.

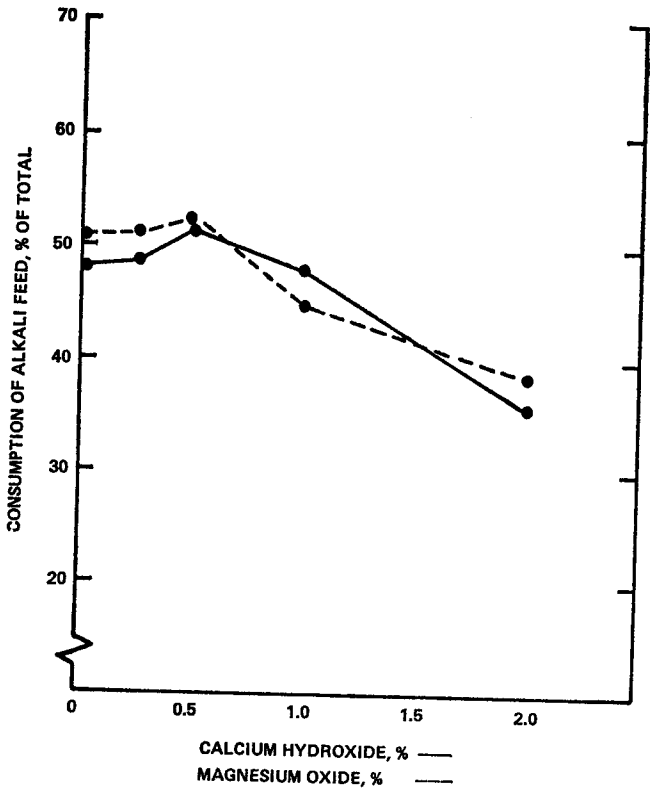

Figure 1. Effect of increasing the concentration of calcium hydroxide or magnesium oxide on the consumption of alkali feed.

Magnesium oxide was included in this study because it is readily available commercially and has potential for use as an antiacid in high concentrate lamb rations. Although long term feeding studies with varying concentrations in the diet have not been conducted with lambs, the use of magnesium oxide at a level of 0.5 percent of the grain mixture has been recommended for inclusion in high concentrate rations for dairy cows to offset the problem of milk-fat depression often encountered with such rations (Thomas and Emery, 1969). Supplementation of the grain ration of dairy cows with magnesium oxide at a level of 84 percent slightly decreased grain consumption. In research by Thomas and Emery (1969) calcium hydroxide inhibited voluntary intake of dairy cows to a greater extent than magnesium oxide. The results in Figure 1 indicate that with lambs the degree of discrimination is about the same for both calcium hydroxide and magnesium oxide.

High concentrate lamb rations based on sorghum grain and cottonseed products are generally marginal or deficient in calcium, potassium and sodium. Calcium hydroxide (hydrated lime, 54 percent calcium) can be used at levels up to 0.5 percent of the ration to provide a supplemental source of calcium. Potassium bicarbonate can be used as a supplemental source of potassium at a level up to about 1 percent of the ration. Sodium is generally provided as sodium chloride; however, sodium bicarbonate (27 percent sodium) could be used to provide supplemental sodium up to about 1 percent of the ration. The upper limit for inclusion of magnesium oxide (60 percent magnesium) in the diet would be about 0.5 percent.

A review of research conducted with alkali supplementation of high concentrate rations indicates that the concentration of alkali in the ration can markedly influence the nature of the results obtained. For example, the addition of 0.5 percent calcium hydroxide has resulted in consistent improvements in rate of gain and feed efficiency whereas at higher levels performance is adversely affected (Shelton and Calhoun, 1970). On this basis, it appears that combinations of acid neutralizing compounds supplemented at levels below which palatability and/or metabolic problems are encountered, which provide supplemental sources of needed nutrients (calcium, potassium, magnesium, sodium) and which maintain a reasonable cation balance would circumvent problems with decreased feed consumption and provide the best possibility for obtaining a positive response. Additional research with these buffers is required to determine the best combination to use under various dietary regimes.

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PR-3024

Feedlot Performance And Carcass Characteristics Of Slaughter Lambs Sired by Exotic Breeds of Rams

Maurice Shelton and Z. L. Carpenter

SUMMARY: Study results suggest that, with the exception of the Barbado, the exotic breeds Landrace, Karakul and Navajo could be used as sires without incurring serious loss in the value of the market lambs produced. The low body weights or slow rates of growth of Barbado-sired lambs indicate that rams of this type should not be used on fine-wool ewes without a very compelling reason for doing so. However, this cross will occasionally occur accidentally, and it may prove desirable to raise crossbred lambs out of Barbado ewes — several have been produced at the Texas A&M University Agricultural Center at McGregor. The primary difficulty with these is the time required to reach acceptable market grade. They will reach slaughter grade more readily if they are sired by early maturing sires such as Dorset or Hampshires.

Introduction

Extensive data are available from crossbreeding studies with sheep utilizing the breeds commonly available in the United States. Even though a large number of breeds are available on a national basis, flocks in Texas continue to be made up primarily of fine-wool ewes which are bred to fine-wool rams or to crossbred or blackface rams, primarily Suffolk, for slaughter lamb production.

Rams of some exotic breeds which have the potential of contributing great genetic diversity were bred to Rambouillet ewes at the Texas A&M University Agricultural Research Center at McGregor to determine whether their use as sires would cause any serious loss in the value of market lambs produced.

Materials and Methods

The Finnsheep or Landrace, which offers the potential of a marked improvement in fertility, was included in the study. Two additional breeds, the Navajo and Karakul, were included as potential sources of genes for hardiness or adaptability to adverse conditions. The Karakul was included as a representative of a large number of desert fat-tail types and the Barbado because it allegedly possesses qualities of both adaptability and increased reproductive level. In addition, either by intent or accident, the Barbado is often crossed with fine-wool sheep on Texas ranges, and it is desirable to obtain data on the performance of this cross. Purebred Rambouillet and blackface rams served as controls. The blackface included Suffolk, Hampshire or Suffolk X Hampshire crossbred rams, and it was not always possible to identify which of these was the sire of individual lambs. Previous studies have shown these three types of rams to be reasonably comparable in growth rate and carcass characteristics.

