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Sheep and Goat, Wool and Mohair—1977

The Texas Agricultural Experiment Station
J. E. Miller, Director, College Station, Texas
The Texas A&M University System

CONTENTS

FOREWORD

Texas is a major State in sheep production and is a world leader in Angora goat and mohair production. These small ruminant animals utilize the mixed plant community to produce both meat and natural fiber. Consequently, they are highly important to both the regional and national economy.

The Texas Agricultural Experiment Station conducts major research efforts in sheep and goats at San Angelo, Sonora, and the Main Station in the College of Agriculture and College of Veterinary Medicine. This publication summarizes recent research efforts to help maintain and advance the Texas sheep and goat industry.

The Station's research programs are designed and intended to provide the base for new technical and economic advances for producers and consumers. From these research programs and other informational sources, the Texas Agricultural Extension Service disseminates useful information and demonstrates new and better practices for agricultural advancement.

BREEDING SEASON VARIATIONS OF SPANISH DOES

Maurice Shelton and Donald Spiller[1]

The numbers of Spanish or meat-type goats have steadily increased in this state in recent decades. There appeared to be a real need to study the potential of this animal as a source of income to Texas rangelands and as a means of brush control. This work was initiated in 1972 at a time when the Angora goat was declining in numbers.

One of the points of interest was the seasonal restriction to mating and the restriction this places on kidding at any season of the year and the potential for kidding more frequently than once per year.

PROCEDURE

In May, 1972, a flock of 50 Spanish does of mixed ancestory was established on the Sonora Station and were run with one or more males continuously since that date. The does were maintained on the range and throughout most of this time were utilized in brush control efforts. This no doubt had some effect on performance as the forage available was often somewhat restricted. Insofar as possible the kids were identified and the date of birth recorded as they were dropped. However, since they were maintained on the range it can be safely assumed that some kids were lost without their being recorded.

In a correlated study, a group of Spanish does were established at San Angelo to study the seasonal occurrence of estrus by checking daily by use of a vasectomized male. However, this proved difficult to accomplish as the does were wild, and frequent handling appeared to disturb the animals and to distort results. As a result, the plans were changed to that of observations of the ovaries at slaughter or laporatomy to record the number of corpora luteua (C.L.) or ovulation sites on the ovaries. This is considered to give a slight underestimate of the total, since without a knowledge of stage of the cycle, a few observations were no doubt made at times when the ovulation points were not very clear. The does utilized were a random sample of those available on the market or on range in station-owned flocks. In general, these were in poor condition, and this no doubt influenced the results obtained.

RESULTS AND DISCUSSION

Shown in Figure 1 is the percent of does with C.L. on the ovaries by months of the year. This is being reported as percent of the does which were cycling or ovulating within each month. These data show a complete absence of does cycling in March, April and May. Essentially all does were cycling from August through January. February, June and July appear to be

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[1] A portion of the animals utilized in these studies was donated to the station by Mr. Jerry Puckett, Fort Stockton, Texas.

*Respectively, professor, The Texas Agricultural Experiment Station, San Angelo, and technician, The Texas Agricultural Experiment Station, Sonora.

transitional months. No doubt a generally higher level of reproduction resulting from improved conditions or selection for a higher level of reproduction would cause the animals to show a high level of cycling in June and July. The data reported here are considered to be the minimum values likely to be observed. It is known that males play a part in initiating cycling of females. This effect is most obvious at initiation of cycling following a period of anestrus. Males may also be seasonal in their sexual activity as they often were in this study. In these studies no more than two males were involved, and it is possible that in dealing with a larger number, some would be rutting at all times of the year, and this could materially alter the results of observations on the does.

Shown in Figure 2 is the distribution of kidding for does run continuously with the males at Sonora. These data show a preponderance of kidding in January which would be from August mating. A smaller number kidded in October, November and December which would be from matings made in the transitional period of May, June and July. Thus, these data agree closely with the observations on seasonal occurrence of estrus (Figure 1). Few kids were dropped in February, March and April which would be from matings made in September, October and November. The apparent explanation for this is that essentially all open does were bred in August, and none were available to be mated later in the year. In general, the does in this study did not kid twice per year. Those which did kid more than once per year are those represented by the May kidding. These are does which kidded in October and November and then remated before going into anestrus. Those producers desiring to manage for multiple kiddings would need to devise breeding and management schemes which maximize the early matings, such as June and July, and optimize feed conditions during the fall months which would facilitate their rebreeding in December or January. In this flock kiddings tend to be grouped, suggesting some force such as male stimulation was interfering with a random distribution of kidding even within the breeding season. Again the performance of these does is considered to be minimal due to the management of the does, and improved conditions would no doubt alter the tendency to kid more often than one time per year.

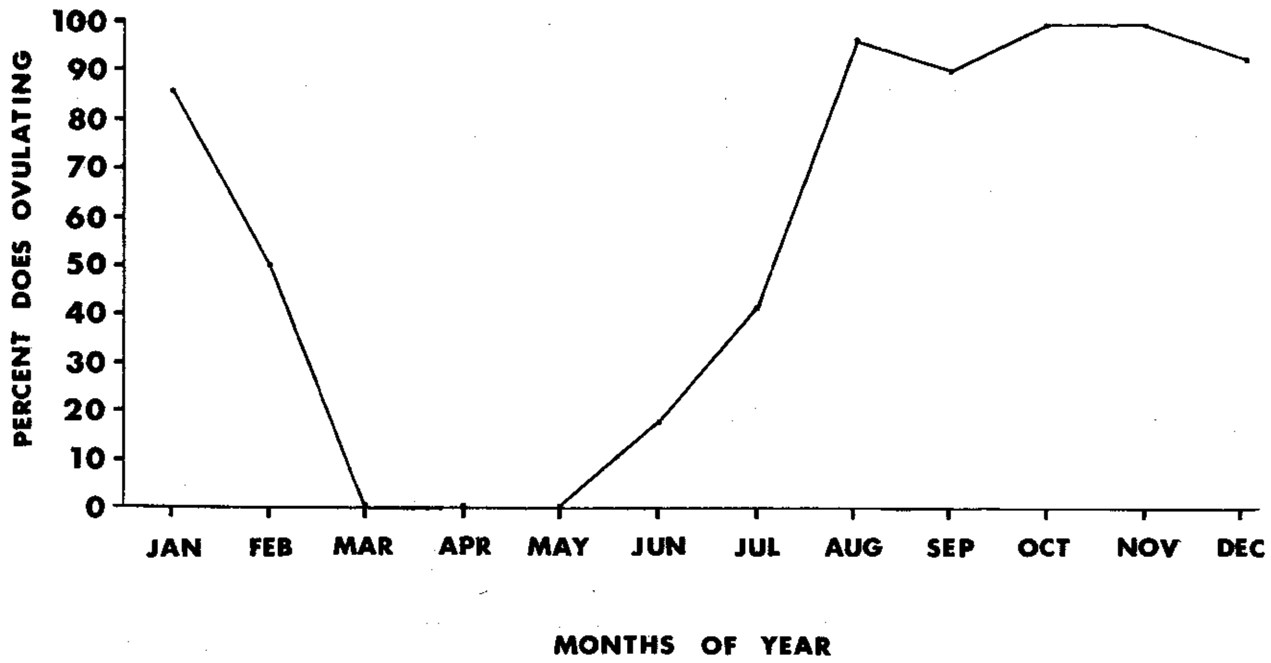

FIGURE 1. PERCENT OF DOES OVULATING BY MONTHS OF YEAR

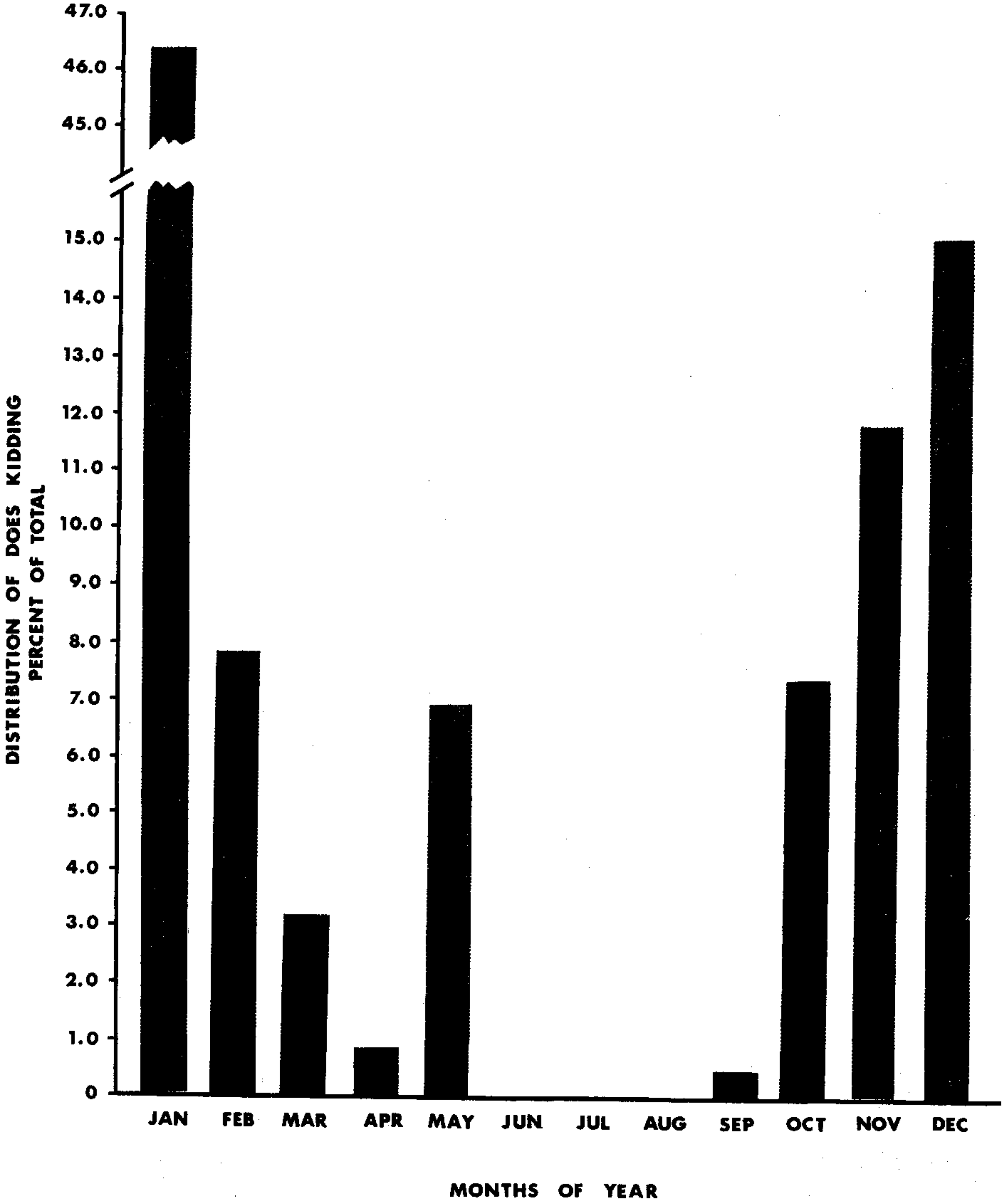

FIGURE 2. DISTRIBUTION OF DOES KIDDING (% OF TOTAL) FOR DOES RUN CONTINUOUSLY WITH MALES ON SONORA STATION

ACCELERATED LAMBING POTENTIAL IN RAMBOUILLET AND EXOTIC-TYPE CROSSBRED EWES

P. V. Thompson and Maurice Shelton*

In an effort to produce a year-round supply of marketable lambs, there is a need to investigate the potential of accelerated (or continuous) lambing. One substantial problem associated with such a management system is the stress upon ewes to mate and produce lambs out of the natural breeding season. There appeared a need to evaluate some of the more exotic types of sheep which might have a special place in an accelerated lambing regime. Under such a regime, the nutritional requirements above ewe maintenance for breeding and lactation will be increased. Texas and other southern sheep producing regions have the advantages of both a longer breeding season[2] and less seasonal restriction on forage production. In these areas accelerated lambing should be of a real interest.

MATERIALS AND METHODS

In September 1972 at the San Angelo Research and Extension Center, a flock composed of 25-Rambouillets, 38-1/2 Finn X 1/2 Rambouillet, 24-1/2 Karakul X 1/2 Rambouillet and 24-1/2 Barbados X 1/2 Rambouillet yearling ewes were placed in an accelerated lambing program and continued until December 1976. Suffolk rams were continually run with the ewes during this period for production of terminal cross market lambs. The ewes were maintained under pasture conditions with a minimal amount of supplemental feeding but were closely monitored in an attempt to obtain accurate lambing dates, birth weights and all ewe and lamb losses. In a few cases ewes were lambed in drylot when pasture forage was unavailable. All lambs were early weaned at approximately 60 days of age. Ewe body weights and grease fleece weights were collected annually on all ewes. Culling was practiced on ewes with unsound udders, disease or consistent infertility. Additional replacement ewes of the similar breeding and age were added to the flock in some cases as needed and available to maintain the original group numbers.

RESULTS AND DISCUSSION

Mean production per ewe year for each breed group is shown in Table 1. Three of the breed groups used exhibited some ability to breed out of season and averaged more than 1.0 lambing per year. Only the 1/2 Finn X 1/2 Rambouillet ewes failed to show some evidence of accelerated lambing. This inability could likely be attributed to their seasonal breeding[3] and to an adverse effect of high temperatures. Under the conditions of this experiment the 1/2 Barbados X 1/2 Rambouillet ewes excelled over all breed groups in number of lambings, number of lambs raised and total 60-day lamb weaning weights per ewe year. The purebred Barbados are noted for their high lambing rates, less restrictive breeding season and heat tolerance. However, those found in this state are often of mixed breeding, occasionally having

* Respectively, research associate and professor, The Texas Agricultural Experiment Station, San Angelo.

been crossed with Mouflon. The latter would not exhibit the desirable traits of the Barbados. Thus, producers who might wish to utilize this animal in their breeding program should select animals as pure as possible. The Rambouillet and 1/2 Karakul X 1/2 Rambouillet groups were intermediate in number of lambings but produced the fewest multiple births per lambing. The 1/2 Finn X 1/2 Rambouillets had the largest number of lambs per lambing, but the lowest 60-day weaning weight and percent survival. Lambs from 1/2 Finn X 1/2 Rambouillet ewes were vigorous but tended to be smaller, and heavy losses were encountered with multiple births as no attempt was made to provide assistance to the ewe or to artificially rear the lambs. The 1/2 Karakul X 1/2 Rambouillet group averaged the heaviest weaning weight per lamb weaned and the highest percent lamb crop raised. Generally, these ewes had and raised only single lambs.

Mean grease fleece weights (Table 2) were significantly different between breed groups for each of the 4 years. Rambouillet fleeces were consistantly heavier and 1/2 Barbados X 1/2 Rambouillets were the lightest every year. Fleece weights for 1/2 Finn and 1/2 Karakul X 1/2 Rambouillets were similar and intermediate in weight at each shearing interval. Fiber diameters taken from side samples at shearing April 1976 and evaluated at the Texas A&M University Wool Laboratory were significantly different for breeds[1]. Rambouillets were finest with an approximate spinning count of 70's; 1/2 Barbados X 1/2 Rambouillet, 62's; 1/2 Finn X 1/2 Rambouillets, 60's and 1/2 Karakul X 1/2 Rambouillet, 54's. It should be noted that despite its relatively fine fiber diameter, the fleece of the 1/2 Barbados X 1/2 Rambouillet is of little market value. Pure Barbados are a hair breed of sheep, and the crossbred fleece is usually short stapled and contains a larger amount of kemp hair fibers.

Annual shorn ewe body weights (Table 3) tended to increase with age. The 1/2 Karakul X 1/2 Rambouillet ewes maintained heaviest mean group body weight with the 1/2 Barbados X 1/2 Rambouillet ewes being lightest.