Rams of the various breeds or types represented were bred to ewes at the McGregor Center to produce both fall and spring lambs. Most of the lambs were out of grade Rambouillet ewes, but a few were out of crossbred ewes. None of the crossbred ewes carried any breeding of the rams represented in this study except for the Rambouillet. Several Rambouillet and blackface rams contributed offspring to this study, but only two Landrace, two Karakul, one Navajo and three Barbado rams were involved. The lambs were early weaned and fed in drylot in a spring and a fall replicate. The terms spring and fall represent the seasons in which the lambs were dropped. They were fed in drylot in seasons subsequent to the one in which they were dropped. The preweaning

TABLE 1. INFLUENCE OF BREED OF SIRE ON PERFORMANCE OF LAMBS IN THE FEEDLOT

Breeding	First replicate (Fall lambs)				Second replicate (Spring lambs)				Summary			
	No.	Avg daily gain, lb.	Daily feed intake, lb.	Feed /lb. gain, lb.	No.	Avg daily gain, lb.	Daily feed intake, lb.	Feed /lb. gain, lb.	No.	Avg daily gain, lb.	Daily feed intake, lb.	Feed /lb. gain, lb.
Blackface cross	10	.620	3.38	5.45	10	.497	2.78	6.24	20	.559	3.08	5.85
Rambouillet	10	.558	3.41	6.10	6	.547	3.09	5.65	16	.553	3.25	5.88
Landrace	5	.721[1]	3.54	4.92	11	.500	3.47	6.95	16	.610[1]	3.51	5.94
Karakul	11	.611	3.18	5.21	4	.431	2.96	6.87	14	.521	3.07	6.04
Navajo	6	.614	3.06	4.98	8	.530	3.16	5.97	14	.572	3.11	5.48
Barbado	12	.426	2.52	5.92	8	.352	2.44	6.92	20	.389	2.48	6.42

[1]Because the Landrace ram which sired the lambs in the fall replicate was put out earlier, this group of lambs went on feed at heavier weights and were fed for a shorter time. This apparently partially accounts for the more favorable performance of these lambs in the first replicate.

performance of these lambs was not analyzed. Because it would be highly influenced by age of ewe, type of birth, and so forth, with the small numbers involved the data would be of limited value. All lambs in both replicates were fed in drylot on the same high concentrate rations as follows:

Ingredient	%
Ground alfalfa hay	10.00
Dry rolled sorghum grain	75.00
Soybean meal	7.00
Molasses	5.00
Urea	0.75
Calcium carbonate	1.25
Trace mineral salt	1.00
Vitamin A – 1000 I.U. per pound	
Auremycin – 15 milligrams (mg) per pound	

The lambs were fed until they weighed approximately 100 pounds at the feedlot. They were sent to the Meats Laboratory, Texas A&M University, for slaughter at periodic intervals with the result that actual slaughter weights varied. The extent of this variability is shown by the carcass weights in Table 2. Due to the slower growth rate of the Barbado cross lambs, some were slaughtered at lighter weights when it became necessary to terminate the feeding trials. In some cases the number of lambs involved in the carcass tabulation is less than that involved in the feeding trials. This is due either to death losses or to the fact that a few individual lambs in all groups had not reached slaughter weight when the feeding trials were discontinued.

Results and Discussion

The feedlot performance data are shown in Table 1 and the carcass data in Table 2. Although these data are somewhat variable because of the limited number of sheep involved, they seem to provide a reasonable answer to the question posed. The straight Rambouillet and blackface crossbred lambs which served as controls were somewhat comparable in performance traits – the comparison tended to favor the crossbred lambs, but only by very small amounts. The Landrace-sired lambs performed similarly to the two control groups. They exceeded in rate of gain in one replicate, but this is likely due to an artifact resulting from their being slightly older. Studies at other locations have suggested that Landrace-sired lambs perform satisfactorily at the lighter weights but are at a disadvantage to certain other breeds such as the Rambouillet or Suffolk when carried to heavier weights. Studies at other locations have suggested also that Landrace-sired lambs have a larger amount of kidney or pelvic fat. In this study these lambs had the largest amount of kidney or pelvic fat of any of the groups represented except for the Barbado crosses. However, the difference was small and should not be of great importance.

The Karakul-sired lambs were distinguished primarily by the presence of an accumulation of fat around the tail head or dock. The Karakul is a fat-tail breed. The crossbred lambs were docked by knife or rubber band at marking time. These lambs can be routinely docked, but the amount of tissue to be cut is greater than with other lambs. It is important that these lambs be docked at an early age as the fat is rapidly accumulated in the tail, making the operation difficult at a later date. Also, it is important that these lambs be closely docked as any significant tail left serves as a fuse for accumulation of a undesirable amount of fat. Other studies have shown that when fat-tail sheep are docked, a portion of the fat that would normally be accumulated in the tail is distributed throughout the carcass and some accumulates around the tail head. In this study all carcasses were trimmed around the tail head to approximately one-fourth inch fat cover. The identity of carcasses was not known to persons doing the trimming. All groups were trimmed but the Karakul lambs more than the others. The total fat trim on the Karakul was on the order of 1 pound per carcass, but this was only approximately 0.65 pounds more than the control groups. However, in normal practice the control lambs would not have been trimmed.

TABLE 2. INFLUENCE OF BREED OF SIRE ON CERTAIN CARCASS CHARACTERISTICS OF SLAUGHTER LAMBS

Trait	Breed of sire					
	Blackface	Rambouillet	Landrace	Karakul	Navajo	Barbado
Number carcasses	18	14	16	13	11	17
Mean carcass wt., lb.	51.7	49.1	51.7	53.0	50.7	48.4
Dressing %[1]	56.8	54.7	56.9	59.0	57.4	55.7
USDA quality grade[2]	12.2	11.2	11.8	11.8	11.6	11.6
USDA yield grade	3.42	3.48	3.45	4.31	3.60	4.29
Estimated % boneless cuts	44.7	44.8	44.6	43.1	44.4	43.2
Estimated % total consumer cuts	82.9	83.8	83.3	82.0	83.0	82.2
Ribeye area, sq inches	2.00	1.92	1.92	1.95	1.80	1.76
Ribeye area per 50-lb. carcass	1.94	1.97	1.88	1.85	1.78	1.83
Fat thickness, inches	.231	.174	.188	.320	.224	.245
Body wall thickness, inches	.918	.785	.874	1.04	.882	.877
Tenderness shear, lb.	7.1	9.9	9.7	8.9	9.6	9.7
% kidney & pelvic fat	3.57	4.43	4.65	4.35	4.28	6.17
% trim from tail & dock	0.67	0.63	0.60	1.93	0.52	0.95
Fat color score[3]	2.89	2.35	2.72	2.54	3.00	2.82
Fat firmness score[3]	3.89	3.36	3.27	3.08	4.09	3.94

[1]Based on slaughter live weight after a 100-mile haul and an 18-hour shrink.

[2]USDA quality grades assigned the following numerical values: High Prime —15, Avg Prime —14, Low Prime —13; High Choice —12, Avg Choice —11, Low Choice —10.

[3]The higher values represent a firm white fat cover; the lower values (1 to 5 scale) represent a soft oily carcass.

Several of the Karakul crossbred lambs have been marketed in larger groups as slaughter lambs with no market discrimination. However, they have been discriminated against on the feeder market. They are readily distinguishable, usually by a variable amount of red color and long carpet type wool.

The Navajo-sired lambs performed in an acceptable manner. However, only one sire and 14 lambs contributed to the data. The data seem to suggest that these lambs have a smaller loineye area than the Rambouillet or blackface cross lambs.

Barbado cross lambs gained poorly due primarily to a lower level of voluntary feed intake. As a result, they required an extended period in the feedlot. Some of the lambs remained in the feedlot for more than 150 days. However, if fed to as much as 100 pounds, they graded as acceptable slaughter lambs. The mean USDA quality grade on these lambs was between average and high choice. This was comparable to the other breed groups except for the blackface crosses. The only noticeable distinction for the Barbado cross carcasses was in the percent of kidney and pelvic fat which at 6.17 percent was well above that of the other groups.

PR-3025

The Problem of Soft, Oily Lamb Carcasses

Maurice Shelton, M. C. Calhoun
and Z. L. Carpenter

SUMMARY: A soft or oily appearance of lamb carcasses has periodically occurred in lambs from feedlots in Texas. This problem is limited primarily to clipped lambs fed on high energy rations during the cool season of the year. A change or shift in any of these variables will generally circumvent the problem, but it is difficult to make a shift in these without adversely affecting the rate or efficiency of gain. A shift to an increased roughage level (20-30 percent cottonseed or peanut hulls) was generally adequate to prevent the occurrence of this problem. The addition of buffering or neutralizing agents to the ration was without effect on the texture or color of the fat produced. Fast-gaining male or wether lambs usually produce the problem carcasses. This can be partially overcome by leaving the lambs in the feedlot for a longer period of time. Female lambs produce both fatter and firmer carcasses.

Introduction

Periodically in recent years in Texas lamb carcasses have been discriminated against in market channels because of soft oily appearance. In extreme cases, this results in substantial economic implications to the feeder and the packer. The discrimination stems from an apparent problem at the retail level in merchandising cuts from these carcasses.

Experimental Procedure and Results

On two occasions fat samples of oily and normal carcasses were taken from packing house coolers. These were analyzed by gas liquid chromatography for fatty acid content. The results are shown in Table 1. The first samples (three of each type) represented the extremes which could be found in the coolers on the date the samples were taken. The second samples were taken from a single lot sent in by

TABLE 1. FATTY ACID ANALYSES OF FAT SAMPLES TAKEN FROM SOFT AS COMPARED WITH NORMAL CARCASSES[1]

	Sample #1, Jan 1971		Sample #2, Jan 1971			
	Dock samples		Kidney fat		Dock samples	
	Normal carcasses	Soft carcasses	Normal carcasses	Soft carcasses	Normal carcasses	Soft carcasses
Fatty acids			Composition, %			
Less than C12	.203		.190	.595	.243	.217
C12:0	.200		.127	.410	.250	.793
C12:1	.100	.300				
C14:0	3.73	2.47	2.91	4.91	2.13	1.81
C14:1	.143	.287	.277		1.25	2.00
C15:0	1.23	2.00	.500	2.02	.770	4.17
C15:1	.067	1.27				
C16:0	23.8	18.7	27.83	26.3	22.2	15.6
C16:1	3.57	8.00	1.57	3.20	3.88	12.9
C17:0	3.63	3.22				
C17:1	1.30	3.67	2.13	1.62	3.00	2.12
C18:0	16.8	7.83	26.05	19.9	16.9	14.3
C18:1	38.3	40.5	33.72	36.0	45.1	34.8
C18:2	2.77	3.63	4.34	4.90	.417	3.10
C18:3	2.13	2.00				
More than C18	.700	.533				
Saturated acids	49.6	37.5	57.6	54.2	42.5	36.9
Monoenoic	45.0	56.6	37.7	40.8	53.2	51.8
Polyunsaturated	5.23	5.90	4.34	4.90	.417	3.10
Total unsaturated	50.4	62.5	42.0	45.7	53.6	54.9
Unsaturated as % of total	50.4	62.5	42.2	45.8	55.8	59.8
Calculated avg chain length	17.0	16.2	17.2	17.1	17.2	16.9

[1]Data are averages of samples from three carcasses, except that for kidney fat from soft carcasses data from only two carcasses are included.

one feeder. Thus, these samples were not only collected on different dates, but the first samples represent more extreme differences.

Soft or oily fat is normally due to a decrease in the length of the carbon chain or an increase in the amount of unsaturation in the fatty acids of which it is composed. These data suggest that both mechanisms are involved in this problem, but the major factor is thought to be an increase in the amount of unsaturated fatty acids. For instance, there was an increase of 12.1 percent in the amount of unsaturated fatty acids in the first samples collected. The kidney fat had substantially less unsaturated fatty acids and also showed less variation between the normal and oily lambs. This is in line with earlier studies (Marchello and Cramer, 1963) which show kidney fat to have a higher melting point and to be affected less by environmental variables than subcutaneous fat.

Two feeding trials were conducted to study factors affecting the oily carcass problem. Also fat texture and color scores were assigned to a number of lamb carcasses derived from other studies. Development of oily carcasses is largely limited to the cool season of the year, seemingly occurring shortly after a rapid change from warm to cool weather. Workers at Colorado (Marchello, Cramer and Miller, 1967) have shown that low temperature reduces the melting point of lamb fat. Consequently, these feeding trials were conducted only in the cool season of the year. They were designed primarily to study the effect of concentrate-roughage ratio and the use of buffering agents since the oily carcass problem is largely restricted to those feeding situations in which high energy rations are used extensively.

The rations fed in the first trial are given in Table 2. The rations contained 10, 25 or 50 percent roughage made up of equal parts peanut hulls and cottonseed hulls. In addition, rations were included with elevated calcium in the carbonate or hydroxide form (rations 4 and 5), and one lot received mixed buffers containing calcium hydroxide, magnesium oxide and potassium bicarbonate (ration 6). High energy rations are known to cause an acid condition in the digestive tract. Buffers were included in the ration in an effort to raise the pH of the digestive tract to determine whether this would alter the nature of the fat produced. Some of these lambs were slaughtered at the Meats Laboratory at College Station, and fatty acid determinations were made by means of gas liquid chromatography. Scores were assigned for the color and texture of the external fat cover on all lambs in this and the subsequent trial according to a 1 to 4 or 1 to 6 ranking with the lower numerical values being yellow in color or soft and oily and the higher numerical values being white and firm fat. The results are shown in Table 3.

These data (Table 3) show that the lambs on the roughage rations produced a firmer fat with less unsaturated fatty acids. There is no indication of an

TABLE 2. PERCENTAGE COMPOSITION OF RATIONS FED (TRIAL 1)

Ingredient	Ration number 1	2	3	4	5	6
	%					
Sorghum grain (dry rolled)	31.40	52.70	74.00	73.00	73.00	72.00
Dehydrated alfalfa	3.00	3.00	3.00	3.00	3.00	3.00
Peanut hulls	25.00	15.00	5.00	5.00	5.00	5.00
Cottonseed hulls	25.00	15.00	5.00	5.00	5.00	5.00
Cottonseed meal	6.00	5.00	4.00	4.00	4.00	4.00
Feather meal	2.50	2.00	1.50	1.50	1.50	1.50
Urea	0.60	0.75	0.75	0.75	0.75	0.75
Calcium carbonate	0.75	0.80	1.00	2.00	1.50	1.50
Trace mineral salt	0.75	0.75	0.75	0.75	0.75	0.75
Molasses	5.00	5.00	5.00	5.00	5.00	5.00
Calcium hydroxide					0.50	0.50
Magnesium oxide						0.50
Potassium bicarbonate						0.50
Vitamin A, 1000 I.U./lb.	+	+	+	+	+	+
Aureamycin, 15 mg/lb.	+	+	+	+	+	+

TABLE 3. INFLUENCE OF ROUGHAGE LEVEL AND BUFFERING AGENTS ON FEEDLOT PERFORMANCE OF LAMBS AND ON THE CHARACTER OF THE FAT PRODUCED (TRIAL 1)

Ration no.	Treatment	No. lambs	Rate of gain, lb.	Feed per lb. gain	Fat color score[1]	Fat firmness score[2]	Fatty acids: Saturated %	Fatty acids: Unsaturated %
1	50% roughage	10	.602	7.89	3.44	4.22	50.9	49.0
2	30% roughage	9	.541	6.95	3.56	4.11	50.5	49.4
3	10% roughage	9	.675	5.43	2.88	3.50	45.6	54.3
4	Ration 3 + elevated calcium carbonate	9	.635	5.54	3.00	3.33	50.0	50.0
5	Ration 3 + calcium hydroxide	9	.652	5.16	2.88	3.00	46.8	53.3
6	Ration 3 + mixed buffers	9	.560	5.79	2.75	3.13	45.6	54.3

[1]Fat color scores: 1 = yellow; 2 = slightly yellow; 3 = creamy white; 4 = white.
[2]Fat texture and firmness scores: 1 = soft and oily; 2 = moderately soft and moderately oily; 3 = slightly soft and slightly oily; 4 = slightly firm and slightly dry; 5 = moderately firm and moderately dry; 6 = firm and dry.

improvement in the characteristics of the fat as a result of the inclusion of buffering agents. Elevated calcium in the carbonate form fed to one lot appears to have resulted in some improvement, but this should receive further study.