SUMMARY

A flock of 25-Rambouillets, 38-1/2 Finn X 1/2 Rambouillet, 24-1/2 Karakul X 1/2 Rambouillet and 24-1/2 Barbados X 1/2 Rambouillet ewes were maintained for 4 years under range conditions on an accelerated lambing program. Suffolk rams were continually run with all ewes on pasture. Records were collected on lambing date, birth weight, 60-day weaning weights, grease fleece and body weights on all ewes. The mean frequencies of lambings and lambs per ewe year were 1.12, 1.58; 0.98, 1.77; 1.19, 1.60 and 1.24, 2.11 for each group, respectively. The average number and total weight (lbs.) of early weaned lambs for each breed group was 1.22, 51.92; 1.27, 51.35; 1.33, 61.10 and 1.64, 68.87. Grease fleece weight and fiber diameter means were significantly different. The 1/2 Karakul X 1/2 Rambouillet ewes maintained the heaviest average body weight (lbs.) of 121.92 and 1/2 Barbados X 1/2 Rambouillets were the lightest at 103.14. The larger ewe size of the 1/2 Karakul X 1/2 Rambouillets did not prove to be an advantage in lamb production. The 1/2 Finn X 1/2 Rambouillet group exhibited the ability to produce multiple

births but weaned the lowest percent of the lambs born. Rambouillet ewes performed at an intermediate level. Only the 1/2 Barbados X 1/2 Rambouillet appeared able to respond to accelerated lambing under these range conditions.

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TABLE 1. MEAN LAMB PRODUCTION PER EWE YEAR

Breed Group	No. Lambings	No. Lambs	Lambs Born Per Ewe Lambing	No. Lambs Weaned	Total Weaned Lamb Weight (Lbs)*	% Lambs Raised Of Lambs Born
Rambouillet	1.12	1.58	1.41	1.22	51.9	77.1
1/2 Finn X 1/2 Ramb.	0.98	1.77	1.80	1.27	51.4	71.4
1/2 Karakul X 1/2 Ramb.	1.19	1.60	1.34	1.33	61.1	82.7
1/2 Barbados X 1/2 Ramb.	1.24	2.11	1.71	1.64	68.9	77.7

* These data do not include lambs weaned after December, 1976.

TABLE 2. YEARLY GREASE FLEECE WEIGHTS (LBS.), MEANS

Year	Rambouillet	1/2 Finn X 1/2 Ramb.	1/2 Karakul X 1/2 Ramb.	1/2 Barbados X 1/2 Ramb.
1973	9.0	5.6	6.3	3.9
1974	9.5	6.4	5.3	3.4
1975	9.2	6.5	6.6	4.2
1976	7.8	5.3	6.0	3.6
Ave.	8.9	6.0	6.1	3.8
Fiber Diam. (u)	20.2	23.8	27.9	22.9

TABLE 3. YEARLY EWE BODY WEIGHT (LBS.), MEANS

		Breed Group		
Year	Rambouillet	1/2 Finn X 1/2 Ramb.	1/2 Karakul X 1/2 Ranb.	1/2 Barbados X 1/2 Ramb.
1973	109.65	113.06	121.43	102.50
1974	112.74	110.93	118.65	101.54
1975	113.00	119.90	129.50	109.38
1976	114.89	121.36	118.11	99.15
Ave.	112.57	116.31	121.92	103.14

PR-3447

PROTEIN LEVEL AND MONENSIN EFFECTS ON OVULATION AND CONCEPTION IN SHEEP

N. Sefidbakht, Y. Assadi, Maurice Shelton and Phil Thompson*

Increasing reproductive efficiency results in higher output of lamb relative to maintenance and consequently improves overall nutritional efficiency for lamb meat production[1,2]. Earlier work at this Center, in which ewes had been bred in confinement on alfalfa pellets, recorded what appeared to be high ovulation rates, but with a great loss in potential embryos from ovulation to conception. Also work with cattle has shown a significant benefit in reproduction as a result of inclusion of the drug monensin in the ration. The latter drug allegedly has an antibiotic effect as well as supports an improved energetic efficiency as a result of a shift in the volatile fatty acid ratio.

The present experiment was undertaken to investigate the effect of protein and alfalfa and the presence of monensin on ovulation and conception. In this experiment the level of protein and level of alfalfa were confounded. Also, it should be noted that even though the rations were formulated to provide a level of protein below the optimum for ewes, laboratory analyses indicate that all rations exceeded the basic requirements of the breeding ewe. Also the experiment would not distinguish between an energy or antibiotic effect of monensin if such an effect were present. The ration was formulated to be isocaloric insofar as possible, but since level of intake was not controlled, this was not totally true in practice.

MATERIALS AND METHODS

A total of 75 aged finewool ewes which had been purchased from a local livestock market in the summer of 1976 were used in this study. The experiment consisted of a 3x2 factorial design consisting of three levels of alfalfa and two levels of monensin (0 and 20 gm per ton) for 55 days starting in September 24, 1976. Rations were mixed by a commercial feedmill according to the composition shown in Table 1. Ration crude protein levels varied from 9.7 to 13.7 percent based on laboratory analysis.

Ewes were maintained in large outside pens with access to self-feeders and water, but no shelter or shade. All rations were fed in lots of 15 ewes. Feed consumption records and body weight changes of ewes were recorded at weekly intervals.

At the initiation of the experiment, all ewes were scored for body condition (amount of fat) by a committee of three on a 1 to 8 basis with

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* Respectively, Associate Professor, Animal Science Department, Pahlavi University, Shiraz, Iran; Associate Professor, Animal Husbandry Department, University of Azarabadegan, Tabriz, Iran; Professor and Research Associate, Texas Agricultural Experiment Station, San Angelo.

the higher values representing a fatter ewe. One ram was run with each lot of ewes starting two weeks after the ewes were placed on experimental rations (November 8). The rams were rotated daily, and the ewes were rotated to different pens at weekly intervals. The rams were marked by painting the brisket with lampblack or other pigments in oil. Mating records were kept by once-a-day (about 8 a.m.) observation of ewes which were marked. The ewes were slaughtered through a commercial abbatoir in groups at 41 days after commingling the rams, or 26 days following the last ewe which was bred for the first time. The reproductive organs were checked for number of corpora lutea, embryos and follicles of different sizes. This provided data on the ovulation and conception ratio at the first estrus and ovulation rate at subsequent estrus for those which did not conceive at the first mating.

It should be noted that all of the ewes which had not shown estrus by October 29 were removed from the experiment. These ewes were checked for pregnancy either by laparotomy or ultrasonic procedures and all were found to be pregnant from matings prior to purchase. The rest of the ewes were kept on the respective treatments and were checked daily for ewes returning to estrus. One ewe from each group except low protein without monensin and medium protein plus monensin groups returned to estrus.

Blood samples were collected from the jugular vein of a sample of the ewes (6 to 9 head) from each group either on October 26, 27 or 28 for determination of blood urea nitrogen (BUN), glucose and total serum protein on sera by auto analyzer. Blood samples were refrigerated overnight, then sera decanted and frozen for delivery to the laboratory. All laboratory determinations were made by the Veterinary Diagnostic Laboratory at Texas A&M University.

The data were analyzed by the least squares procedure[3] for analyzing data on the number of corpora lutea, embryos and follicles (3-6 mm and 7-10 mm); constants were fitted for level of protein, monensin and interaction of level of protein x monensin. Regression of each trait on initial weight, weight at termination of flushing and gain during this period, initial condition score, final condition score, changes in score were also included in the model. For analyzing data on amount of blood glucose, blood urea nitrogen and serum protein constants were also fitted for level of protein, monensin and interaction of level of protein x monensin. Regression of each trait on number of CL and number of embryos were also included in the model.

RESULTS AND DISCUSSION

The basic performance of the six groups of ewes is shown in Table 2. Pooled data summaries by crude protein or alfalfa levels and monensin level are shown in Tables 3 and 4, respectively.

Protein

Increasing the crude protein content or alfalfa level did not have a statistically significant effect on final body weight, total gain, change in condition score, number of corpora lutea or embryos. Total weight gains were greater for ewes consuming the low and medium protein levels, and although not statistically significant, the high protein ration appeared to have an adverse effect. Changes in overall body condition were similar for each group. Average daily feed consumption was basically the same for each feed group.

The level of crude protein did significantly affect the amounts of blood glucose and blood urea nitrogen (BUN) ($P<.01$). These values tended to increase with protein levels in the three diets. Crude protein had no significant effect on serum protein. The significant relationship between glucose and protein level may well be an artifact of the method of sampling. An elevated BUN value and the absence of an effect on total serum protein conforms to what would be expected when animals were consuming protein in excess of their needs. The amount of serum protein in the blood had a significant negative relationship ($P<.05$) on number of corpora lutea. Serum protein showed to have a significantly negative relationship with number of embryos. Blood urea nitrogen had no significant relationship to ovulation rate or number of embryos.

The observed ovulation rate per ewe was higher for animals on the low protein regime. The numbers of embryos per ewe were not different. Ewes on the medium protein diet had the highest conception rate, 84.7%. There appeared to be a strong suggestion in these data that the high protein level had an adverse effect on the animals. Since the increased protein was provided by alfalfa, the possible explanation would be elevated estrogen levels associated with the alfalfa.

Monensin

The addition of the drug monensin at the rate of 20 grams per ton significantly increased ewe body weight gains during the test period ($P<.05$). The three groups of ewes were twice as efficient (lbs. feed/lbs. gain) in their gains as those ewes not receiving monensin. This difference in energetic efficiency is presumably explained by a shift in volatile fatty acid production from acetic acid to propionic acid production in the rumen. Monensin in the ration only slightly reduced feed consumption.

Monensin in the diet did not significantly affect the number of corpora lutea or embryos, blood glucose, BUN or serum protein. There is no evidence from these data that monensin had any specific effect on reproduction. It did appear to have a marked effect on animal performance, in terms of weight grains, and this might be of special interest under certain production conditions.

Weight and Condition

In this test the most significant factor effecting the ovulation rate (number of corpora lutea) and number of embryos was initial weight at breeding ($P<.01$ and $P<.05$, respectively). The initial condition of ewes was also significantly related to number of corpora lutea ($P<.01$). This data would indicate that the conditioning of ewes prior to the breeding season was more advantageous to increasing reproductive efficiency than an increased plane of nutrition during mating. This would suggest that if feeding is practical to increase reproductive performance, it should be done prior to the breeding season. It should be of some interest to note that in these studies good ewe performance, in terms of reproduction, was obtained even on the number one ration which contained over 50% peanut hulls.

SUMMARY

In September 1976, 56 nonpregnant Rambouillet ewes were fed three levels of protein and two levels of monensin in a 3x2 factorially designed experiment. Level of protein was varied by the addition of ground sun-cured alfalfa hay. The drug monensin was fed at the rates of 0 and 20 grams per ton. Ewes were slaughtered at a local commercial abbatoir for collection of reproductive data. Blood samples were randomly taken from 6 to 9 ewes per treatment for analysis of blood urea nitrogen (BUN), glucose and serum protein by auto analyzer. Neither the addition of protein nor monensin significantly increased the reproductive potential of the ewes on test. Monensin did significantly increase 48-day body weight gains ($P<.05$). Protein in the diet showed a significant effect on blood urea nitrogen ($P<.01$). The only variables which were significantly related to corpora lutea and number of embryos was initial weight or condition of the ewe.

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Table 1. EXPERIMENTAL RATIONS UTILIZED

Ingredients In %	Ration No.	Low Protein 1	2	Medium Protein 3	4	High Protein 5	6
Alfalfa hay		10.00	10.00	47.00	47.00	85.00	85.00
Sorghum grain		28.00	28.00	14.00	14.00	0.00	0.00
Peanut hulls		56.00	56.00	33.50	33.50	5.00	5.00
Molasses		5.00	5.00	5.00	5.00	5.00	5.00
Dicalcium phosphate		1.00	1.00	0.50	0.50	0.00	0.00
Monensin		0.0	20 gms. per ton	0.0	20 gms. per ton	0.0	20 gms. per ton
Protein % (analyzed)		- 9.7 -		- 11.9 -		- 13.7 -	

Table 2. RELATION OF RATION PROTEIN LEVEL AND MONENSIN ON BODY WEIGHT CHANGE AND OVULATION AND CONCEPTION

Protein Level	Low		Medium		High	
Monensin Level	-	Mon.	-	Mon.	-	Mon.
Number of animals	9	9	9	9	14	6
Initial weight (lb.)	101.4	111.1	113.5	105.0	111.5	101.8
Final weight (lb.)	114.1	124.1	121.7	121.8	116.1	114.6
Ave. daily gain (lb.)	0.264	0.270	0.170	0.350	0.095	0.266
Ave. daily feed (lb.)	5.49	5.17	5.54	5.59	5.97	5.01
Body condition score						
Initial	5.1	5.7	5.5	5.1	5.4	5.3
Final	6.2	6.6	6.3	6.7	6.5	6.4
Change in condition score	+ 1.1	+ 0.9	+ 0.8	+ 1.6	+ 1.1	+ 1.1
Blood urea nitrogen, mg%	19.69	16.75	17.43	22.67	30.09	30.38
Total serum protein, g%	7.03	7.64	7.33	7.23	7.74	7.57
Ovulation rate	2.22	1.78	1.89	1.78	1.71	2.17
Number of embryos	1.67	1.22	1.67	1.44	1.29	1.50

Table 3. EFFECT OF PROTEIN LEVEL ON EWE PERFORMANCE

Protein Level	Low	Medium	High
Number of animals	18	18	20
Initial weight (lb.)	106.2	109.2	108.6
Final weight (lb.)	119.1	121.8	115.7
Ave. daily gain (lb.)	0.268	0.262	0.147
Ave. daily feed (lb.)	5.33	5.57	5.49
Body condition score			
Initial	5.4	5.3	5.4
Final	6.4	6.5	6.5
Change in condition score	+ 1.0	+ 1.2	+ 1.1
Blood urea nitrogen, mg%	18.22	20.05	30.23
Total serum protein, g%	7.33	7.28	7.65
Ovulation rate	2.00	1.83	1.85
Number of embryos	1.44	1.55	1.35

Table 4. EFFECT OF MONENSIN ON EWE PERFORMANCE

Monensin Level	None	20 g/ton
Number of animals	32	24
Initial weight (lb.)	109.2	106.5
Final weight (lb.)	117.1	120.9
Ave. daily gain (lb.)	0.164	0.300
Ave. daily feed (lb.)	5.67	5.26
Body condition score		
Initial	5.4	5.4
Final	6.4	6.6
Change in condition score	+ 1.0	+ 1.2
Blood urea nitrogen, mg%	22.40	23.26
Total serum protein, g%	7.37	7.48
Ovulation rate	1.90	1.87
Number of embryos	1.50	1.37

PR-3448

PARTITIONING LOSSES IN REPRODUCTIVE EFFICIENCY OF SHEEP

Maurice Shelton and Phil Thompson*

INTRODUCTION

A large gap exists between the potential level of reproduction in sheep and net lamb crop realized by most producers. Research directed toward bringing the potential and the realized more in line should receive high priority. An initial step in this process should be to determine where this loss in potential is occurring. Reasonable simple and effective procedures are available to accomplish this goal. It is known that season has an important effect on reproduction in the sheep and that the maximum potential exists with ewes bred in the fall of the year. The present studies were all conducted in the fall of the year to eliminate season as a source of variation.

PROCEDURE

To date, observations were made on three different groups of ewes as shown in Table 1. In all cases the ewes were either solid mouth or aged ewes. In each case a sample of the ewes (20-25 head) was slaughtered approximately 25 days after the close of the breeding season, and the reproductive tract was recovered for study. The ovulation rate can be determined from the number of corpora lutea (C.L.) on the ovaries. This represents the potential lamb crop at mating with the minor distinction that among ewes which did not conceive during the breeding season, the number of C.L. recorded would be from an estrus cycle subsequent to the breeding season. This difference is thought to be very minor. The number of embryos can be determined by dissection of the uterus. Thus these data provide information on the number of ewes ovulating, number of ewes conceiving and the number of embryos present. Information is not provided on the number of ewes mated, but it is assumed that this is the same as the number of ewes ovulating. These would differ substantially only in the case of inadequate number or lack of vigor on the part of the rams. A sample of the ewes (50) or the entire lot was lambed under observation in which the number of ewes lambing and the number of lambs born could be determined. The number of lambs raised was based on the entire number of ewes surviving. No attempt was made to artificially rear lambs, and thus the lambs raised were dependent on the ability of the ewe to rear the lambs.

RESULTS

The results to date are shown in Table 1. These data are somewhat preliminary, and this work will be repeated in subsequent years; however, the results fit a pattern suggested by earlier observations. A great disparity exists between the ovulation rate and the number of embryos present (in this case 42.1 potential embryos per 100 ewes). This loss may be due to a failure of fertilization or failure of implantation and development of the fetus.

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* Respectively, professor and research associate, Texas Agricultural Experiment Station, San Angelo.