The rations fed in the second feeding trial are given in Table 4. Fatty acid anlyses were not done in the second trial. However, fat color and firmness scores were assigned as in the previous study. Results again indicate an effect for roughage level but no

TABLE 4. PERCENTAGE COMPOSITION OF RATIONS FED (TRIAL 2)

Ingredient	Ration number 1	2	3	4	5	6	7
	%						
Sorghum grain	82.25	71.50	60.55	38.65	71.00	70.50	70.00
Peanut hulls		10.00	20.00	40.00	10.00	10.00	10.00
Cottonseed meal	6.25	7.00	8.00	10.00	7.00	7.00	7.00
Dehydrated alfalfa	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Urea	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Calicum carbonate	1.75	1.75	1.70	1.60	1.75	1.75	1.75
Trace mineral salt	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Molasses	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Calcium hydroxide					0.50		0.50
Potassium bicarbonate						1.00	1.00

TABLE 5. INFLUENCE OF ROUGHAGE LEVEL AND BUFFERING AGENTS ON FEEDLOT PERFORMANCE OF LAMBS AND ON THE CHARACTER OF THE FAT PRODUCED (TRIAL 2)

Rations	No. lambs	Avg daily gain, lb.	Daily feed, lb.	Feed/ lb. gain	Fat thickness L. dorsi, inches	Fat color score[1]	Fat firmness & texture score[2]
All concentrate	22	.446	3.43	7.70	.188	2.29	2.67
10% peanut hulls	11	.417	3.50	8.39	.157	2.36	2.91
10% peanut hulls + 0.5% $Ca(OH)_2$	11	.492	3.82	7.76	.196	2.18	2.64
10 % peanut hulls + 1% $KHCO_3$	11	.511	3.81	7.45	.186	2.18	2.82
10% peanut hulls + 1% $KHCO_3$ +0.5% $Ca(OH)_2$	11	.485	3.67	7.57	.191	2.27	3.27
20% peanut hulls	11	.419	3.99	9.52	.177	2.46	3.18
40% peanut hulls	11	.395	4.66	11.81	.186	2.91	4.18

[1]Fat color scores: 1 = yellow; 2 = slightly yellow; 3 = creamy white; 4 = white.
[2]Fat texture and firmness scores: 1 = soft and oily; 2 = moderately soft and moderately oily; 3 = slightly soft and slightly oily; 4 = slightly firm and slightly dry; 5 = moderately firm and moderately dry; 6 = firm and dry.

consistent evidence of any beneficial effect from the use of buffering agents (Table 5). The effect of roughage level and sex on fat character scores is shown in Figures 1 and 2. The differences for these factors appear to be small, but only limited improvement is normally adequate to prevent market discrimination. The relationship between rate of gain and fat thickness and the scores assigned are shown in Table 6. These data seem to confirm a definite relationship between these variables with the faster gaining lambs with less fat cover showing more of a tendency to the oily conditions.

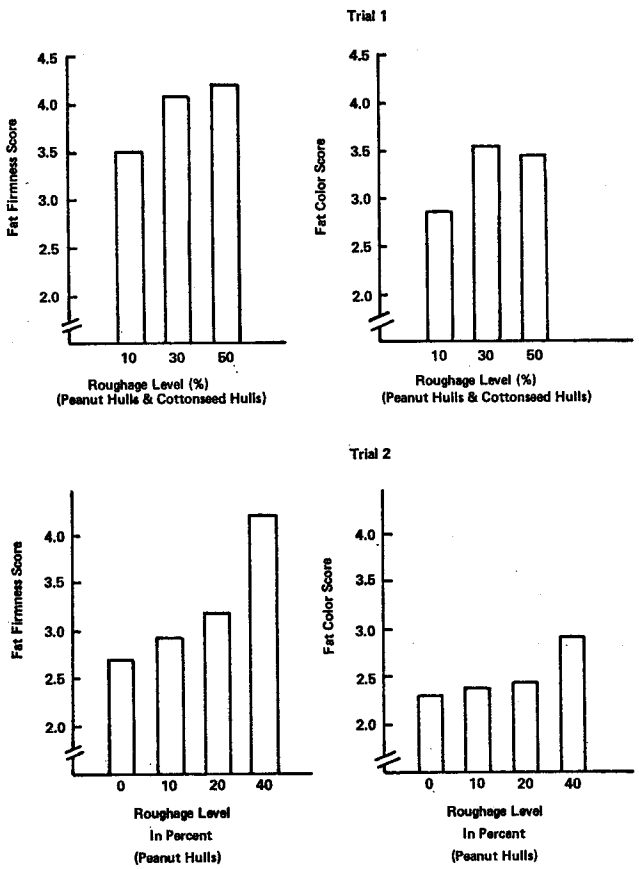

Figure 1. Relation of roughage level to fat firmness and color scores.

Discussion

The apparent explanation for oily carcass problems being limited primarily to the cool season of the year is that fat in an individual cell is in a dynamic

TABLE 6. THE RELATIONSHIP OF RATE OF GAIN AND FAT THICKNESS TO SCORES FOR FAT FIRMNESS AND COLOR

Fat firmness & texture score[1]	Trial 1 No.	Trial 1 Daily gain, lb.	Trial 1 Fat thickness	Trial 2 No.	Trial 2 Daily gain, lb.	Trial 2 Fat thickness
1	2	1.055	.220	3	.524	.100
2	6	0.622	.250	30	.477	.150
3	18	0.621	.206	47	.438	.203
4	16	0.582	.268	22	.444	.209
5	9	0.588	.236	7	.403	.193

Fat color score[2]	Trial 1 No.	Trial 1 Daily gain, lb.	Trial 1 Fat thickness	Trial 2 No.	Trial 2 Daily gain, lb.	Trial 2 Fat thickness
1	2	1.055	.220	2	.625	.100
2	10	0.648	.205	68	.458	.174
3	22	0.583	.225	39	.417	.210
4	15	0.585	.267			

[1]Fat texture and firmness scores: 1 = soft and oily; 2 = moderately soft and moderately oily; 3 = slightly soft and slightly oily; 4 = slightly firm and slightly dry; 5 = moderately firm and moderately dry; 6 = firm and dry.
[2]Fat color scores; 1 = yellow; 2 = slightly yellow; 3 = creamy white; 4 = white.