The technique utilized here does not permit distinguishing between these two types of losses. Work from Australia (Restall, Brown, Blockey, Cahill and Kearins, 1976) suggest that fertilization of the ovum tends to be an all or none situation. However, this is not necessarily the case with embryo survival as many ewes had multiple ovulations, but only a single embryo. The loss from conception to lambing was relatively small, 4.5% of the ewes or 7.9 potential lambs. This loss, due to abortion or reabsorption of the embryo, might be expected to be greater if certain disease agents were present or if the ewes had been bred earlier in the year when hot weather could cause a loss. The loss of lambs born equalled 19.6 lambs per 100 ewes. This includes any lambs which were born dead.

These data suggest that major losses occur between ovulation and conception and in death loss of lambs produced. Predation was not thought to be a factor in these data. Future work will look at these segments of the reproductive process in more detail.

SUMMARY

Over a three-year period, 458 finewool ewes were fall mated at three different research locations to study the various losses in reproductive efficiency. Depending upon location, ewes were either pen or pasture mated to Rambouillet, Suffolk or crossbred rams. Ewes were closely observed during the lambing period so that the number of ewes lambing and number of lambs born could be determined. Twenty to twenty-five ewes from each breeding group were commercially slaughtered to obtain the reproductive tract for observation of number of corpora lutea (C.L.) and number of embryo present 25 days after the close of breeding. Data from these studies showed that the greatest loss in reproductive potential (42.1%) was between ovulation and conception. The subsequent loss from conception to lambing was relatively small, 7.9%. Lambs lost following parturition was 19.6%.

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Table 1. Losses in Reproductive Efficiency

Source or Location	No. Ewes	Breeding Weight	Date or Season	% Ovulation	Ovulation Rates [1]	% Pregnant	No. Embryos Present [1]	% Lambing	Lambing Rate [1]	Lambs Raised
Winters Ranch 1976	234	107.0	Sept.	100.0	188.0	96.0	136	92.0	118.0	110.9[2]
Hill Ranch 1975	76	112.6	Oct.	100.0	155.0	100.0	135	92.3	128.6	109.5
San Angelo 1974 (Drylot)	148	-	Nov.	100.0	189.1	93.0	135	91.2	135.5	103.0[3]
Average				100.0	177.4	96.3	135.3	91.8	127.4	107.8

1. The number of ovum shed, embryos present or lambs born per 100 ewes.

2. This figure is based on lambs surviving to shearing in May.

3. These ewes were lambed in open lots with some inclement weather, and these conditions contributed to heavy lamb losses.

LAMB PRODUCTION FROM FINEWOOL EWES IN ANNUAL AND ACCELERATED BREEDING PROGRAMS

J. E. Huston*

Several producers have attempted to adopt some form of accelerated lambing, but some have become discouraged because of low lamb weights and non-uniform looking lamb crops. These data compare productivity of an accelerated flock and a conventional flock in number and characteristics of lambs produced and ultimate value of these lambs.

EXPERIMENTAL PROCEDURE

Large, finewool ewes were purchased as yearlings and were bred to Suffolk or Suffolk X Hampshire rams. The study period began in May, 1975, and ended in May, 1977. A portion of the ewes had lambed in the spring of 1975, and the rest were purchased at the beginning of the study. The ewes comprising the accelerated flock were given opportunity to breed during May and June, 1975, and rams put with the flock subsequently for 45-day periods beginning on or about September 15, 1975; January 15, 1976; May 15, 1976, and September 15, 1976. The conventional flock was bred during the fall of 1975 and 1976 beginning on or about September 15. Conventional lambs were weaned on June 1 and lambs considered milk fat were sold. All accelerated lambs were weaned at the beginning of the breeding season subsequent to their birth (about 75 days of age). All accelerated lambs and conventional feeder lambs were placed in a feedlot and fed to market specifications as described in accompanying report (1).

RESULTS AND DISCUSSION

There was essentially no effect of the breeding treatment on weight change in the ewes. The slight decrease in weight overall is probably due to seasonal conditions at the time rather than an overall decline in body weight. It can be seen that over the two-year period the accelerated ewes weaned more lambs than the conventional ewes, 1.24 to 0.92 lambs per ewe per year, respectively. However, weaning weight was so much greater for the conventional group that these ewes actually weaned more lamb weight than the accelerated ewes, 59.4 to 53.0 lb. lamb weight per ewe per year, respectively (Table 1).

The important question is, "Which is more important, more lambs or more weight?" It is the author's opinion that the accelerated management systems best fit the needs of the farm flock. Also, farm flock producers should consider the advisability of feeding his own lambs to market specifications. Data from this study are treated using constants derived in the accompanying report (1) to project the value of a weaned lamb from those different systems after it is fed to meet fat lamb requrirements

* Associate professor, Texas Agricultural Experiment Station, San Angelo.

and after feed costs have been deducted. These are tabulated in the lower portion of Table 1 and reflect per unit feed costs. It is obvious that the answer to the above stated question could change depending on feed cost and associated expenses, but in the present example, the increased number of lambs more than offset the reduction in weaned lamb weight. However, the producer is likely to benefit from this stimulated production only if he takes advantage of the profit potential found in the feedlot phase of the system.

LITERATURE CITED

(1) Huston, J. E. 1977. Evaluation of lamb feeding requirements from from accelerated lambing. Tex. Agr. Exp. Sta. PR-3452.

TABLE 1. RELATIVE PRODUCTIVITY OF EWES BRED ANNUALLY IN THE FALL OR AT EIGHT-MONTH INTERVALS OVER A TWO-YEAR PERIOD

	Breeding Flocks	
Item	Conventional	Accelerated
Number of ewes	49	67
Ewe weights (lb.)		
5-15-75	121.8	120.3
5-10-77	111.8	112.4
Change	- 10.0	- 7.9
Number of lambs born	125	193
Number of lambs weaned	90	166
Number weaned/ewe/year/season		
January	-	0.68
May	-	0.50
June	0.92	-
September	-	0.06
TOTAL	0.92	1.24
Weaned lamb/ewe/year (lb.)	59.4	53.0
Value of ewe production above feed cost at per unit feed cost of:		
4¢	$ 29.90	$ 45.00
5¢	28.67	41.97
6¢	27.17	38.94
7¢	26.50	35.51
8¢	24.15	32.89
9¢	22.65	29.86
10¢	21.14	26.83

LAMB PRODUCTION AND POISON PLANT LOSSES FROM TWO SYSTEMS OF GRAZING

Leo B. Merrill and Charles A. Taylor, Jr.*

Grazing management studies on the Texas Range Station have shown over the years that any well-planned deferred rotation grazing system had an advantage over a continuous grazing program in production of beef, lamb and wool. It also suffered fewer losses from poisonous plants. Both rate of grazing and combinations of animals affected the production from a pasture.

Differences in lamb production from a 4-pasture rotation grazing system in which each pasture was grazed 12 months, then rested 4 months, and continuous grazing are shown in Table I. Ewes on the 4-pasture system were fed 30 pounds of 20% grain cubes per head at 1/3 pound per day for 100 days while ewes on the continuously grazed pasture were fed 60 pounds of the grain cubes per head at 2/3 pound per day for a 100-day period, and their lambs were fed 50 pounds of 11% grain cubes from birth to weaning. Stocking rates were the same, but the 4-pasture system was stocked with 60% cattle and 40% sheep while the continuously grazed pasture was grazed with 45% cattle and 55% sheep. Ewes on the continuously grazed pasture were selected as the best registered animals and were being used as the stud flock; however, ewes on the 4-pasture system were also of high quality and were nearly equivalent to those on the continuous pasture. Rams used on the two pastures were nearly identical in performance records on the Ram Performance Test; therefore, the primary differences in performance were in the grazing treatment and management methods.

Table I shows that the 4-pasture rotation system in 1975 and 1976 produced a 110% lamb crop while continuous grazing produced a 100% crop despite extra feed to both ewes and lambs on continuously grazed pasture. The average weaning weights of lambs at 5 months of age were 104.2 pounds per head for the 4-pasture system compared with 86.2 pounds for continuous use, although the lambs on the 4-pasture system received no creep feed while those on the continuously grazed pasture were on full creep feed until weaning. With only cost of feed removed from both grazing treatments, the 4-pasture rotation system produced $19.40 more per ewe in lamb sales than did continuous grazing when lambs were sold at 50¢ per pound.

The continuously grazed pasture was also sprayed with 2-4,D for bitterweed control at a total cost of $2.00 per acre per year. The area was sprayed two years, then left unsprayed in 1976-77. The 4-pasture system was not treated for bitterweed control. Prorating the cost of spraying over a 3-year period, the spraying cost was $853.00 per section per year on the continuously grazed pasture. There was no cost on the 4-pasture system. The bitterweed losses were very high on the Barnhart

*Respectively, professor in charge and research associate, The Texas Agricultural Experiment Station, Sonora.

station in 1976-77. The total loss was 31 ewes from a flock of 262 animals or an 11.8% death loss. The death loss on the 4-pasture system was 6% or 2.8 ewes per section while the death loss on the continuously grazed pasture was 25.7% or 20.5 ewes per section. When ewes were valued at $50.00 per head, the total loss per section on the 4-pasture system was $140.00 while the loss on continuous grazing was $1,025.00 per section. When the prorated cost of spraying was added, the total cost and loss on continuous use was $1,878.00 per section. It was, therefore, concluded that a grazing management system produced greater returns per ewe and suffered much fewer death losses from poison plants than from continuous use.

TABLE I. LAMB PERFORMANCE FROM TWO GRAZING TREATMENTS - 1975-1976

	Percent Lamb Crop	Average Weaning Weight Of Lambs	Pounds Lamb Per Ewe	Average Wool Weight Of Lambs At Weaning	Cost Of Feed Per Ewe	Cost Of Creep Feed For Lambs Per Ewe	Value Of Lamb Per Ewe At 50¢ @ Pound	Value Of Lamb Per Ewe Less Feed Costs
4-Pasture Rotation	110	104.2	114.6	2.58	2.40	0.00	$57.30	$54.90
Continuous Use-Lambs Creep Fed	100	86.2	86.6	2.21	4.80	3.00	$43.30	$35.50
Difference In Pastures	10	18.0	28.0	.37	2.40	3.00	$14.00	$19.40

TABLE II. POISON PLANT TREATMENT AND DEATH LOSS ON TWO GRAZING TREATMENTS

	Poison Plant Control	Number Ewes Died Per Section 1976-77	Cost Spray Per Section For 2 Years	Cost Of Bitterweed Loss Per Section With Ewes @ $50.00 Per Head	Total 1976-77 1/3 Share Of Spray Cost And Cost Of Death Loss
4 Pasture Rotation	None	2.8	0	$140.00	$140.00
Continuous Use	Aerial Spray 2-4,D 1974 And 1975	20.5	$25.60	$1,025.00	$1,878.00

FEEDING THREE SUPPLEMENTS TO ANGORA KIDS

C. A. Taylor, Jr., and Leo B. Merrill*

Under normal range conditions a high percentage of Angoras will not breed satisfactorily as yearlings to kid at two years; however, this failure is more a result of lack of condition and development than age (Shelton and Groff, 1974). Since Angora kids require special treatment, they should be managed separately throughout much of the year. An important factor in maximizing the growth and development of Angora kids is feeding a proper supplement. This study was designed to determine the most economical and effective means of developing Angora kids.

Experimental Procedure

Three supplemental rations were fed to Angora nannie kids in a two-year study on the Texas A&M University Experiment Station at Sonora, Texas. Experiment 1: In 1975-76 fifty-four Angora kids at approximately nine months of age were randomly placed into three equal groups of 18 each (Table 1). Three pastures designated 1, 2, and 3 were selected to carry the animals throughout the study. Respectively, groups A, B, and C were fed corn, 20% range cubes, and 41% cottonseed cake at an equivalent of .25 pounds per head per day. Each group of kids was rotated through all three pastures in an attempt to reduce pasture effects. Supplement was fed from December 16, 1975 through April 16, 1976.

Experiment 2: In 1976-77 supplemental feed was increased to .5 pounds per head per day with the same feeds as above. Animals were fed from November 30, 1976 to April 12, 1977. There were 27 kids in each group on this test (Table 1). Five goats from each group was implanted with Ralgro. Three different pastures were used; otherwise the management was the same as the previous year.

RESULTS

In experiment 1 Angora kids on cottonseed cake (Group C) gained significantly more weight than those on corn (Group A) (Table 2). Although the difference was not significant, the cottonseed cake group outgained the 20% range cube group (Group B) by 1.1 pounds per head. Gain in animals in the corn group varied from -.2 to 16.3 ($\bar{x}$ = 4.3) pounds per head. The 20% range cube group had more consistent individual animal response ranging from 3.3 to 13.5 ($\bar{x}$ = 6.7) pounds per head.

*Respectively, research associate and professor in charge, The Texas Agricultural Experiment Station, Sonora

Different pastures played an important role in individual gains of the Angora kids (Table 3). Kids in pasture one had a net gain of 0 regardless of supplement, whereas animals gained 6.3 pounds per head in pasture 2 and 12.0 pounds per head in pasture 3. Gains by pastures were significantly different, indicating the importance of proper range management as a tool to improve the nutritional level of Angora kids. Also, the group on cottonseed cake produced a net mohair income advantage of $1.65 over the corn group and a $0.45 advantage over the range cube group.

A more favorable response was recorded for experiment two. This probably resulted from both an increase in the amount of supplement fed and better pasture conditions. Animals on cottonseed cake gained significantly more weight than either those on corn or 20% range cubes (Table 2). The corn group gained from 0 to 14 ($\bar{x}$ = 9.7) pounds per head. The 20% range cube group gained from 5 to 15 ($\bar{x}$ = 10.4) pounds while the group on cottonseed cake gained from 10 to 23 ($\bar{x}$ = 17.8) pounds per head. For two consecutive years the group fed 41% cottonseed cake had significantly greater gains.

Pasture differences remained important for the second year (Table 3). Kids in pasture one had a net gain of 4.9 pounds regardless of supplement. Respectively, animals gained 16.7 and 16.5 pounds per head for pastures 2 and 3.

Gains of Angora kids implanted with Ralgro were not significantly greater than the control (Table 4). In fact, Ralgro implants in cottonseed cake group averaged 15.6 pounds of gain compared to 18.3 for the control. Ralgro implants across treatments averaged 12.1 pounds of gain while goats exempt of implants averaged 12.7 pounds.

SUMMARY

Three supplemental feeds were evaluated to determine their effectiveness in developing Angora kids. Forty-one percent cottonseed cake provided the most economical gains. These gains were significantly greater than for other supplements fed. Angora kids supplemented with corn had less body gain than animals fed a twenty-percent range cube supplement. Different pastures played an important role in individual gains of Angora kids, indicating the importance of proper range management. Individual gains of Angora kids implanted with Ralgro were not significantly greater than the control.

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TABLE 1. EXPERIMENTAL SUPPLEMENTS FED TO 3 GROUPS OF ANGORA KIDS

Supplement	1975-76			1976-77	
	Group	Lbs./hd./day	No. Goats @ treatment	Lbs./hd./day	No. goats @ treatment
Corn	A	.25	18	.50	27
20% Range Cubes	B	.25	18	.50	27
41% Cottonseed Cake	C	.25	18	.50	27

TABLE 2. AVERAGE GAIN OF ANGORA KIDS FROM THREE SUPPLEMENTS

Group	1975-76 Gain (Lbs./hd.)	1976-77 Gain (Lbs./hd.)
A	4.3[B]	9.7[B]
B	6.7[AB]	10.4[B]
C	7.8[A]	17.8[A]

[A,B]Values having uncommon superscripts within the same column are significantly different ($P<0.05$).

TABLE 3. INFLUENCE OF PASTURE EFFECTS ON GAINS OF ANGORA KIDS

Pasture	1975-76					1976-77				
	No. Acres	Corn	RC[1]	CSC[2]	Total Gain (Lbs/hd)	No. Acres	Corn	RC	CSC	Total Gain (Lbs/hd)
1	15.1	1.3	-2.0	.7	0[C]	60	-1.0	8.8	-2.9	4.9[B]
2	46.2	1.9	3.4	1.0	6.3[B]	134	-1.0	3.2	14.5	16.7[A]
3	41.7	3.5	4.2	4.3	12.0[A]	50	11.9	-1.6	6.2	16.5[A]

[A,B,C]Values having uncommon superscripts within the same column are significantly different ($P<0.05$).

[1]20% Range Cubes.

[2]41% Cottonseed Cake.