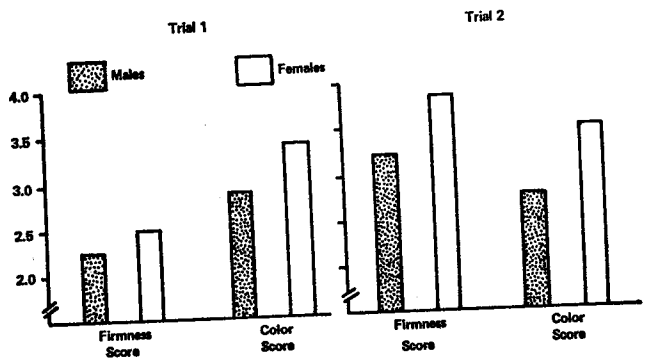

Figure 2. Influence of sex on character of fat produced.

rather than a static state, and it can be metabolized by the animal only in the liquid state. When exposed to low temperatures, the skin surface temperature of a freshly shorn lamb is well below the internal core temperature. Thus, there is apparently a natural process in which the melting point of the subcutaneous fat is lowered by reducing the chain length or amount of unsaturation in the fatty acids involved. This problem is limited almost entirely to freshly shorn lambs. Numerous lambs have been fed during the winter in full fleece at the McGregor Center and in other experimental studies (Marchello, Cramer and Miller, 1967) with no evidence of a soft carcass problem. Lambs with as much as one-half inch fleece or more are protected against effects of cold regardless of external temperature.

The second major factor contributing to the oily carcass problem is the roughage level in the ration. It is now well established that lambs on a high energy ration deposit fat with a lower melting point. It appears from these studies that a 25- to 30-percent roughage component made up of peanut hulls or cottonseed hulls is adequate to prevent this problem. The mechanism whereby the type of ration fed influences the type of fat deposited is not clear. It is known that most of the fatty acids in plant materials which constitute the diet of ruminants are unsaturated. These acids are normally hydrogenated by the action of microorganisms in the rumen (Mills, Scott, Russell and Smith, 1970). The feeding of high concentrate rations markedly alters the acid-base balance and microbial populations of the rumen. Thus, the capacity of the animal to hydrogenate these fatty acids is apparently affected by the nature of the ration fed, but the shift in the microorganisms responsible for this effect is not known.

Within a given group of lambs, the fast-gaining intact male or wether lamb with a minimum of fat cover is likely to be oily. A recent report by Jacobs *et al.*, (1972), has shown that intact rams are more likely to be oily than wethers. Female lambs are much less likely to show an oily tendency. Lambs with a greater fat cover are less likely to be soft. Since female lambs are normally substantially fatter than males, it is not clear whether it is sex *per se* or the amount of fat cover which makes the female carcasses firmer. Both factors probably are involved as Cramer and Marchello (1964) have shown female lambs to have a higher concentration of the long chain fatty acids. Faster gaining lambs definitely appear more oily, but it is not clear whether this is an exclusive effect of rate of gain. If this is the case, it probably can be explained as a limited capacity of the animal to hydrogenate the fatty acids consumed. An alternative explanation, which must be a consideration, is the fact that fast gaining lambs reach market weight and condition quicker and a higher proportion of the fat cover would have been deposited during the early postshearing period.

The occurrence of oily carcasses is sporadic and generally of low frequency. However, the contributing factors such as improved rate of gain, short feeding periods for clipped lambs, marketing of higher yielding lambs and the increased feeding of male lambs are likely to increase the frequency of occurrence of the problem. For this reason lamb feeders should be aware of this potential problem and the available control measures.

Acknowledgment

The authors wish to acknowledge the assistance of Nestor R. Bottino, Department of Biochemistry, Texas A&M University, for assistance in conducting some of the fatty acid analyses reported in this study.

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PR-3026

Current Studies Of Lamb Cutability

W. L. Varnadore, G. C. Smith and Z. L. Carpenter

SUMMARY: Further research was conducted to identify more clearly cutability differences among lamb carcasses and to relate these differences to current dollar returns per hundredweight of carcass. Data

were collected from 25 lambs selected to include five lambs each from yield grades 1, 2, 3, 4 and 5 (USDA, 1969). Percent of retail cuts decreased 4.6 percent for each one-unit increase (from 1 to 2, 2 to 3, and so forth) in USDA yield grade. Percent of fat changed 5 percent, and dollar return per hundredweight of carcass changed $5.67 for each one-unit change in yield grade. Assuming that all other factors of procurement, dressing, storage, shrinkage and so forth remained constant, the lamb buyer could pay $2.00 per hundredweight differential between lambs of adjacent yield grades.

Introduction

The ultimate worth of lamb to the consumer is determined by the amount and quality of edible meat that the retail cuts contain (Carpenter, 1966). Correspondingly, the retailer should demand higher cutting carcasses from the wholesaler who, in turn, would seek lambs of superior cutability from the producer. Many factors have been considered, and numerous equations predicting the cutability of lamb carcasses have been reported (Smith *et al.*, 1970). In March 1969, the USDA adopted yield grades as the cutability standard for lamb carcasses. The USDA yield grade equation is comprised of measures of (1) the amount of subcutaneous fat, (2) the amount of kidney and pelvic fat and (3) the conformation grade or the amount of muscling in the leg. However, the highest cutting carcass (yield grade 1) may not necessarily be the most desirable carcass for all segments of industry (Jeremiah *et al.*, 1972).

Kammlah *et al.* (1971) provided evidence that purchasing higher yielding lambs (yield grades 1 and 2) could be advantageous from the dollar return standpoint. The present study was designed to investigate further the value-yield concept and to provide current pricing information.

Experimental Procedure

Data were collected from 25 lambs selected to include five U.S. Choice carcasses from each of the USDA yield grades. Each lamb carcass was fabricated to provide closely trimmed bone-in retail cuts according to procedures suggested by the American Lamb Council. Current (February 1972) retail prices were used to determine retail values per hundredweight for carcasses of each yield grade group.

TABLE 1. CUTTING YIELDS FOR CARCASSES IN EACH USDA YIELD GRADE GROUP

Yield grade group	1	2	3	4	5
Actual yield grade[1]	1.8	2.5	3.3	4.6	5.4
Carcass weight (lb.)	34.0	38.3	47.8	53.5	54.1
Total retail cuts (%)	82.6	79.2	74.5	70.3	65.9
Total fat (%)	9.4	12.5	17.3	22.9	27.4
Total bone (%)	7.5	8.0	8.0	6.4	6.3
Total cutting loss (%)	0.5	0.3	0.2	0.4	0.3

[1]The average yield grade of the five lambs in each yield grade group.