TABLE 4. INFLUENCE OF RALGRO IMPLANTS ON GAINS OF ANGORA KIDS

	Gain (Lbs./hd.)	No. Goats Per Treatment
	Group A	
Ralgro Implant	10.0	5
Control	9.6	22
	Group B	
Ralgro Implant	10.8	5
Control	9.9	22
	Group C	
Ralgro Implant	15.6	5
Control	18.3	22
	Group A,B,&C	
Ralgro Implant	12.1	15
Control	12.7	66

EVALUATION OF LAMB FEEDING REQUIREMENTS FROM ACCELERATED LAMBING

J. E. Huston

Accelerated or multiple lamb ewe flocks have been shown to consistently produce more lambs and frequently more weight of lamb per ewe than conventional ewe flocks. The value of the lambs produced however has been questioned. Frequently lambs must be weaned at a very young age and at an unfavorable time for good feedlot performance. These data were summarized to determine the overall value of lambs from conventional and accelerated breeding flocks.

EXPERIMENTAL PROCEDURE

A long-term nutrition study is being conducted to study lifetime supplemental feed treatments on ewe productivity. Half the ewes are bred annually in September and October and one-half are given opportunity to breed for 45 days beginning about May 15, September 15 and January 15. Lambs are weaned on about the beginning of the next breeding season after birth (approximately 75 days). Lambs are fed a high concentrate ration (90% concentrate) from the outset. They are hand fed the equivalent of about one pound per head per day for three days and self-fed thereafter. No special care is given to the lambs except to keep clean feed and water before them at all times. Lambs are pulled out when they reach about one hundred pounds and are sold at public competitive auction. The price received is recorded. Conventional lambs are weaned on or about June 1 each year. Lambs that are considered milk fat are sold at weaning. Those not sold at weaning are placed in the feedlot and treated as described above. Ewes are large finewool types, and the rams are either Suffolk or Suffolk X Hampshire.

The data presented cover one conventional set of lambs and four sets of accelerated lambs beginning with the weaning of fall born lambs on January 23, 1976, and ending with the sale of the 1976 fall born lambs in the spring of 1977.

RESULTS AND DISCUSSION

A total of one hundred fifty nine lambs was weaned during this study period (Table 1). Forty two were weaned from the conventional group of which five were sold as fat lambs at weaning. The five lambs averaged ninety pounds and had an average per head value of $50.31. The remaining conventional lambs and all of the accelerated lambs were fattened in the feedlot. Age and seasonal variations obviously affected weaning weights. Some death losses occurred in the feedlot. Sale weights, feed requirements and sale value are expressed on the basis of number of lambs weaned rather than number of lambs sold. Lambs from the accelerated group had a greater

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* Associate professor, Texas Agricultural Experiment Station, San Angelo.

per head market value than those from the conventional group primarily because of the price structure during this study. Fed conventional lambs were sold during July, August and September during which time prices were relatively unfavorable. However, this relative price difference is not unusual and can be considered predictable. The accelerated lambs were lighter; therefore, more feed was required to grow them to market size and degree of fatness. In Table 2, the feed cost required to bring the feeder lambs to market specifications is shown and the influence of unit cost of feed is given. Because more feed was required per weaned lamb, the total feed cost goes up more rapidly in the accelerated groups.

Table 3 summarizes the value of the lambs from the two management systems. These data indicate essentially no difference in the value of weaned lambs on a per head basis from conventional and accelerated management systems. It should be remembered that the relative advantage of the accelerated lambs was price and of the conventional lambs was weaning weight. It is probable that if weaning weight could be increased in the conventional group to move a greater percentage into milk fat lambs, the conventional lambs would be of greater value. Also, the accelerated lambs reached their value because they were fed and could not be considered of comparable value to conventional lambs at weaning.

TABLE 1. FEED REQUIRED AND SALE VALUE OF LAMBS WEANED FROM CONVENTIONAL AND ACCELERATED EWE FLOCKS

	Conventional Weaning Date	Accelerated Weaning Dates		
	June 1	Jan. 23-26	May 4	Sept. 9
Number of lambs weaned				
Milk fat	5	0	0	0
Feeders	37	101	8	8
Average weights (lb.)				
Milk fat	90.0[1]	-	-	-
Feeders	64.9	38.0	48.8	50.8
Weight sold/weaned feeder (lb.)[2]	84.2	83.2	92.0	82.4
Feed consumed/weaned feeder (lb.)[2]	171.1	259.6	225.4	226.2
Sale value/weaned feeder[2]	$ 37.87	$ 47.85	$ 44.21	$ 41.14

[1] Sale value was 55.9 cents per pound or $50.31 per head. This rate was received on 11.9% of the weaned lamb crop from the conventional group.

[2] These values were computed based on the number of weaned lambs and include the influence of feedlot death losses. Sale value reflects actual value received at public competitive auction.

TABLE 2. TOTAL FEED COSTS AT VARIOUS UNIT COSTS FOR FATTENTING LAMBS WEANED FROM CONVENTIONAL AND ACCELERATED EWE FLOCKS

Unit Feed Cost Per Pound (Cents)	Total Feed Cost			
	Conventional Lamb Weaned June 1	Accelerated Lambs Weaned		
		Jan.	May	Sept.
4	6.84	10.38	9.02	9.05
5	7.53	12.98	11.27	11.31
6	9.03	15.58	13.52	13.57
7	10.54	18.17	15.78	15.83
8	12.05	20.77	18.03	18.10
9	13.55	23.36	20.29	20.36
10	15.06	25.96	22.54	22.62

TABLE 3. EXAMPLE CALCULATION OF PROJECTED NET VALUE OF LAMBS FROM CONVENTIONAL AND ACCELERATED EWE FLOCKS

	Conventional Lambs Weaned June 1	Accelerated Lambs Weaned		
		Jan.	May	Sept.
Value of milk fat lamb	$ 5.99[1]	-	-	-
Value of fed lamb	33.36[2]	47.85	44.21	41.14
Total value/weaned lamb	39.35	47.85	44.21	41.14
Feed cost @ 7¢/lb.	10.54	18.17	15.78	15.83
Sale value above feed cost per lamb weaned	$ 28.81	29.68	28.43	25.31

[1] Contribution from 12% of the lamb crop sold as fat at weaning.

[2] Contribution of 88% of the lamb crop sold after feeding.

USE OF SALT ON LIMITING FEED INTAKE OF SHEEP AND GOATS

Y. Assadi, J.E. Huston and Maurice Shelton*

There is a very real need for a means of restricting or controlling feed intake of sheep and goats. The major interest is in regulating intake of range supplements for these animals to eliminate the labor required and the disruptive effect of hand feeding these supplements. Salt has long been used for this purpose in Texas, but producers have not always been satisfied with the results obtained from the use of salt. Extensive experience and limited early research has shown that the high intake of water associated with the use of salt can influence the grazing behavior in relation to the placement of water. Also, this method of feeding is known to have adverse effects during times of cold stress. These effects may be an increase in energy required to elevate to body temperature due to the large amount of cold water which may be injested or refusal to take feed at a critical time if water is frozen or not available. In extreme cases, these complications can contribute to increased losses from cold stress among freshly shorn sheep or goats.

Recent research results from Australia (Hemsley, 1975; Hemsley, Hogan and Weston, 1975) have suggested that the high level of water intake associated with the use of salt can speed up movement of injesta through the tract. This has the potential of both favorable and unfavorable effects. Hemsley, Hogan and Weston (1975) have reported that ration digestibility is reduced as a result of this increased rate of transport through the gut. However, Hemsley (1975) has shown that this disruption of movement can have the effect of increasing the amount of intact protein available in the lower tract and thus stimulate the level of fiber production. Earlier work by Huston and Shelton (1967) has suggested an increased protein loss as a result of salt loading. The present experiment was undertaken in an attempt to obtain data on some of these variables under local conditions.

EXPERIMENTAL PROCEDURE

Two studies were conducted to determine the effect of salt consumption on ration digestibility, water intake and urine output. Experimental animals were adult Angora goat and finewool crossbred ewe females in Experiments 1 and 2, respectively. In each experiment, the animals were placed in metabolism stalls to facilitate separate collection of urine and feces. During a preliminary period, 200 g of concentrate and free choice sorghum hay were fed. Salt was added to the concentrate at a low level and increased daily until the level of salt prevented total consumption of the

* Associate professor, College of Agriculture, University of Azarabadegan, Tabriz, Iran; associate professor and professor, Texas Agricultural Experiment Station, San Angelo, respectively.

concentrate. Three animals were selected to receive salt at near this maximum level, three were given half that amount and salt was withheld from the remaining four animals. Sorghum hay was offered at near maximum consumption level. Feed and water intake, feces and urine were measured over a five-day collection period. Feed and feces were later analyzed for dry matter and crude protein. Results of the two studies are presented in Tables 1 and 2, respectively.

RESULTS AND DISCUSSION

Increasing salt consumption resulted in an expected rise in water intake and urine output. This was more dramatic in the sheep study probably because of the higher level of salt consumption. In each experiment, an increase in water consumption corresponded to an increased urine output, reflecting the need for water to facilitate urinary excretion of the large amounts of consumed sodium.

Results of the goat study (Table 1) support the hypothesis that high salt intake can have a depressing effect on ration digestibility. Balch, et al. (1953) found that restricted water intake increased feed digestibility in dairy cows and suggested that the observed result was due to slower movement of the feed particles through the gastrointestinal tract. The reverse appears to have happened when the goats were fed high salt levels. Water consumption increased, possibly causing a rapid rate of passage of feed particles through the gastrointestinal tract, reducing the exposure time of the feed particles to the various digestive enzymes. Protein digestibility was also depressed as salt consumption was increased.

The increased water intake observed in the sheep trial did not result in an associated depression in ration digestibility (Table 2). In contrast to the results of the goat study, there appeared to be a slight increase in ration digestibility by the sheep with increasing salt intake. The authors have no explanation for this observed difference in the effects of salt on sheep and goats. However, it reinforces the authors' belief that the digestive systems of sheep and goats are quite different and suggests that additional studies intended to clarify these differences are justified.

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TABLE 1. EFFECTS OF INCREASING LEVELS OF SALT CONSUMPTION IN ANGORA FEMALES (EXPERIMENT 1)

Item	Salt Level		
	Control	Low	High
Number of animals	4	3	3
Weight, kg	33.5	30.1	29.0
Feed intake, g/day[1]			
Hay[2]	421.3	418.9	419.1
Concentrate[3]	176.0	118.4	135.5
Salt[4]	0	16.8	34.3
Total (excluding salt)	597.3	537.3	554.6
Water intake, g/day[5]	1686.7	1598.0	2644.3
Dry matter digestibility, %	59.8	58.4	51.9
Protein digestibility, %	63.0	63.5	57.5
Urine output, g/day[5]	757.3	891.0	1611.7

1 Dry matter basis.

2 Sorghum hay, 9.12% crude protein.

3 Two parts cottonseed meal, one part sorghum grain.

4 Feed grade sodium chloride.

5 One thousand grams approximately equal to 1 liter or 1.06 quarts.

TABLE 2. EFFECTS OF INCREASING LEVELS OF SALT CONSUMPTION IN FINEWOOL CROSSBRED EWES (EXPERIMENT 2)

Item	Salt Level		
	Control	Low	High
Number of animals	4	3	2
Weight, kg	42.8	37.0	40.6
Feed intake, g/day[1]			
Hay[2]	672	672	672
Concentrate[3]	188	188	188
Salt[4]	0	50	100
Total (excluding salt)	860	860	860
Water intake, g/day[5]	2289.8	5066.7	5585.0
Dry matter digestibility, %	56.5	57.5	60.3
Protein digestibility, %	55.4	58.6	59.9
Urine output, g/day[5]	797.0	3121.7	4420.2

1 Dry matter basis.

2 Sorghum hay, 8.3% crude protein.

3 Two parts cottonseed meal, one part sorghum grain.

4 Feed grade sodium chloride.

5 One thousand grams approximately equal to 1 liter or 1.06 quarts.

ECOLOGY OF COYOTE DEPREDATIONS ON SHEEP AND GOATS

S. L. Beasom, D. R. Gober and F. S. Guthery*

Although it is accepted by most individuals concerned that there are numerous problems responsible for the decline in the sheep and goat industry in the United States, losses of stock animals to predation is usually cited by stockmen as the most important or at least the most readily identifiable and/or manageable. While there are but a few persons who will argue that coyotes do not prey on sheep or goats, there exists widespread disagreement as to the magnitude of the losses that do occur. Predation rates generally are affected by numbers of predators, numbers of prey species concerned with, and quality and quantity of alternative food sources. This research was established to determine the importance of the interrelationships between coyote predation and these associated ecological factors and to establish the magnitude of the predation problem on sheep and goats in parts of Texas.

PROCEDURE

Two study locations were selected with known differences in coyote populations. At one location, near Batesville, two approximately 800-acre pastures were treated with two different levels of predator control (intensive vs no control). Intensive control consisted of the use of traps, snares, M-44's, shooting and helicopter gunning.

Approximately 100 bred Angora nannies were individually numbered and placed on each of these pastures in January of 1975 and 1976 and husbanded until late July at which time they were removed. Daily carcass searches were made on foot to determine cause of death of all mortalities. Numbers of white-tailed deer, quail, rabbits, rodents, and predators were censused monthly by standard techniques to determine their interrelationships and response to predator control.

Another location, between Ft. Stockton and Alpine, was chosen because of its relatively low coyote population (0.5-1.0 per square mile) as opposed to the estimated 4.0-6.0 per square mile near Batesville. Three pastures of roughly 3,000 acres each were represented by three different levels of predator control (intensive, M-44 only, and no control), and 150 pregnant ewes, bred for March or April lambing, were placed on each at approximately the same time schedule as the Batesville study. Monitoring of ewe and lamb losses and wildlife populations also was conducted in a similar manner.

RESULTS AND DISCUSSION

South Texas Angora Goat - Predator Ecology

One hundred thirty-two coyotes and 18 bobcats were killed on the intensive removal area over the two study periods. This removal lowered the density of these predators by 60-85% compared to the no control area. The kid crop was 27 times greater in the removal area than the no control. High predation rates in both areas both years, however, resulted in only a 13.5% crop in the removal area. Predators killed 24% of the nannies in the no control area and none in

*Respectively, assistant professor, graduate research assistant, and instructor, The Texas Agricultural Experiment Station, College Station.

the other.

Rodent and rabbit numbers were greater on the no control area throughout the study. This lack of homogeneity created a difficulty in assessing the effect of their numbers on predation levels; however, rates of change within-years were similar in both areas, indicating their populations fluctuated independent of coyote numbers. Overall numbers, however, were lower in 1976 than in 1975. Similarly, quail populations were apparently unaffected by coyote numbers. Quail were abundant in 1975 and not in 1976 because of differences in reproductive success, but the trends were similar on both areas.

Fawn:doe ratios of white-tailed deer were approximately 0.72 in 1975 and 0.30 in 1976 in both areas, but fawn production per unit area was 50% greater on the removal area because of a higher density of does. Inasmuch as pretreatment adult deer densities were roughly equal, this observed difference was likely due to either higher survival in the removal area or emigration from the no control area.

These data suggest it is unlikely to be economical to raise kid goats in South Texas, where coyote densities are high, even with a high intensity of use of existing legal predator control techniques, but the likelihood of success with raising muttons appears reasonable. The higher loss rates and lower survival of goats and deer in 1976, when compared to the lower populations of buffer foods (rabbits and rodents), suggest potential management possibilities, but more data must accumulate to adequately test the hypothesis.

West Texas Sheep - Predator Ecology

Predators removed from experimental areas in 1975 and 1976, respectively, were two and four coyotes on the M-44 only area; 50 and 24 coyotes and 8 and 14 bobcats on the intensive removal area. No reliable index to coyote abundance was available for both years, but predator "sign" generally showed that predator numbers were unaffected by the M-44 only and markedly reduced by the intensive removal efforts.

Lamb total loss rates for 1975 and 1976, respectively, were approximately 36 and 81% on the no control area, 13 and 95% on the M-44 only area, and 31 and 69% on the intensive removal area. Those losses identified as predators kills ranged from roughly 1/4 to 1/2 of these values. Losses of ewes to all causes ranged from 4 to 12% but those attributed to predation were less than 1% on all pastures in both years.

Rodent and rabbit populations declined about 28-38% from 1975 to 1976. It is likely that this reduction in food base contributed to the marked increase in predation during this period. A further indication that coyotes had less alternative food availability in 1976 resulted from the eating behavior on sheep carcasses. In 1975 multiple kills were not noted and of those sheep killed, generally less than 10% of the carcass was eaten. In contrast, multiple kills were common in 1976; the average amount consumed from carcasses was roughly 80%.