TABLE 2. RETAIL VALUE OF CARCASSES IN EACH USDA YIELD GRADE GROUP

Retail cut	Price per pound	Yield grade group 1	2	3	4	5
Leg	1.19	37.72	34.75	32.86	29.44	27.22
Loin chops	1.99	16.16	16.02	15.26	14.93	13.23
Rib chops	1.89	12.55	12.11	11.62	12.21	10.85
Arm chops	1.19	5.96	5.83	5.28	4.80	4.86
Blade chops	1.09	12.18	11.67	11.54	10.56	10.06
Boneless stew	.99	3.04	2.71	2.19	2.43	2.15
Bone-in-stew	.59	2.96	3.05	2.76	2.61	2.86
Shank	.79	2.93	3.15	2.96	2.42	2.31
Spareribs	.69	4.03	4.18	3.86	3.91	3.71
Lean trim	.79	1.98	1.67	1.79	2.65	1.87
Cubed steaks	1.19	1.81	1.63	1.62	1.65	1.79
Total[1]		$101.32	$96.77	$91.74	$87.61	$80.71

[1]The total value computation is equivalent to retail value per hundredweight of carcass.

Results and Discussion

As yield grade increased from 1 to 5, the percent of fat increased and the percent of retail cuts decreased (Table 1). This agrees with previous studies (Kammlah *et al.*, 1971 and Carpenter and Oliver, 1969) although there is some difference in absolute percentage values. A change of one unit in USDA yield grade was associated with an average decrease of 4.6 percent in retail cuts, an increase of 5.0 percent in trim fat and a decrease of $5.67 per hundredweight in retail carcass value. Increases of $4.55 between carcasses of yield grades 1.8 and 2.5, $5.03 between carcasses of 2.5 to 3.3, $4.13 between carcasses of 3.3 and 4.6 and $6.70 between carcasses of yield grades 4.6 and 5.4 were observed (Table 2). These values suggest considerable advantage to the retailer buying higher cutting lambs. Unfortunately, lambs of yield grade 1 previously have been shown to exhibit excess carcass shrinkage (Rea *et al.*, 1970), and such lambs had the highest cutting loss in the present study (Table 1). Smith *et al.* (1970) reported that higher degrees of fatness were associated with increased juiciness, tenderness and overall satisfaction of cooked lamb. Jeremiah *et al.* (1971, 1972) indicated that yield grade 1 lamb carcasses produced cuts which were both less satisfactory in palatability and less flavorful and had reduced caselife from the standpoints of color, odor and psychrotrophic bacterial growth. Rea *et al.* (1970) suggested that a minimum level of 0.10 inch of subcutaneous fat at the 12th rib is necessary to prevent excessive shrink. In the present study, yield grade 1 carcasses were very difficult to fabricate into retail cuts that would be of acceptable quality to the consumer. The rack and loin were especially difficult to prepare because the removal of the fell

membrane often mutilated the entire surface of the wholesale cut. Nevertheless, the retailer must recognize the reduced value of carcasses in yield grades 4 and 5 due to the trim. The results of the present and associated studies suggest that buyers should limit purchases of lamb carcasses to those ranging from 1.9 to 3.1 in USDA yield grade to insure maximum dollar returns from merchandising and optimal consumer satisfaction.

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PR-3027

Comparative Boning Yields For Goat Carcasses

G. C. Smith, B. W. Berry and Z. L. Carpenter

SUMMARY: Cutability data were collected from aged goat carcasses of different degrees of muscling and compared with similar data from aged sheep carcasses. Aged sheep carcasses were larger and more heavily fleshed, could be boned with lower unit processing costs and yielded larger quantities of soft tissues in relation to bone. Goat carcasses with heavy muscling yielded higher percentages of edible portion, lower percentages of bone and could be fabricated more efficiently than goat carcasses which were thinly fleshed. Advantages in dressing percent (11.6 percent) and edible portion (7.3 percent) combined with the advantage in unit processing costs for boning indicate that heavily muscled goats merit higher prices per hundredweight upon marketing.

Introduction

Goat meat is eaten extensively in many areas of the Southwest and for many years has been a popular barbecue attraction. Most of the goats presently marketed are processed locally, and the meat finds a ready market or is incorporated into processed items such as sausage or chili. The meat from young kid goats is referred to as "cabrito" and is regarded as a delicacy for the barbecue trade. At present, there is little consistency among markets in either classification or grading of goats or goat carcasses. Effective marketing depends upon a commonly understood market terminology that is related to utility and value and an efficient system for market reporting. Correspondingly, a need exists for grading standards which can be uniformly applied in classifying the population of goats and goat carcasses into more homogeneous groups.

The comparative desirability of goat meat as a food item in fresh, processed or comminuted form is not presently known. While a number of investigations (especially in New Zealand) have indicated high substitutive rates with mutton as a fresh meat item, the latter product is not considered acceptable by the vast majority of American consumers. Texas packers have indicated that goat meat is firmer, drier and far superior to mutton for incorporation into sausage. Correspondingly, it has been estimated that more than 90 percent of the goat meat processed in Texas is presently used for sausage manufacture.

One of the primary limiting factors in the utilization of lean from goat carcasses is the low yield achieved in handboning. Goat carcasses exhibit low muscle to bone ratios, and attempts to achieve efficient rates of tissue separation are hampered by the high unit processing costs for boning. This report summarizes the current status of research designed to effect solutions to the goat meat marketing problems in Texas.

Experimental Procedure

Complete slaughter and cutability data were collected from 18 aged goats and 16 aged sheep. The animals were slaughtered, using conventional procedures, chilled 3 to 5 days in a 34° F cooler and subsequently fabricated to determine boning yields. Each carcass was graded according to USDA standards for mutton carcasses, and measurements were obtained for ribeye area and fat thickness opposite the ribeye at the 12th rib. Each carcass was boned under conditions selected to simulate closely commercial practice with regard to speed and manual dexterity.

Results and Discussion

Previous research has indicated that the dressing percentage of Angora goats is low and that the amount of usable meat from goats approximates 21 percent of the live weight. Therefore, to slaughter

and process aged goats profitably for meat purposes would require large volumes moving through packing houses at increased rates of processing to reduce overhead costs. Slaughtering and boning facilities would be similar to those required for mutton, suggesting that goat processing operations would combine favorably with existing slaughtering and boning facilities for mutton.

Aged goat carcasses chosen to be representative of heavy, intermediate and light muscling were fabricated to obtain comparative boning yields. Heavy muscling was evaluated as plump, full-fleshed legs, wide loin and rack and thickly fleshed shoulders. Carcasses which were thinly fleshed were very long and angular with distinct concavity in the legs and shallow fleshing in the loin, rack and shoulder. Yield of edible portion from aged goat carcasses is low (Table 1). The time required to remove the lean from goat carcasses approximated 8 minutes per carcass; thus, it would require approximately 64 cents worth of labor to bone individual goat carcasses. Data in Table 1 indicate that subjective evaluations of muscling were more closely related than ribeye area to relative boning yields, since carcasses of intermediate muscling had approximately the same cross-sectional area of ribeye as heavily muscled goats but 2.7 percent less edible portion. Heavily muscled goats yielded 21.7 pounds of edible portion which was removed from the carcass at a cost of 2.8 cents per pound; thinly fleshed (light muscled) carcasses yielded 11.5 pounds of edible portion which was removed at a cost of 5.6 cents per pound. The advantages in dressing percent (11.6 percent) and edible portion (7.3 percent) combined with the advantage in unit processing costs for boning suggest that heavily muscled goats merit higher prices per hundredweight upon marketing.