Inasmuch as ecological factors seemed to influence levels of predation on sheep more than predator control efforts, it may be that if we can determine a predictive equation for expected buffer foods for predators during lambing, we can program predator control efforts accordingly and channel manpower and resources to other management tasks more efficiently. Hopefully, continued research will answer this important question more satisfactorily.

CHEMISTRY OF THE TOXIC PRINCIPLE OF BITTERWEED

B. J. Camp and H. L. Kim*

Livestock losses from poisonous plants in Texas exceed $100 million annually. In the Edwards Plateau and Southern Rolling Plains, sheep and goats are affected by poisonous plants such as bitterweed, senecio, conyza, milkweed and sneezeweed. Brush and noxious weeds reduce productivity of ranges and increase labor requirements for livestock management. Significant research effort has been expended on the chemistry of the toxic principle of bitterweed.

A toxic, sesquiterpene lactone (hymenoxon) has been isolated from bitterweed when administered to animals.[1] The intraperitoneal LD_{50} (lethal dose that kills 50% of animals) for sheep is 7 milligrams per kilogram of body weight.[2] The oral LD_{50} for the rabbit is 160 milligrams per kilogram of body weight. In addition, when fasted rabbits were fed hymenoxon orally labelled with the radio-isotope tritium, less than 50% of the compound had been absorbed from the gastrointestinal tract in five hours.[1] These studies demonstrate that the lactone is highly toxic when absorbed into the bloodstream, but that the compound is not readily absorbed from the gastrointestinal tract of animals.

Hymenoxon contains a group that reacts readily with a sulfhydryl group present in the sulfur-containing amino acid cysteine. The reaction rate is enhanced in an alkaline condition which is present in the small intestine.[1]

An analytical procedure has been developed for assaying the hymenoxon content of bitterweed. This technique will permit a study of environmental parameters such as soil moisture, temperature, daylight length, etc., on the synthesis of hymenoxon by the plant.

Moreover, this technique led to a study conducted at the Sonora Experiment Station by Dr. Leo Merrill on the effects of 2,4-D butyl ester herbicide on the hymenoxon content of bitterweed. In this study, it was observed that the hymenoxon content of bitterweed increased significantly during the first 15 days posttreatment. In addition, it was found that the herbicide treatment increased the palatability of bitterweed to sheep.[1]

Using tritium-labeled hymenoxon, it was found that the compound is metabolized in the liver of rabbits, and the metabolites are excreted in the urine and bile.[1]

Under alkaline conditions greater than pH 9, hymenoxon is converted into two different dilactones called greenein and psilotropin. However, the alkaline conversion of hymenoxon should not occur under normal physiological conditions in livestock.

*Respectively, professor and research chemist, The Texas Agricultural Experiment Station (Department of Veterinary Physiology and Pharmacology).

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BITTERWEED CONTROL RESEARCH IN THE EDWARDS PLATEAU

D.N. Ueckert, C.J. Scifres, J.L. Mutz and S.G. Whisenant*

Bitterweed (*Hymenoxys odorata*), a poisonous plant inhabiting an array of range sites in the western half of Texas, causes severe economic losses to sheep ranchers in the Edwards Plateau when it is abundant in the early winter and spring. Sperry (2) emphasized that good grazing management and grazing with a combination of livestock species are the most effective methods for avoiding bitterweed problems. However, the severe droughts of the 1930's and 1950's have greatly intensified the bitterweed problem. In many cases, application of herbicides in conjunction with good grazing management is required to avoid livestock poisoning.

Amine and ester formulations of 2,4-D [(2,4-dichlorophenoxy)acetic acid] have given good to excellent short-term control of bitterweed in winters when soil moisture is abundant and temperatures are favorable for bitterweed growth (1,3). Aerial application of 2,4-D has been the standard practice for bitterweed control for over 20 years. However, control of bitterweed with 2,4-D has severe limitations, including (1) often only temporary control since 2,4-D does not have an extended residual life in the soil (a new crop of bitterweed seedlings may emerge with the first precipitation after spraying); (2) detrimental effects on associated forbs (which are highly nutritious and important in the diets of sheep and goats); and (3) unsatisfactory control of bitterweed when growing conditions are unfavorable (when soil moisture is limiting or during extremely cold winters).

This research was initiated to (1) evaluate various herbicides and herbicide combinations for improved initial control of bitterweed, and for satisfactory control during years when growing conditions are not optimum for growth of bitterweed; and (2) to evaluate herbicides with adequate soil residual lives to extend control of bitterweed infestations which develop with rainfall subsequent to the initial herbicide application.

METHODS AND MATERIALS

1975-76 Studies

A "Pawnee 260" aircraft (swath width of 39 ft) was used to aerially apply herbicides on December 16, 1975 on the Bill Scott Ranch near Mertzon, Texas. The carrier was 1 gallon per acre of a 1:4, diesel oil:water emulsion, and the plots were 19 to 28 acres in size. Herbicide treatment results included 2,4-D as the dimethylamine (DMA) salt at 0.75 and 0.84 pound per acre; 2,4-D ethylhexyl ester at 0.75 and 1.0 pound per acre; 2,4-D as DMA salt + 2,4-D ester at 0.5 + 0.5 pound per acre; 2,4-D as alkanolamine salts at 1.0 pound per acre; 2,4,5-T as triethanolamine salt at 0.5 pound per acre; dicamba (3,6-dichloro-*o*-anisic acid) + 2,4-D (both DMA salts) at 0.25

* Respectively, associate professor, The Texas Agricultural Experiment Station, San Angelo; professor and research associate, The Texas Agricultural Experiment Station (Department of Range Science); and research technician, The Texas Agricultural Experiment Station, San Angelo.

+ 0.75 pound per acre, dicamba as DMA salt + 2,4,5-T as isooctyl ester at 0.5 + 0.5 pound per acre, atrazine [2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine] (80% wettable powder) at 1.0 pound per acre; 2,4-D ester + atrazine at 0.75 +1.0 pound per acre; 2,4,5-T + picloram (both as triethanolamine salts) at 0.25 + 0.25 pound per acre and picloram as the potassium salt at 0.25, 0.5, and 1.0 pound per acre. Pretreatment counts of bitterweed density were taken from 25 to 35 quadrats (0.67 ft^2) spaced 150 ft apart down the center of each plot.

A small-plot tractor sprayer equipped with a 20-ft boom with nozzles spaced 20 inches apart was used to apply herbicides to small plots (70 by 100 ft) on the Reginald Atkinson Ranch near Mertzon. Herbicides applied on December 16, 1975 included 2,4-D amine at 0.5, 0.75 and 1.0 pound per acre; 2,4-D ester at 0.5, 0.75 and 1.0 pound per acre; dicamba + 2,4-D ester at 0.125 + 0.375 pound per acre and 0.25 + 0.75 pound per acre; and picloram at 0.125, 0.25 and 0.5 pound per acre. Pretreatment bitterweed density was recorded in 50 quadrats across each plot. All treatments were applied in 23.3 gallons per acre of water.

On May 6, 1976, 2,4-D amine at 1.0 pound per acre, 2,4-D ester at 1.0 pound per acre, a combination of 2,4-D amine and 2,4-D ester at 0.5 pound per acre of each herbicide, dicamba at 1.0 pound per acre, dicamba + 2,4-D at 0.25 + 0.75 pound per acre, picloram at 0.5 and 1.0 pound per acre, and 2,4,5-T + picloram at 0.5 pound per acre of each herbicide were applied in 40- by 100-ft plots on the Atkinson Ranch with the tractor sprayer in 25 gallons per acre of water. Pretreatment bitterweed density was recorded in 5 quadrats in each plot.

Bitterweed densities were recorded on all plots during the winter, spring, summer and fall after spraying by methods similar to those described for determination of pretreatment densities.

Environmental conditions were recorded at the time of spraying. The environmental and bitterweed growth conditions were considered optimum for the application of herbicides in all studies.

1976-77 Studies

Herbicides and herbicide combinations were applied with ground equipment to experimental plots during 1976 and 1977 on the following ranches in the Edwards Plateau:

Ranch	Location	Date of Spraying
Bill Pfluger	S.E. of San Angelo	December 7, 1976
Hal Noekle	E. of Barnhart	December 15, 1976
Tony Allen	N.W. of Ozona	December 10, 1976
H&H Cattle Co.	N.E. of Sterling City	April 20, 1977
James Powell	N.W. of Ft. McKavett	April 22, 1977

Herbicides were applied to plots 20 by 100 ft in size. Herbicides were applied in 15 gallons per acre of a diesel oil:water emulsion (except for tebuthiuron [1-(5-tert-butyl-1,3,4-thiadiazol-2-yl)-1,3-dimethylurea] which was applied in 15 gallons per acre of water only). The emulsifier Tryad[R] was used in all diesel oil:water emulsion sprays at 0.05% by volume. Herbicide treatments evaluated included 2,4-D ester at 1.0 pound per acre, dicamba + 2,4-D (1:3) at 1.0 pound per acre, 2,4,5-T + picloram (1:1) at 0.5 and 1.0 pound per acre, picloram at 0.25, 0.50 and 1.0 pound per acre and tebuthiuron at 0.5 and 1.0 pound per acre. In addition, a carrier control of 15 gallons per acre of a diesel oil:water emulsion (1 gallon per acre of diesel oil) was included to determine the phytotoxic effects of diesel oil in herbicide mixtures used for bitterweed control. Preliminary results on plots sprayed in December 1976 indicated that the carrier (diesel oil) had no detrimental effect on bitterweed and that tebuthiuron was not effective for bitterweed control, thus these treatments were not included in the experiments intitated in April 1977.

A Pawnee 260 aircraft was used to apply herbicides to 15.4 acre plots on the Hal Noelke Ranch, each of Barnhart, on December 8, 1976. Herbicides applied by air included: 2,4-D ester at 1.0 pound per acre, dicamba + 2,4-D (1:3) at 1.0 pound per acre, 2,4,5-T + picloram (1:1) at 0.5 and 1.0 pound per acre and picloram at 0.5 and 1.0 pound per acre. The emulsifier Tryad[R] was included in the diesel oil:water emulsion carrier and the surfactant Ortho X-77[R] was included at 0.1% in the water carriers.

Permanent transects were established in each plot, and pretreatment and post-treatment bitterweed densities were taken from 10, permanently-marked quadrats in each plot. Quadrat sizes were 0.11 ft^2 for ground plots, and 0.43 ft^2 for aerially-sprayed plots. All treatments applied with ground equipment were replicated three times in completely randomized designs. Treatments applied by airplane were not replicated, but three permanent transects were located within each plot.

RESULTS AND DISCUSSION

1975-76 Studies

No precipitation had been received on the study areas near Mertzon from the time herbicides were applied on December 16, 1975 until the first evaluation on January 23, 1976. Consequently, at the first evaluation (January 23, 1976), the bitterweed plants were under visible moisture stress. The highest level of control (100%) on aerially-sprayed plots was achieved with picloram at 1.0 pound per acre (Table 1). One pound per acre of 2,4-D amine and 2,4-D ester resulted in 87% and 88% control, respectively. All other treatments resulted in lower bitterweed control. There was no apparent difference between the ester and amine formulations of 2,4-D applied at 1.0 pound per acre. However, the 0.75 pound per acre rate of 2,4-D amine controlled less than 50% of the bitterweed, whereas the same rate of 2,4-D ester controlled 72%. At 38 days after treatment, the 2,4-D + dicamba combination was less effective than the equivalent rate of 2,4-D. The amine of 2,4,5-T at 0.5 pound per acre controlled about 53% of the bitterweed; and dicamba + 2,4,5-T at 0.5 pound per acre of each herbicide controlled less than 40% of the bitterweed by 38 days after spraying. The low rate (0.25 pound per acre) of picloram and the 2,4,5-T + picloram combination at

0.25 pound per acre of each herbicide had not effectively controlled bitterweed at 38-days post-treatment. Since both dicamba and picloram are absorbed by both roots and foliage, their activity was apparently seriously reduced by the low soil moisture condition, the lack of precipitation following spraying, and the stressed condition of the bitterweeds.

On May 6, all herbicide treatments except the 2,4-D amine at 0.75 pound per acre and 2,4,5-T amine at 0.5 pound per acre were controlling 88% or more of the bitterweed (Table 1). The dicamba + 2,4-D combination and picloram sprays completely controlled the bitterweed. Evidently, there was adequate herbicide residue in the soil, even following application of the low rate of picloram to maintain high levels of control.

On January 22, 1976 (38-days after spraying) none of the herbicides applied with ground equipment on the Atkinson Ranch were effectively controlling the bitterweeds (Table 2). The highest level of control (about 50% density reduction) resulted from application of the higher rates of 2,4-D and of picloram. However, on May 6, 1977, all herbicide treatments had controlled at least 90% of the bitterweed. The 2,4-D ester resulted in 97 to 99% control, regardless of rate. Dicamba + 2,4-D amine and picloram at rates as low as 0.125 pound per acre resulted in complete control of bitterweed.

Plots sprayed on May 6, 1976 with ground equipment at the Atkinson Ranch were observed during early July, 1976, but could not be evaluated because dry, hot weather had resulted in mortality of all bitterweed.

Neither formulation of 2,4-D resulted in acceptable control at 36 days after spraying (Table 3). However, both formulations, regardless of application rate, were providing good to excellent control by 104 days post-treatment. By 182 days after treatment, bitterweed control was reduced where the low rates of both formulations and where 1 pound per acre of 2,4-D amine were applied. By 310 days after treatment, bitterweed densities in plots treated with 0.5 pound per acre were no different from that of untreated plots. Control in plots treated with 1 pound per acre of the ester formulation exceeded 40%.

Both formulations of 2,4-D resulted in better initial control of bitterweed on aerially-sprayed plots as compared to ground sprayed plots, and excellent control was maintained for 140 days (Table 4). Both formulations had lost effectiveness by 310 days after spraying. There was no apparent advantage to mixing the amine and ester formulations.

A comparison of bitterweed control achieved with 2,4-D amine and dicamba + 2,4-D over the 310-day evaluation period, applied with ground equipment, is presented in Table 5. Neither 2,4-D alone nor the dicamba/2,4-D combination resulted in acceptable bitterweed control by 36 days after spraying but all treatments were effective 140 days after spraying (dicamba in the mixture increased control by only 9%). The 0.5 pound per acre rates of both treatments had seriously lost effectiveness by 182 days after spraying, and no treatment provided acceptable bitterweed control by 310 days after spraying (Table 5).

A comparison of bitterweed control achieved by aerial application of picloram at 0.25 and 0.5 pound per acre, and picloram + 2,4,5-T at 0.25 + 0.25 pound per acre of each herbicide (Table 6) indicated that 2,4,5-T in the mixture has no additive effect (possibly even a detrimental effect) relative to bitterweed control. Only the higher rate of picloram (0.5 pound per acre) demonstrated significant residual activity in the soil for effective bitterweed control at 310 days after spraying (Table 6).

1976-77 Studies

Even though soil moisture conditions were excellent, conditions were suboptimal for spraying bitterweed in December, 1976. Soil and air temperatures were low and the weather was cloudy and cold for several weeks prior to and following spraying. In April, soil and air temperatures were warm, there was abundant sunshine and soil moisture conditions were excellent. Thus, conditions were favorable for spraying bitterweed. However, by April a large proportion of the bitterweeds had flowered.

Bitterweed control resulting from treatments applied in December, 1976 by air and with ground equipment (averages of results in all 4 locations) is presented in Table 7. No treatment had effectively controlled bitterweeds at 45 days after spraying (Table 7). Bitterweed plants in all plots treated with sprays containing picloram exhibited severe necrosis at 45-days post-treatment, but few bitterweeds had died. By contrast, bitterweeds treated with 2,4-D exhibited slight epinasty, those treated with dicamba + 2,4-D exhibited moderate epinasty with slight necrosis, and those treated with tebuthiuron exhibited very slight chlorosis. The oil: water carrier had no visible effect on bitterweed plants. However, increase of bitterweed in the plot air-sprayed with 2,4-D ester at 1.0 pound per acre in water only was greater during the 45-day period than in plots ground-sprayed with the same herbicide in the diesel oil: water emulsion. Bitterweed density increased on all plots, except those treated with 2,4,5-T + picloram at 1.0 pound per acre and picloram at 0.25 and 1.0 pound per acre, during the first 45 days after spraying. This demonstrates that during cold, cloudy weather, even when soil moisture conditions are favorable, rapid initial control of bitterweed may be very difficult to achieve with any herbicide.

Results of counts of bitterweed at 110 days after spraying indicated that good control (91%) had been achieved with dicamba + 2,4-D at 1.0 pound per acre, and that excellent control (99.2% to 100%) resulted where 2,4,5-T + picloram at 0.5 and 1.0 pound per acre and picloram at 0.25, 0.5 and 1.0 pound per acre were applied. The 2,4-D ester at 1.0 pound per acre applied in the diesel oil:water emulsion carrier resulted in 11% reduction in bitterweed numbers (average of 3 separate experiments), whereas the same treatment applied in a water carrier resulted in a 44.5% increase in bitterweed numbers (data from one experiment). Bitterweed numbers increased by 15.5% on unsprayed plots over the 110 day period, by 23.4% on the plots sprayed with the diesel oil:water emulsion only, and by 44.5% on plots air sprayed with 2,4-D in the water carrier (Table 7). Tebuthiuron at 0.5 and 1.0 pound per acre reduced bitterweed density but was slightly less effective than 2,4-D ester.

Results of the two bitterweed control experiments applied on April 20 and April 22, 1977 near Sterling City and Ft. McKavett are presented in Table 8 (averages of results at the two locations). Hot, dry conditions following spraying at both locations resulted in almost 60% mortality of bitterweeds on unsprayed plots by 40 days after initiation of the experiment. Mortality was only about 65% on plots sprayed with 2,4-D ester at 1.0 pound per acre. Thus, this treatment increased bitterweed mortality only about 5% above natural mortality. About 95% control was achieved with dicamba + 2,4-D, and 98 to 100% control was achieved with 2,4,5-T + picloram at 0.5 and 1.0 pound per acre and picloram at 0.5 and 1.0 pound per acre. Picloram at 0.25 pound per acre resulted in 91% bitterweed control. This demonstrates that good to excellent bitterweed control can be achieved late in the growing season, even of plants that are flowering and when soil moisture and temperature conditions are not optimal for bitterweed growth.

Additional counts of bitterweed will be taken in the fall of 1977 and winter of 1978 to evaluate residual activity of all herbicides. Laboratory studies have been initiated to determine the effect of all herbicides, applied in April, 1977 to flowering bitterweed plants, on viability of bitterweed seeds.

SUMMARY AND CONCLUSIONS

The ester formulation of 2,4-D usually provides a slight advantage over the amine formulation for bitterweed control in that (1) initial control (40± days) may be somewhat greater and (2) residual activity of the ester is slightly longer than that of the amine. However, the residual activity of both 2,4-D formulations decreases fairly rapidly, and new populations of bitterweed may appear within a few months after spraying. In addition to these disadvantages, 2,4-D will not effectively control bitterweed during cold, wet winters or during the spring after bitterweed plants begin to flower, temperatures rise and soil moisture becomes limiting. Mixing of the amine and the ester of 2,4-D apparently may reduce initial bitterweed control as well as residual activity as compared to either formulation used alone. Mixing dicamba and 2,4-D amine did not increase the intital control (36 to 45 days) of bitterweed sprayed in winter as compared to that from 2,4-D alone. However, at 110 to 140 days after spraying in December, the mixture increased bitterweed control from 9% to 80% over that with 2,4-D alone. In April, after bitterweeds began to flower, dicamba + 2,4-D (1:3) increased mortality by 30% over that with 2,4-D alone at the same rate (1 pound per acre).

Picloram sprays resulted in better initial control (evaluated after 45 days) of bitterweed than other herbicides evaluated during the cold wet winter of 1976-77. However, control (based on the number of plants killed) was less than acceptable initially. Picloram offers advantages in that (1) its extended soil residual activity results in effective bitterweed control for 310 days after spraying at rates of 0.5 to 1.0 pound per acre, and (2) it effectively controls bitterweed in years and during phenological stages when 2,4-D is almost totally ineffective. Addition of 2,4,5-T amine to picloram sprays has no additive herbicidal effect on bitterweed. Tebuthiuron wettable powder offers no advantage over 2,4-D for bitterweed control in winter.

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Table 1. CONTROL OF BITTERWEED ON JANUARY 23 AND MAY 6, 1976 AFTER AERIAL APPLICATION OF VARIOUS HERBICIDES AND HERBICIDE COMBINATIONS ON DECEMBER 16, 1975 NEAR MERTZON, TEXAS

Herbicide(s)	Formulation	Rate (lb/A)	Control (%) 1/	
			Jan. 23	May 6
2,4-D	amine	0.75	46	76
2,4-D	amine	0.84	77	96
2,4-D	amine	1	87	96
2,4-D	ester	0.75	72	98
2,4-D	ester	1	88	95
2,4-D	ester + amine	0.5 + 0.5	63	96
2,4,5-T	amine	0.5	53	47
Dicamba + 2,4-D	amines	0.25 + 0.75	65	100
Dicamba + 2,4,5-T	amine + ester	0.5 + 0.5	38	100
Atrazine + 2,4-D	WP + amine	1 + 0.75	75	88
2,4,5-T + picloram	amines	0.25 + 0.25	0	94
Picloram	salt	0.25	0	100
Picloram	salt	0.5	41	100
Picloram	salt	1	100	100

1/ $\%\text{control} = \frac{\text{pre-treatment density} - \text{post-treatment density}}{\text{pre-treatment density}} \times 100$

TABLE 2. CONTROL OF BITTERWEED ON JANUARY 23 and MAY 6, 1976 FOLLOWING APPLICATION OF HERBICIDES WITH GROUND EQUIPMENT ON DECEMBER 16, 1975 NEAR MERTZON, TEXAS

Herbicide(s)	Formulation	Rate (lb/A)	Control (%) Jan. 23	Control (%) May 6
None		0	0	0
2,4-D	amine	0.5	23	91
2,4-D	amine	0.75	48	95
2,4-D	amine	1	35	91
2,4-D	ester	0.5	10	97
2,4-D	ester	0.75	15	99
2,4-D	ester	1	52	99
Dicamba + 2,4-D	amines	0.125 + 0.375	0	100
Dicamba + 2,4-D	amines	0.25 + 0.75	5	100
Picloram	salt	0.125	0	100
Picloram	salt	0.25	38	100
Picloram	salt	0.5	50	100

TABLE 3. MEAN CONTROL (%) OF BITTERWEED AFTER APPLICATION OF 2,4-D FORMULATIONS WITH GROUND EQUIPMENT NEAR MERTZON, TEXAS ON DECEMBER 16, 1975.

2,4-D treatment		Days after treatment			
Formulation	Rate (lb/acre)	36 (Winter)	104 (Spring)	182 (Summer)	310 (Fall)
Amine	0.5	23	91	61	0
Ester	0.5	10	97	75	0
Amine	1	35	91	81	19
Ester	1	52	99	93	42
L.S.D. (.05)		14	17	11	14

TABLE 4. MEAN CONTROL (%) OF BITTERWEED AFTER AERIAL APPLICATION OF 2,4-D FORMULATIONS NEAR MERTZON, TEXAS ON DECEMBER 16, 1975

2,4-D formulation (1 lb/acre)	Days after treatment		
	36 (Winter)	140 (Spring)	310 (Fall)
Amine	87	96	20
Ester	88	95	47
Amine + ester	63	96	0

TABLE 5. MEAN CONTROL (%) OF BITTERWEED AFTER APPLICATION OF 2,4-D ALONE AND IN COMBINATION WITH DICAMBA WITH GROUND EQUIPMENT NEAR MERTZON, TEXAS ON DECEMBER 16, 1975.

Herbicide(s)	Rate (lb/acre)	Days after treatment			
		36 (Winter)	140 (Spring)	182 (Summer)	310 (Fall)
2,4-D amine	0.5	23	91	61	0
2,4-D amine	1	35	91	81	19
Dicamba + 2,4-D (1:3)	0.5	0	100	68	0
Dicamba + 2,4-D (1:3)	1	5	100	98	30
L.S.D. (0.5)		14	17	11	14

TABLE 6. MEAN CONTROL (%) OF BITTERWEED AFTER AERIAL APPLICATION OF PICLORAM ALONE AND IN COMBINATION WITH 2,4,5-T NEAR MERTZON, TEXAS ON DECEMBER 16, 1975.

Herbicide(s)	Rate (lb/acre)	Days after treatment		
		36 (Winter)	140 (Spring)	310 (Fall)
Picloram	0.25	0	100	23
Picloram	0.5	41	100	89
Picloram + 2,4,5-T	0.25 + 0.25	0	94	8

TABLE 7. MEAN CONTROL (%) OF BITTERWEED AVERAGED ACROSS FOUR LOCATIONS[1/] IN THE EDWARDS PLATEAU AT 45 AND 110 DAYS AFTER APPLICATION OF VARIOUS HERBICIDES AND HERBICIDE COMBINATIONS IN DECEMBER, 1976

Herbicide(s)	Rate (lb/acre)	Control at days after[2/] treatment 45	110
Control	-	- 20.0	- 15.5
Carrier control	1 gal/acre diesel	- 20.2	- 23.4
2,4-D ester (DOEM)	1.0	- 12.1	11.0
Dicamba + 2,4-D (1:3)	1.0	- 13.9	91.2
2,4,5-T + picloram (1:1)	0.5	- 0.3	99.9
2,4,5-T + picloram (1:1)	1.0	10.3	99.9
Picloram	0.25	16.7	99.2
Picloram	0.5	- 24.0	99.9
Picloram	1.0	28.3	100.0
Tebuthiuron	0.5	- 24.2	9.0
Tebuthiuron	1.0	- 16.1	8.2
2,4-D ester (water)	1.0	- 70.4	- 44.5

[1/] All treatments except 0.25 pound per acre of picloram, 0.5 pound per acre tebuthiuron, and 1.0 pound per acre tebuthiuron and 2,4-D ester (in water carrier) were applied at four locations. These four treatments were applied at 3,3,3 and 1 locations, respectively.

[2/] $\% \text{ control} = \frac{\text{pre-treatment density} - \text{post-treatment density}}{\text{pre-treatment density}} \times 100$

TABLE 8. MEAN CONTROL (%) OF BITTERWEED AT STERLING CITY AND FT. MCKAVETT, TEXAS AT 40 DAYS AFTER APPLICATION OF VARIOUS HERBICIDES ON APRIL 20-22, 1977

Herbicide(s)	Rate (lb/acre)	Control [1/] (May 31, 1977)
Control (no treatment)	-	59.5[2/]
2,4-D ester	1.0	64.7
Dicamba + 2,4-D (1:3)	1.0	94.6
2,4,5-T + picloram (1:1)	0.5	98.3
2,4,5-T + picloram (1:1)	1.0	99.9
Picloram	0.25	91.3
Picloram	0.5	98.7
Picloram	1.0	100.0

[1/] $\% \text{ control} = \frac{\text{pre-treatment count} - \text{post-treatment count}}{\text{pre-treatment count}} \times 100$

[2/] This indicates that 59.5% of the bitterweed plants had dies from natural causes on plots that were not sprayed.

HYMENOXON CONCENTRATION IN BITTERWEED AFTER HERBICIDE APPLICATION

Darrell N. Ueckert, Bennie J. Camp and Leo B. Merrill*

"Hymenoxon", a toxic lactone, has been isolated as the toxic principle in bitterweed (Hymenoxys odorata) (2). Bitterweed sprayed with the herbicide 2,4-D has been found, in some cases, to be highly palatable and much less toxic than unsprayed bitterweed to sheep that grazed experimental plots (1). However, the concentration of hymenoxon in the sprayed bitterweed was not significantly different from the concentration of hymenoxon in the unsprayed bitterweed. Thus, the relationship between 2,4-D and hymenoxon concentration of bitterweed and its toxicity to sheep is unclear. The effect of other herbicides on bitterweed toxicity has not been studied.

This study was initiated in 1976 to obtain information on the effect of various registered and experimental herbicides on hymenoxon concentration of bitterweed.

METHODS AND MATERIALS

A small-plot tractor sprayer equipped with a 20-ft boom with nozzles spaced 20 in. apart was used to apply herbicides to small plots (20 ft X 100 ft) on the Bill Pfluger Ranch (S.E. of San Angelo) on December 7, 1976 and on the Hal Noelke Ranch (E. of Barnhart) on December 15, 1976. Treatments applied included 2,4-D ester at 1.0 lb/acre, dicamba + 2,4-D (1:3) at 1.0 lb/acre, 2,4,5-T + picloram (1:1) at 0.5 and 1.0 lb/acre, picloram at 0.25, 0.5 and 1.0 lb/acre, tebuthiuron at 0.5 and 1.0 lb/acre and a carrier control (diesel oil at 1.0 gal/acre). Check plots were left untreated. All treatments (except tebuthiuron wettable powder) were applied in 15 gal/acre of a diesel oil:water emulsion. Each treatment was replicated three times in a completely randomized experiment.

Samples of bitterweed from each treatment were randomly collected on January 11, 1977 from both locations. These samples were placed in paper bags, air dried and taken to the laboratory for determination of hymenoxon concentration. The bitterweed samples were ground, and three sub-samples from each treatment were analyzed.

RESULTS AND DISCUSSIONS

At the time samples were collected (January 11, 1977), the bitterweed plants in the unsprayed check plots and the carrier-control treatment were under a slight degree of stress, as evidenced by slight foliar necrosis, probably due to unusually cold weather. Bitterweeds in the 2,4-D treatment exhibited only slightly more necrosis than untreated plants, and no evidence of epinasty (curling and twisting of leaves and stems) or plant mortality was found. Those in plots treated with dicamba + 2,4-D exhibited slight

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*Respectively, associate professor, The Texas Agricultural Experiment Station, San Angelo; professor, The Texas Agricultural Experiment Station (Department of Veterinary Physiology and Pharmacology); and professor, The Texas Agricultural Experiment Station, Sonora.

to moderate epinasty, but no mortality. Bitterweeds that had received sprays of 2,4,5-T + picloram or picloram alone exhibited severe necrosis and a few of the plants had died. Plants receiving tebuthiuron sprays exhibited slight foliar necrosis, or symptoms identical to the unsprayed bitterweed.

At the Noelke Ranch, at 27 days after spraying, all treatments except picloram at 1.0 lb/acre and tebuthiuron at 1.0 lb/acre resulted in a significant reduction in hymenoxon concentration in bitterweed (Table 1). Picloram at 0.25 lb/acre resulted in the greatest reduction in hymenoxon concentration. Tebuthiuron at 1.0 lb/acre increased hymenoxon concentration of bitterweed most, but not significantly above the level found in unsprayed plants.

At 35 days after spraying at the Pfluger Ranch, three treatments, including picloram at 0.25 and 0.5 lb/acre and tebuthiuron at 1.0 lb/acre, had significantly increased hymenoxon concentration of bitterweed as compared to unsprayed controls. Five treatments, including the carrier control (1 gal/acre of diesel oil), 2,4-D ester at 1.0 lb/acre, dicamba + 2,4-D at 1.0 lb/acre, picloram at 1.0 lb/acre and tebuthiuron at 0.5 lb/acre, had caused significant reductions in hymenoxon concentration. Hymenoxon concentration of bitterweed was not affected by the 2,4,5-T + picloram sprays.

Unsprayed bitterweed at the Noelke Ranch contained significantly more hymenoxon on January 11 than that at the Pfluger Ranch on the same date. Four treatments were consistent in causing significant reductions of hymenoxon at both locations, including the carrier control, 2,4-D ester, dicamba + 2,4-D and tebuthiuron at 0.5 lb/acre. None of the treatments were consistent in causing significant increases in hymenoxon at both locations (Table 1).

SUMMARY AND CONCLUSIONS

Hymenoxon concentration of bitterweed may vary significantly between locations on a given date. A study has been initiated to determine the variation in hymenoxon concentration between individual bitterweed plants inhabiting the same range site, but analyses have not been completed. Several treatments, including diesel oil at 1 gal/acre, 2,4-D ester at 1.0 lb/acre, dicamba + 2,4-D (1:3) at 1.0 lb/acre and tebuthiuron at 0.5 lb/acre, caused significant reductions in hymenoxon concentration of bitterweeds on two ranches in the Edwards Plateau at 27 and 35 days after spraying. Other treatments were inconsistent in their effect on hymenoxon concentration. Picloram at 0.25 and 0.5 lb/acre, for example, caused a significant decrease at one location, but a significant increase in hymenoxon at another location. The influence of these treatments on bitterweed hymenoxon concentration at times prior to and subsequent to 27 and 35 days after spraying was not determined.