To facilitate comparisons of aged goats with aged ewes, 16 mature ewes were fabricated in the manner previously described for aged goats. Comparative data are presented in Table 2. These data suggest that aged ewes can be more profitably fabricated than aged goats because they are heavier fleshed, higher yielding and larger and can be boned with lower unit costs for boning. However, the sheep carcasses were more heavily finished than the goats; thus, goats and sheep may have more nearly comparable amounts of fat-free lean. Unless the additional fat could be incorporated into sausage manufacture, the added boning time per ovine carcass would result in a decided advantage for goat carcasses. Further studies are being conducted to compare heavier weight goats with lighter weight ewes and sheep and goats of more nearly equal finish to facilitate more accurate processing comparisons.

TABLE 1. CUTABILITY DATA FOR AGED GOAT CARCASSES

Trait	Degree of muscling[1]		
	Heavy	Intermediate	Light
Carcass weight, lb.	32.8	31.3	20.8
Dressing percent	48.3	47.1	36.7
Conformation score	Avg Good	High Utility	Low Utility
Fat cover, inches	.07	.06	.02
Ribeye area, sq inches	1.03	1.06	0.50
Edible portion, %	62.8	60.1	55.5
Bone, %	37.2	39.9	44.5
Boning time/carcass	8 min 36 sec	7 min 50 sec	7 min 45 sec

[1]Based on subjective evaluations of muscle to bone ratio in the regions of the leg, loin, rack and shoulder.

TABLE 2. COMPARATIVE CUTABILITY DATA FOR AGED SHEEP VS. GOAT CARCASSES

Trait	Aged goats	Aged sheep
Carcass weight, lb.	28.3	65.1
Dressing percent	47.4	51.6
Conformation score	High Utility	Avg Good
Fat cover, inches	0.05	0.35
Ribeye area, sq inches	0.87	1.84
Edible portion, %	59.5	65.8
Bone, %	40.5	34.2
Boning time/carcass	8 min 3 sec	12 min 5 sec

PR-3028

Postnatal Secondary Follicle Maturation in the Angora Goat

J. R. Gallagher

SUMMARY: Histological studies of Angora goat skin were conducted to measure the development of the secondary follicle population in early postnatal life. The ratio of secondary follicles containing mature fibers to primary follicles doubled from birth to 14 days of age and increased to 7.4:1 at 118 days of age. It was concluded that the rapid maturation of the secondary follicle population in early postnatal life bore some similarity to results of previous studies with Merino sheep.

Introduction

Many studies of mohair fleece characters have been documented, but only one U.S. study (Margolena, 1966) has attempted to characterize the skin follicle population of the Angora goat. More recently Dreyer and Marincowitz (1967) reported follicle studies with Angora goats in South Africa. Such histological studies are essential for studying the initiation, development and production of the mohair fiber.

Fibers are produced in follicles, small fingerlike projections of the outer into the inner layer of the

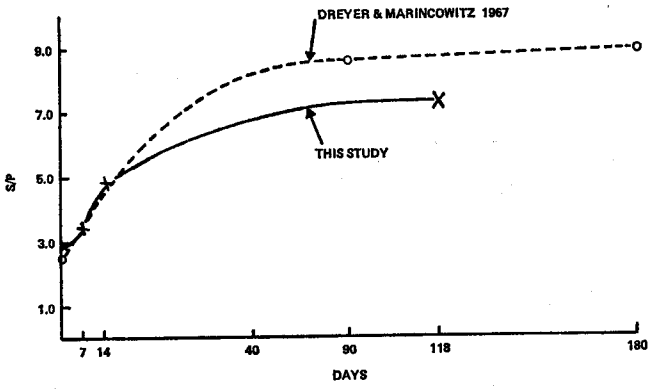

Figure 1. Postnatal secondary follicle maturation in the Angora goat.

skin. Follicles are initiated during fetal life, occur in bundles and are characterized by primary and secondary follicles. Primary follicles are initiated earlier than secondary follicles and differ from secondaries in their spatial position in the bundle and in their accessory structures. A characteristic of all fiber producers is that in each bundle, primary follicles usually occur together in groups of three. Secondary follicles complete the bundle, and the ratio of secondary follicles containing mature fibers to primary follicles with mature fibers (S/P) characterizes the follicle population of the animal.

Margolena (1966) reported S/P ratios at 1 year of age while Dreyer and Marincowitz (1967) reported ratios at birth and at 3-month intervals to 2 years of age. A study of the maturation of the secondary follicle population from birth to 118 days of age in Angora kids of mixed sexes is reported here.

Experimental Procedure

Skin samples were harvested from the mid side of four Angora kids at birth, 7, 14 and 118 days of age. The procedure of skin sampling, wax embedding, sectioning, staining and counting has been described by Carter and Clarke (1957).

Results and Discussion

No real differences in S/P ratios were observed between sexes. The pooled S/P ratios estimated at the four samplings are shown in Figure 1. The S/P ratio almost doubled in the first 2 weeks from the birthcoat estimate of 2.6:1 and continued to increase to 7.4:1 at 118 days of age. The S/P ratio of 7.4:1 lies within the range of 6.5:1-8.3:1 which was reported by Margolena (1966) for 1-year-old Texas Angora does.

Values given by Dreyer and Marincowitz (1967) for South African Angora goats (Figure 1) show a rapid increase in S/P ratio from 2.3:1 at birth to 8.5:1 at 90 days of age and a slower rate of increase to 9.1:1 at 180 days of age. The S/P ratio did not increase beyond 180 days of age.

The sequential maturation of the secondary follicle population in the present study and in the South African study followed a trend demonstrated in Merino sheep by Hardy and Lyne (1956) who indicated that all follicles are initiated prenatally but that some secondary follicles do not produce mature fibers until after birth. The near doubling of the S/P ratio in the first 14 days after birth bears some similarity to results of studies with Merino sheep (Short, 1955) that indicated a rapid maturation of secondary follicles, particularly in the first month after birth.

This study was initiated to provide information on the secondary follicle population in early postnatal life, a period which sheep researchers Schinckel and Short (1961) indicated is critical in fleece development. They found that the rate of maturation of secondary follicles and the future capacity of the follicles to produce fibers are extremely sensitive to early postnatal nutrition. Since rapid maturation of secondary follicles in early postnatal life was noted in the present Angora study, further histological studies involving nutritional treatments probably would improve knowledge of the development and production of the Angora fleece.

Acknowledgment

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PR-3029

Effects of Removing Belly Wool at Shearing

J. W. Bassett, J. A. King,
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SUMMARY: Over 700,000 pounds of grease wool had the belly wool removed from fleeces on the shearing floor and sacked separately. The balance of each

fleece was classed for length and sacked without tying. Samples of the Staple, French Combing and Skirts (belly wool) were scoured and processed into wool top. The belly wool was slightly coarser and shorter than both the Staple and French Combing lots in both grease state and wool top. It was not as strong and contained more vegetable matter defect and colored fiber content. The belly wool yielded approximately 7 percent less wool top and 7 percent more noils. There was virtually no difference between the Staple and French Combing wools except for the length. Removal of belly wool on the shearing floor was accomplished with no increase in labor and little overall change in shearing practices. The improvement in the market quality characteristics of the resulting top should warrant premiums larger than the 1 to 2½ cents per grease pound shown for these wools.