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TABLE 1. EFFECT OF VARIOUS HERBICIDES AND HERBICIDE COMBINATIONS ON HYMENOXON CONCENTRATION (%) OF BITTERWEED (HYMENOXYS ODORATA) AT 27 AND 35 DAYS AFTER SPRAYING

Treatments	Rate (lb/acre A.E.)	Mean Hymenoxon Concentration (%)	
		Noelke Ranch[1/]	Pfluger Ranch[2/]
Control (no treatment)	-	3.80[3/]	3.03c
Carrier control (1 gal/acre diesel oil)	-	2.59b	2.22b
2,4-D ester	1.0	2.62b	2.02b
Dicamba + 2,4-D (1:3)	1.0	2.60b	2.62b
2,4,5-T + picloram (1:1)	0.5	2.62b	3.27c
2,4,5-T + picloram (1:1)	1.0	2.20b	3.07c
Picloram	0.25	1.22a	4.19d
Picloram	0.5	2.48b	3.68d
Picloram	1.0	3.92d	2.71b
Tebuthiuron	0.5	2.02b	1.82b
Tebuthiuron	1.0	4.22d	3.80d

1/ Treatments applied on December 15, 1976 and samples collected on January 11, 1977 (27 days post-treatment).

2/ Treatments applied on December 7, 1976 and samples collected on January 11, 1977 (35 days post-treatment).

3/ Means within columns and rows of data followed by similar letters are not significantly different at the 5% significant level.

PR-3458

BITTERWEED HERBICIDES: EFFECT ON COOL-SEASON FORBS

D.N. Ueckert, S.G. Whisenant and R.C. Papasan*

Thousands of acres of rangeland are sprayed with herbicides each year in the Edwards Plateau resource area of Texas for bitterweed (*Hymenoxys odorata*) control. Most of this acreage is sprayed with 2,4-D, although dicamba + 2,4-D (1:3) and 2,4,5-T + picloram (1:1) are also commonly used. One objection many ranchers have to broadcast spraying of herbicides for bitterweed control is that many cool-season forbs (commonly called "weeds" by most ranchers) are also killed.

Cool-season forbs are high in nutritional value to domestic livestock as well as wildlife. Edwards Plateau forbs maintain higher levels of crude protein throughout the year (range: 10.8 to 17.5%) than browse (range: 5.6 to 17.0%) and grasses (range: 4.2 to 10.0%) (3). The phosphorus content of Edwards Plateau forbs exceeds that of grasses in all months except June, and organic matter digestibility of forbs exceeds that of grasses throughout the year (3).

Edwards Plateau forbs have been reported to contribute 47%, 8%, 3% and 1% to the spring, summer, fall and winter diets of sheep and 12%, 2%, 5% and 0% to the diets of goats during these seasons, respectively, on moderately-grazed pastures (2). Malechek and Leinweber (1) reported that the average yearlong diet of Angora goats contained 10.9% forbs on lightly grazed rangeland and 7.2% forbs on heavily grazed rangeland in the Edwards Plateau; thus the value of forbs to the sheep and goat industry is evident.

This study was initiated in 1976 to evaluate the effects of various herbicides, sprayed in December for bitterweed control, on density and production of cool-season forbs.

METHODS AND MATERIALS

Three ranches in the Edwards Plateau resource area were utilized for aerial and ground application of various herbicides for bitterweed control in December, 1976, including:

Ranch	Location	Date Treated	Method
Bill Pfluger	S.E. of San Angelo	December 7, 1976	Ground
Hal Noelke	E. of Barnhart	December 15, 1976	Ground
Hal Noelke	E. of Barnhart	December 8, 1976	Aerial
Tony Allen	N.W. of Ozona	December 10, 1976	Ground

Respectively, associate professor, research technician, and farm worker, The Texas Agricultural Experiment Station, San Angelo.

A tractor-mounted sprayer, equipped with a 20-ft boom with nozzles spaced 20 in. apart was used to apply herbicides to plots 20 ft X 100 ft. All herbicides were applied in 15 gal/acre of a diesel oil:water emulsion (1 gal/acre of diesel oil). Each herbicide treatment was replicated three times. Estimates of density of forbs (number of plants/quadrat) were taken on March 30 to April 1, 1976 on ten quadrats (0.1 m^2) taken along a permanent transect within each plot on the three experiments where herbicides had been applied with ground equipment. Herbicides evaluated on these ground plots included 2,4-D ester at 1.0 lb/acre, dicamba + 2,4-D (1:3) at 1.0 lb/acre, 2,4,5-T + picloram at 0.5 and 1.0 lb/acre, picloram at 0.25, 0.5 and 1.0 lb/acre and tebuthiuron (EL-103) at 0.5 and 1.0 lb/acre. We also applied a carrier-control treatment (one gal/acre of diesel oil + 14 gal water/acre) to determine the effect of the carrier on forbs. Untreated plots were left as checks.

A Pawnee 260 aircraft was used to apply herbicide treatments to 15.4 acre plots on the Hal Noelke Ranch. All treatments were applied in 1.0 gal/acre of a water carrier with 0.1% surfactant (Ortho X-77). These plots were not grazed by livestock to facilitate obtaining data on forb production. Herbicide treatments included 2,4-D ester at 1.0 lb/acre, dicamba + 2,4-D (1:3) at 1.0 lb/acre, 2,4,5-T + picloram at 0.5 and 1.0 lb/acre and picloram at 0.5 and 1.0 lb/acre. An untreated plot served as a check. All forbs were clipped from 15 quadrats (0.25 m^2) on each plot on May 10, 1977; the samples were oven-dried at 60°C for 48 hrs, then weighed and forb production converted to lb/acre.

RESULTS AND DISCUSSION

All herbicides seriously reduced forb density on the ground-applied experimental plots (Table 1). Picloram at 1.0 lb/acre reduced the number of forbs by 96% and was the most detrimental to forbs of all herbicides tested. However, 2,4,5-T + picloram (1:1) at 0.5 and 1.0 lb/acre reduced forb numbers by 90% and 86%, respectively. Picloram at 0.5 lb/acre reduced forb numbers by 83% while picloram at 0.25 lb/acre caused a 67% reduction, and dicamba + 2,4-D at 1.0 lb/acre caused a 62% reduction. 2,4-D ester at 1.0 lb/acre was less damaging to forb numbers than the herbicides listed above (49% reduction) but was slightly more destructive than tebuthiuron at 0.5 and 1.0 lb/acre. The addition of 2,4,5-T to picloram had a significant additive effect in reducing forb densities, especially at the lower rates. The carrier control (1 gal/acre of diesel oil) did not negatively affect forb numbers.

All aerially applied herbicide treatments caused significant decreases in forb production (Table 2). 2,4-D ester at 1.0 lb/acre and dicamba + 2,4-D (1:3) at 1.0 lb/acre caused 49% and 53% reduction in forb production, respectively, but were significantly less detrimental than the other herbicides tested (Table 2). Picloram at 0.5 and 1.0 lb/acre and 2,4,5-T + picloram (1:1) at 0.5 and 1.0 lb/acre reduced forb production by over 90%. Addition of 2,4,5-T to picloram had a slight (but not significant) additive effect in reducing forb production. Forb production on the untreated check plot was 411.5 lb/acre.

SUMMARY AND CONCLUSIONS

All herbicides tested for efficacy in controlling bitterweed caused serious losses of associated forbs, which are extremely important in sheep and goat diets, especially during spring. Tebuthiuron was least detrimental to forb numbers than all other herbicides tested (Table 1) but is not as effective as the other herbicides for controlling bitterweed (see PR-3456 in this publication). 2,4-D ester and dicamba + 2,4-D were less detrimental to associated forbs than the herbicides containing picloram, causing reductions of 51% and 62%, respectively, in forb densities and reductions of 49% and 53%, respectively, in forb production. Unfortunately however, these herbicides are not consistently effective in controlling bitterweeds (see PR-3456). Picloram at 0.25 lb/acre was only slightly more damaging to forb numbers than dicamba + 2,4-D and has proven effective for bitterweed control in seasons when 2,4-D is not dependable. Unfortunately, herbicides that give effective initial control of bitterweed and offer residual herbicidal action against bitterweed (picloram at 0.5 and 1.0 lb/acre and 2,4,5-T + picloram at 0.5 and 1.0 lb/acre) are most detrimental to associated forbs.

Data on effect of these herbicides on species composition of forbs have been collected but are not summarized at this time.

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TABLE 1. DENSITY (NO./0.1 m^2) OF EDWARDS PLATEAU FORBS ON MARCH 30 - APRIL 1, 1977 AS AFFECTED BY GROUND APPLICATION OF VARIOUS HERBICIDES IN DECEMBER, 1976 FOR BITTERWEED CONTROL 1/

Treatments	Rate (lb/acre A.E.)	Mean Forb Density	
		No./0.1 m^2	% of Unsprayed
Picloram	1.0	1.0	3.6
2,4,5-T + picloram	0.5	2.8	10.1
2,4,5-T + picloram	1.0	3.9	14.1
Picloram	0.5	4.8	17.4
Picloram	0.25	9.1	33.0
Dicamba + 2,4-D	1.0	10.6	38.4
2,4-D ester	1.0	13.4	48.6
Tebuthiuron	0.5	16.9	61.2
Tebuthiuron	1.0	19.6	71.0
Check	(no treatment)	27.6	100.0
Carrier control	diesel oil @ 1.0 gal/acre	32.0	115.9

1/ Averages for three experiments on three different ranches in the Edwards Plateau.

TABLE 2. COOL-SEASON FORB PRODUCTION (LB/ACRE) AS AFFECTED BY AERIAL APPLICATION OF VARIOUS HERBICIDES ON DECEMBER 8, 1976 FOR BITTERWEED CONTROL

Treatments	Rate (lb/acre A.E.)	Cool Season Forb Production	
		lb/acre 1/ (oven-dry)	% Reduction
Control (no treatment)	-	411.5a 2/	0.0
2,4-D ester	1.0	209.5b	49.1
Dicamba + 2,4-D	1.0	192.7b	53.2
2,4,5-T + picloram	0.5	23.9c	94.2
2,4,5-T + picloram	1.0	14.3c	96.5
Picloram	0.5	31.1c	92.4
Picloram	1.0	13.2c	96.8

1/ Data on forb production taken on May 10, 1977.

2/ Means followed by the same letter are not significantly different at the 5% significance level.

KLEINGRASS INDUCED PHOTOSENSITIZATION IN SHEEP

E.M. Bailey, Jr., C.H. Bridges, C.W. Livingston, C.S. Menzies, R.A. Tabor, R.E. Pettit and D. Muchiri*

Panicum coloratum (Kleingrass) was introduced in Texas in the 1950's. After more than ten years of research, Kleingrass 75 was released as the desirable variety through the joint efforts of the Texas Agricultural Experimental Station and the U.S. Soil Conservation Service.

At the present time, several hundred thousand acres of Kleingrass have been planted in Texas. In recent years, Kleingrass has been suspected of causing photosensitization in sheep in some parts of Texas. The objective of the current project will be to investigate the suspected association between the ingestion of Kleingrass and the occurrence of photosensitization under laboratory conditions.

In 1937, Panicum coloratum was suspected of causing photosensitization in sheep in South Africa, and the condition was called dik-oor or geeldikkop.

Recent suspicions on Panicum coloratum causing photosensitization have been expressed.[a] In this report, some lambs on newly mowed Kleingrass pasture developed photosensitization in less than a week. Thus, photosensitization of animals from the ingestion of Kleingrass is a potential problem in some sheep-raising areas in Texas.

Photosensitization (Swell-head) is a disease of sheep which causes considerable economic loss both in animal deaths and in loss of production. Photosensitization is an abnormal blistering and peeling of the skin due to increased sensitivity to sunlight. With 2 or 3 exceptions, there is almost always liver damage associated with this condition so that the liver cannot function properly. The specific liver involvement is due to an inability of the animal to handle biliary excretion of normal metabolic products, either due to swelling of bile ducts or liver cell disfunction. The liver is a hotbed of activity including the breakdown of main chemicals. One of these is chlorophyll, the green pigment of plants. When chlorophyll is not completely broken down, the intermediate products are reactive to sunlight while circulating in the blood stream, even through the skin. The reaction of the circulating chemical with sunlight causes injury to the skin with resulting swelling and other skin problems. The only areas readily exposed to sunlight are

* Respectively, associate professor, The Texas Agricultural Experiment Station (Department of Physiology and Pharmacology); professor, The Texas Agricultural Experiment Station (Department of Veterinary Pathology); professor and resident director of research, The Texas Agricultural Experiment Station, San Angelo; research associate, The Texas Agricultural Experiment Station (Department of Plant Sciences); and research assistant, The Texas Agricultural Experiment Station (Department of Veterinary Physiology and Pharmacology).

[a] Bynum, D.V., Texas A&M University System, District 7, San Angelo, Texas: Written Communication, 1975.

a) ears, b) eyes, c) nose and muzzle, d) anus and vulva, e) bag and teats and f) coronary band of hooves and horns. Abnormal sensitivity of these areas to sunlight causes the swelling of the ears and the lameness associated with photosensitization.

Previous investigations have shown that Kleingrass in the Brazos River Valley does not produce photosensitization in sheep. Additional studies have shown that the flora on Kleingrass in the two geographical areas of concern are different. A known photosensitizing fungus (Pithomyces chartarum) has been isolated from the San Angelo area. Proposed research on Kleingrass will involve two separate studies. One study will be a multi-discipline study involving field experiments and the second will involve controlled laboratory conditions.

Field Studies:

Photosensitization associated with Kleingrass 75 will be studies in a multidisciplinary manner during the summer of 1977. The study will involve the use of groups of sheep grazing 1-acre plots of Kleingrass along with several treatment regimens in an effort to control the growth of Pithomyces chartarum, a photosensitizing inducing agent.

A minimum of 15 groups of 4 sheep each will be utilized in this study. The sheep will be examined and bled before initiation of the grazing trials in order to establish baseline data and the normalcy of the animals. The sheep will be examined daily and bled at least once a week during the 13-week grazing period. The sheep, in an individual treatment group, may be bled more frequently if a member of the group develops photosensitization. Those animals, or groups of animals, developing photosensitization will be necropsied in an effort to more adequately define the disease syndrome.

This study should establish the following:

1. Relationship of Pithomyces chartarum to photosensitization associated with Kleingrass.

2. An adequate description of the disease as it occurs in West Texas associated with Kleingrass 75.

3. The economical and management feasibility of control of Pithomyces chartarum and the photosensitization associated with Kleingrass 75 by topical application of anti-fungal agents.

Laboratory Studies:

A minimum of four healthy rabbits of the same sex and age will be kept in separate metal cages. Initially, finely ground alfalfa rabbit pellets[b] will be

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[b] Chickasha Cotton Oil Company, Fort Worth, Texas.

fed *ad libitum*, and adequate fresh drinking water will also be provided. During this control period, all the rabbits will be exposed to long wavelength ultraviolet light[c] daily. Each rabbit will then be weighed, and adequate blood samples collected weekly for four weeks. The serum will be separated by centrifugation, and SDH activity in each serum sample determined separately using a commercial test kit.[d] The SDH determinations will be recorded as baseline levels for each rabbit. Thus, each animal will act as its own control.

The feed will then be changed to a mixture of equal weights of finely ground alfalfa rabbit pellets and Kleingrass seeds and stems. The Kleingrass will be in the dry form and finely ground. The rabbits will also be exposed to long wavelength ultraviolet light daily as in the control period. Serum SDH determinations and body weight measurements will be made weekly for eight weeks. The rabbits will also be observed for any changes in their clinical appearance during the test period.

The experimentation with sheep will be conducted using four mature, crossbred males and females. These animals will be kept in open field enclosures where they will be exposed to sunlight. The control diet will consist of hay which will be fed *ad libitum* in troughs. Mineral supplement, grain and adequate drinking water will also be provided.

Rumen fistulas will be surgically prepared in two sheep after which each of the test animals will be weighed weekly and adequate blood samples collected at the time of weighing. Sorbitol dehydrogenase activity in the serum of each sheep will be determined as in the rabbits to establish baseline levels. As with the rabbits, each sheep will act as its own control.

After the control period, the two sheep with rumen fistuals will be dosed with cultures of *Pithomyces chartarum* isolated from suspected Kleingrass. These animals will be fed the control diet during the post dosing period. The third sheep will be fed dry, ground Kleingrass which will replace the control diet during the test period, while the fourth sheep will act as an additional control. The body weight measurements and serum SDH activity determinations will be recorded for a period of eight weeks. The animals will also be observed for any changes in their clinical picture during the test period.