Introduction

Wools imported into the United States have generally come in at clean prices below comparable domestic wools. The addition of the wool tariff, however, has made the cost of the wool to the manufacturer higher than that of similar domestic wool. This has always been considered as a price differential reflecting improved preparation and greater uniformity of the imported wools. Efforts have been made for a long time to institute preparation practices in this country which would provide more uniform sale lots. A company was organized in 1915 to promote, prepare and sell wool under the Australian system. The company and system failed for a variety of reasons, although improved preparation and uniformity have continued to be stressed at all levels of production and marketing. Domestic wools will probably never be prepared at the shearing floor by methods comparable to those used for the majority of imported wools, but there are practices which can be routinely adopted if the producer has an incentive to do so.

One practice holding promise for the Texas fine-wool clip which is relatively uniform for grade (fiber diameter) is to remove the belly wool on the shearing floor and sack it separately. Belly wool can be identified visually by its distinct difference in color and physical appearance, but little effort has been made to determine differences of importance in processing. If there are significant differences, removal of the belly wool on the shearing floor would be relatively easy, with no increase in cost and no significant change in shearing floor practices. However, if the practice is to receive producer support, it will be essential that the producer receive a price incentive for the belly-free wool reflecting its increased value to the manufacturer.

Experimental Procedure

In spring 1971 the Sonora Wool and Mohair Company asked the patrons of the company to consider removing belly wool from fleeces on the shearing floor and to sack this separately. There was a twofold purpose for this suggestion. First, it was an effort to produce a better prepared, more uniform product which would warrant at least a part of the normal price differential paid for imported fine-wool. The second purpose was to determine whether there is a difference in the amount of black or colored fibers present in the different fleece portions.

TABLE 1. GREASE WOOL WEIGHTS

Classification	Staple length, inches	Weight	
		Pounds	Percent
Staple	Over 3	396,896	56.7
French combing	2 - 3	152,459	21.8
Clothing	Under 2	75,671	10.8
Skirts		52,278	7.5
Tags		22,921	3.2
Total		700,225	100.0

Over 700,000 pounds of wool were prepared in this manner: The belly wool was shorn and gathered separately from the bulk of the fleece and sacked separately. The major fleece portion was rolled as usual, classed according to length of staple and sacked without tying. This reflects two changes – removal of belly wool, which should require no additional labor costs; and not tying the individual fleeces, which would represent a saving of both labor and materials. The amount of each wool classification is shown in Table 1.

The belly wool averaged out as 7.5 percent of the total wool shorn. The belly wool for individual clips varied from 3.9 percent to 12.8 percent except for a clip which was heavy with burr clover on the legs and belly area; the belly wool from this clip amounted to 17.3 percent. The majority of the clips (79.2 percent) had between 6.0 and 8.9 percent belly wool, 9.7 percent had less than 6.0 percent and 11.1 percent had 9.0 percent or higher.

The Staple and French Combing length wools comprised 78.5 percent of the total wool. These wools were sold on a clean basis subject to yield determination by core test. Each bag of wool was core sampled, and a hand sample was taken from the same place as the core sample. The belly wool was sold on a

TABLE 2. SCOURED AND CORE TEST YIELDS

Classification	Scoured wool		Core test Yield, %
	Yield, %	Vegetable matter, %	
Staple	49.4	1.5	49.4
French combing	46.9	1.2	48.6
Skirts	43.2	3.0	43.4

grease basis, but each bag was core sampled and hand sampled.

The hand samples from each bag were combined into composite samples representing the Staple, French Combing and Skirts (belly wool). No samples were taken from the clothing or tag wools. The hand samples were scoured at the Wool and Mohair Laboratory, Texas A&M University. Scoured yields were very similar to core test yields (Table 2) indicating that the hand samples should be representative of the sampled wools.

The belly wool was 5 and 6 percent lower yielding than the French Combing and Staple wools, respectively, using the core-test yields. The scoured belly wool also contained approximately twice as much vegetable matter defect.

Lock samples were taken as the wools were removed from the bags and put into the scouring train feedhopper. These lock samples were measured for length and fiber diameter (Table 3). The staple lengths are approximately what was anticipated for Staple and French Combing length classifications. The belly wools were slightly shorter than the French Combing wools, but the standard deviations indicate that the belly wool was considerably more variable. If the bellies had not been removed from the fleeces, the Staple and French Combing wools would have been both shorter and more variable. Fiber diameter was 0.5 microns coarser for the belly wool.

The scoured wools were sent to the Textile Research Center, Texas Tech University, where they were combed into wool top (Table 4). There was no significant difference in card wastes or processing wastes between any of the three lots. The belly wool, however, yielded about 7 percent less top and 7 percent more noils than the Staple and French Combing wools. This is of major concern to the wool processor.

Wool top fiber diameter, fiber length, strength and colored fiber count were each measured by from two to five laboratories. These laboratories represented industry, custom testing, U.S. Department of Agriculture and state research laboratories. Average results of the various traits measured are shown in Table 5.

The fiber diameter of the belly wool which measured coarser in the grease state produced a coarser top. Fiber length of all lots was shorter than the corresponding staple length measurements of grease wool. This is probably an artifact of processing these small lots and not representative of what would be obtained in commercial processing. The belly wool top was not significantly shorter than the French Combing lot but both were over ½-inch shorter than the Staple wool top. Tensile strength of the belly wool was less than that shown by both of the other lots and was just below the required level of 10 grams per tex for desirable strength. Of major importance in today's styles and fabrics is the large differences in colored fiber count. A major criticism of domestic wool as compared to imported wool has been the presence of colored fibers in the domestic clip. These data indicate that this criticism might be justified if the belly wool had remained in the fleece. Removal of the belly wool produced Staple and French Combing wool top which would meet the requirements of all but the most stringent specifications for colored fiber content.

The Staple, French Combing and Skirts netted the producers from 1 to 2½ cents more per grease pound than if they had sold their wool classed for length but with the belly wool left in the fleeces. These increases do not reflect incentive payments. Neither do they reflect any saving as a result of not tying the fleeces. The Staple and French Combing

TABLE 3. STAPLE LENGTH AND FIBER DIAMETER

Classification	Staple length, inches	Fiber diameter	
		Microns	Spinning count
Staple	3.25 ± 0.59	20.3 ± 4.0	70's
French combing	2.63 ± 0.49	20.2 ± 4.3	70's
Skirts	2.48 ± 0.80	20.8 ± 3.9	64's

TABLE 4. COMBING RESULTS

	Staple	French Combing	Skirts
Scoured wool, lb.	85.00	54.00	24.00
Oil 2%	1.70	1.08	.48
Total	86.70	55.08	24.48
Top, lb.	69.24	43.61	17.74
percent	79.86	79.18	72.47
Noils, lb.	9.35	7.10	4.58
percent	10.78	12.89	18.71
Processing waste, lb.	4.04	2.22	1.03
percent	4.66	4.03	4.21
Card waste, lb.	4.07	2.15	1.13
percent	4.70	3.90	4.62

TABLE 5. MARKET QUALITY CHARACTERISTICS OF THE WOOL TOP

	Staple	French Combing	Skirts
Fiber diameter			
Spinning count	70's	70's	64s'
Microns, avg	20.4	20.5	21.2
Fiber length, inches	2.87	2.29	2.23
Tensile strength, gms/tex	11.3	11.6	9.9
Colored fiber count, no./½ oz	1.3	2.8	36.9

wools did not receive premiums for freedom from black fiber content since these data were not available prior to the sale of the wool.

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