Animals that develop signs of photosensitization will be euthanitized using sodium pentobarbital solution. A post-mortem will then be conducted on all these animals immediately after euthanasia and the findings recorded. Appropriate tissue slices will be placed in 10% buffered formaldehyde solution at the time of the post-mortem examination and preserved for histology. The histological examination will be carried out using thin sections stained with hematoxylin and eosin or other appropriate stains.

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[c] UVL-56 (Blak-Ray[R]), Ultraviolet Products, Inc., San Gabriel, California.

[d] Sigma Chemical Company, St. Louis, Missouri.

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HARD YELLOW LIVER (HEPATIC FATTY CIRRHOSIS) IN RUMINANTS

E. M. Bailey, Jr., Darrel M. Ueckert, and Gary L. Adams*

Hard Yellow Liver Disease occurs sporadically in sheep, cattle, goats and antelope in a definite area in West Texas that covers parts of five to seven counties. The disease occurs at 4- to 7-year intervals and usually affects practically all of the ruminants in a pasture. Efforts to transmit the disease have failed; it appears to be a disease of toxic origin. The disease appears be due to an anti-lipotropic agent which allows excessive accumulation of fat in the liver. The excessive fat causes rupture of the liver cells, followed by a gradual destruction of normal liver and cirrhosis. When the amount of functioning liver is reduced below that required by the body, the animal starts exhibiting signs of illness. Approximately 80 different plants from the area where HYL occurs have been fed in various amounts to sheep but have not reproduced typical HYL.

The current study was initiated in November 1976. Twenty-five head of pregnant ewes were purchased by the Hard Yellow Liver Committee to be placed on 137 acres of land furnished by Mr. E. G. Cauble, Jr. The sheep were bled, wormed, weighed and identified. Eight of the ewes were chosen randomly and their livers visually examined and surgically biopsied to determine the status of the livers morphologically as well as functionally. All animals will be bled monthly for monitoring liver function, and the same eight ewes will be biopsied at three-month intervals. Any of the others will be biopsied if indications of HYL appear. At the end of the experimental period, all ewes including offspring will be slaughtered and the livers examined for evidence of HYL or any other liver injury. A new group of ewes will be placed on the experimental pasture each year.

Simultaneously with the animal trials, forage surveys are being made periodically under the supervision of Dr. Darrel Ueckert of the San Angelo Station. In addition, fecal samples will be taken and preserved for later investigations to aid in identifying the types and estimated quantities of plants consumed. Attempts will be made to correlate the occurrence of the HYL injury with the flora being ingested by the affected ewes as well as gain information concerning the environmental factors such as temperature and rainfall.

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*Respectively, associate professor, The Texas Agricultural Experiment Station (Department of Veterinary Physiology and Pharmacology); associate professor, The Texas Agricultural Experiment Station (Department of Range Science); and associate professor, The Texas Agricultural Experiment Station (Department of Veterinary Pathology).

PR-3461

PROPOSED PREPARATION OF BLUETONGUE VIRUS MULTIVALENT MODIFIED LIVE VIRUS VACCINE

S. McConnell, L. C. Grumbles, C. W. Livingston*

Bluetongue has become an important economic disease of the sheep and cattle industries in Texas in the past few years. Field evidence indicates that the decrease in clinical disease of Bluetongue in vaccinated and unvaccinated flocks has increased. The increase in vaccinated flocks has been concurrent with the withdrawal of the old cutter egg attenuated vaccine.

Identification of several Bluetongue virus types from clinical outbreaks in the past 2 years in the western states indicates that types 10, 11, 17, and 13 are all active in disease outbreaks.[1/] Most of the outbreaks recently occurring have been attributed to type 17. As a consequence of the increased activities of the virus in the field, a pilot study has been initiated to produce a multivalent modified live virus vaccine for use in Texas. Each of the known types of virus has been collected, adapted to cell culture, and plaque purified three times to eliminate adventitious agents. The primary seed after adaptation and plaque purification have been stored at -80C and in liquid nitrogen for subsequent use.

Two of the four virus types have been subjected to rapid passage in cell culture in an attempt to effect attenuation. At the tenth rapid passage level, the virus pools were assayed in suckling mice and in susceptible sheep for evidence of virulence. Exposed sheep were monitored daily for evidence of clinical disease and blood collected before exposure and 28 days after exposure to assay for evidence of antibody induction. Preliminary results indicate that the product is immunogenic but not avirulent. The attenuation and efficacy of these products will be tested at periodic intervals to detect that point at which effective attenuation without loss of immunogenicity has occurred.

Plaque purified pools of each of the international types of Bluetongue virus have been inoculated into gnotobiotic sheep or goats to produce reference grade antisera for future studies. These reference grade antisera have been tested for antibody content and log neutralizing indices for each specimen established. Further testing is in progress, and the reference antisera will be used to identify and type viruses isolated for future Bluetongue disease outbreaks. This investigation is very preliminary, and satisfactory vaccines for use under field conditions will not be available for an undetermined period of time. A thorough evaluation of each product must be made before extensive field testing is attempted.

1/ Report of the Committee of Sheep and Goats; in Proceedings, Eightieth Annual Meeting, U. S. Animal Health Association. Miami Beach, Florida, November, 1976.

* Respectively, professor, professor and head, The Texas Agricultural Experiment Station (Department of Veterinary Microbiology); and professor, The Texas Agricultural Experiment Station, San Angelo.

PR-3462

GASTRO-INTESTINAL PARASITES OF SHEEP AND GOATS

R. R. Bell and T. M. Craig*

Internal parasites are a continuing problem for sheep and goat producers. The severity of the problem varies from year to year and between months within years. An epidemiologic study of gastro-intestinal parasites of sheep was conducted at the Texas Agricultural Experiment Station at Sonora in 1975 and 1976. This study compared the parasite burdens of lambs reared on pasture versus those maintained free of parasites except for an 18-day grazing period each month.

RESULTS AND DISCUSSION

Results indicate that sheep acquire infections of Haemonchus, Trichostrongylus and Strongyloides in the months of May through August and those of Nematodirus primarily March through August. Populations of worms found in the abomasum and small intestine during other times of the year are due to the maturation of larvae which are acquired during these months (March/May through August) and remain in a state of arrested development. Arrested development is a mechanism whereby parasites are able to survive periods of unfavorable climatic conditions by remaining within the host in an inactive state. When more favorable environmental conditions occur, the arrested larvae resume development. While larvae are in the arrested state, the sheep cannot express its resistence to infection, nor are the commonly utilized anthelmintics of great value in terminating infection. A high percentage of Haemonchus larvae acquired from pasture during May and June and those of Nematodirus during March, April and May underwent arrested development. Termination of the arrested state and continued development occurred throughout the year, but peaked in the early spring.

SUMMARY

This study confirmed that Haemonchus contortus, the barber pole worm, is the most important sheep parasite in the Edwards Plateau region of Texas, and research is being carried out to determine the most economically feasible method of controlling this parasite. During lactation, ewes are unable to mount a normal resistance against gastro-intestinal parasites and in as much as few larvae are thought to over-winter in pastures on the Edwards Plateau, the emergence of arrested larvae during the spring are thought to contribute the primary challenge to susceptable lambs on pasture. Ewes were treated with a commonly used anthelmintic at the time the lambs were docked. Both ewes and lambs are being monitored for the number of parasite eggs being produced and the response of the sheep to the parasites. Thus far, treated ewes indicate a significantly lower worm production than non-treated ewes, but the effects on lambs has not yet been ascertained.

*Respectively, professor, The Texas Agricultural Experiment Station (Department of Veterinary Parasitology); and assistant professor, Department of Veterinary Parasitology, Texas A&M University.

SEROLOGIC EVIDENCE OF A NEW GOAT HERPESVIRUS IN TEXAS ANGORA GOATS

C. W. Livingston, Jr., Betty B. Gauer and S. McConnell*

In 1974-1975 a new herpesvirus was isolated from Angora and French Alpine goats in California.[1,3] The disease was characterized by a rapid onset with inappetance, dyspnea, evidence of abdominal pain and presence of blood-stained fluid feces. Necrotic and ulcerative lesions occurred in the gastrointestinal tract particularly in the cecum and cephalic portion of the colon. Experimental inoculation of pregnant does resulted in abortion.[2] Kids inoculated experimentally had marked central nervous system depression with nasal and ocular discharges. The California workers reported that the disease condition was more severe in young goats than in mature goats.[2]

Case History 1

On January 19, 1976 a rancher at Sonora, Texas found several Angora nannies which had recently aborted. Abortion was not observed the previous year in this flock of approximately 1,000 nannies. Vaginal specimens (1547-1551) were obtained on sterile cotton swabs for cultural purposes and blood serum obtained for serological tests. On February 19, 1976, 3 aborted fetuses (1571, 1572, 1573) were obtained from the same flock. The owner collected and froze the fetuses holding them for 10 days at -20°C before bringing them to the laboratory.

Case History 2

On April 4, 1976 an Angora billy kid, 1639, was obtained from the Texas A&M University Experimental flock at Brady, Texas. All kids and nannies were on range land. A large number of the kids were scouring. Blood serum and feces were obtained from the billy kid for diagnostic purposes. On June 22, 1976, 1672, a young Spanish doe from the same flock with swollen vulva and vaginal discharge was admitted to the laboratory. Approximately 10% of the does were having a similar disease problem.

Case History 3

Angora kids, 1738-1742, raised in a flock at the San Angelo Research and Extension Center, had been treated for clinical coccidiosis on September 14, 1976 with sulfamethazine. Blood serum was obtained for serological tests.

METHODS AND MATERIALS

Bacterial Isolation

All specimens were cultured for the presence of bacteria and Mycoplasmatales using blood agar plates, Hayflicks mycoplasma medium and modified Hayflick mycoplasma medium.

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*Respectively, professor and research associate, The Texas Agricultural Experiment Station, San Angelo; and professor, The Texas Agricultural Experiment Station (Department of Veterinary Microbiology).

Viral Isolation

The tissue specimens from the goats for virus isolation were triturated and checked for sterility in thioglycolate medium and on blood agar. All specimens were stored at -90° until used.

Each specimen was screened for virus in a primary goat testicle cell line in an undiluted and $\log_{10}$ dilution scheme.

Infected cell monolayers were observed daily for cytopathogenic effect (CPE) and blind passaged three times before being considered negative. The cell monolayers were frozen and thawed prior to blind passage to effect intracellular virus release.

Serum Antibody

The sera from several of the goats assayed for virus were also tested for evidence of specific antibody to goat herpesvirus using varying serum and constant virus analysis. The virus challenge inoculum* varied between 10 and 32 $CCID_{50}$ (cell culture infective $doses_{50}$), a dose sensitive enough to detect even a minimal threshold of antibody. Serum was reacted with virus for 2 hours at 35°C, adsorbed onto the cell monolayer for 1 hour and then maintenance medium was added. All cultures were incubated at 35°C. Tests were terminated on day 7 and results recorded.

RESULTS AND DISCUSSION

Bacterial Isolation

L-forms of bacteria were isolated from the vaginal specimens of goats 1549, 1550 and 1551. No significant bacterial isolations were made. A ureaplasma was isolated from goat 1689 with a vaginal discharge.

Viral Isolations

All viral isolation attempts were negative (Table 1).

Serological Results

All five goats 1547-1551, from the Sonora flock had positive serum titers to the California goat herpesvirus. The Spanish doe 1639 from the Texas A&M University Ranch at Brady, Texas also had antibodies to the goat herpesvirus (Table 2).

All other specimens were negative for goat herpesvirus antibodies. It is noteworthy that the control groups of goats, 1738-1742 (those with clinical coccidiosis), were negative to goat herpesvirus antibodies. These goats had been raised in a closed flock and should not have been exposed to the goat herpesvirus.

From the evidence submitted, it is likely that the California goat herpesvirus is present in Texas and may be producing losses in Texas goats.

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*Goat herpesvirus was obtained from Dr. McKercher, Univ. of California, Davis, California.

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TABLE 1. VIRUS ISOLATION

Specimen Number	Tissue Specimen	Results 1P	2P	3P
1548	Vaginal swab	-	-	-
1549	Vaginal swab	-	-	-
1550	Vaginal swab	-	-	-
1551	Vaginal swab	-	-	-
1571	Liver, peritoneal fluid, stomach	-	-	-
1572	Liver, peritoneal fluid, stomach	-	-	-
1573	Liver, stomach	-	-	-
1575	Liver	-	-	-
1639	Cecum, colon	-	-	-
1672	Vaginal mucosa	-	-	-

TABLE 2. ANTIBODY TO GOAT HERPESVIRUS

Specimen Number	Serum Dilution	Virus Titer $CCID_{50}$	Antibody Present
1547	1:5	25-32	yes
1548	1:5	25-32	yes
1549	1:5	25-32	yes
1550	1:5	25-32	yes
1551	1:5	25-32	yes
1639	1:5	25-32	yes
1738	1:5	25-32	no
1739	1:5	25-32	no
1740	1:5	25-32	no
1741	1:5	25-32	no
1742	1:5	25-32	no

ALTERNATIVE PROCESSING METHODS FOR LAMB CARCASSES

R. A. Bowling, G. C. Smith, T. R. Dutson, Z. L. Carpenter
and W. H. Marshall

INTRODUCTION

In recent years, chilling methods have become much more efficient and thus more severe and have been profitable because they prevent carcass shrink and bacterial decomposition; however, these advancements have seemingly been made without careful evaluation of energy expenditures or alternative processing methods. High postmortem temperatures (2), electrical stimulation (6), delayed chilling (5) and extremely rapid chilling (3) have been investigated, but their efficacy has not been fully determined. Lamb carcasses are small and chilling the carcass to 32°F is not normally a problem in conventional (32°± 5°F) chilling facilities; however, certain alternative processing methods could reduce energy and labor expenditures and enhance the quality of the lean tissue.

Although New Zealand is a relatively small country, it is the principal exporter of meat - 656 tons or 11.9% of the world total (1). Lamb production in the U.S. between 1925 and 1975 fell from 15,430 thousand to 8,057 thousand head - almost half; however, lamb and mutton imports were 6.2% of total domestic production in 1975. New Zealand packers have used a variety of processing methods to accelerate carcass conditioning, retard carcass shrinkage and bacterial growth and enhance the quality and processing characteristics of lamb and mutton. New Zealand meat production has increased 21% during the past 15 years; yet per capita consumption in that country over the same period has increased only 6%. Accelerated conditioning has enabled New Zealand packers to process a higher quality export product in less time, more economically and with less energy expenditure. If U.S. packers were to implement certain alternative processing methods, an added economy and increased palatability might be realized without substantially increasing processing time. The question is, are U.S. packers and producers willing to abandon conventional processing methods to deter decreasing domestic production and consumption of lamb and mutton?

EXPERIMENTAL PROCEDURE

Eighty-four ewe, wether or ram lambs (less than 1 year of age) were slaughtered by conventional methods and the carcasses maintained at six prerigor storage temperatures from +120°F to -30°F (at 30°F intervals) for various periods of time (Table 1). Twelve of the lamb carcasses were electrically stimulated (ES) with 120 volts, 5 amps until no further contraction was observed and placed in the -30°F treatment (Table 1). Carcass temperature was monitored continuously by use of a recording thermometer and copper constantine thermocouples placed in the center of the <u>longissimus dorsi</u> at the 12th rib. Temperature, relative humidity and wind speed were monitored in each treatment chamber during the specified storage period. At the completion of each initial temperature treatment, lamb carcasses of each group were stored for the remainder of the 72-hr period at 30° ± 5°F.

Appropriate weights were obtained at 24-and 72-hr intervals to determine

*Respectively, research assistant, professor, assistant professor, professor, and graduate fellow
(Tom Slick Fellowship), The Texas Agricultural Experiment Station (Department of Animal Science).

carcass shrinkage. USDA quality and yield grade factors (7) were assigned to each lamb carcass 24 hrs postmortem by a three member panel of trained evaluators. In addition, consumer acceptance (8-point scale: 8 = extremely desirable; 1 = extremely undesirable) and lean color (9-point scale: 9 = very light cherry red; 1 = black) were scored 48 hrs postmortem by the same panel.

Muscles for palatability determinations were removed from frozen storage (-30°F), sized (1.2 in. thick), thawed and cooked to an internal temperature of 165°F in a 350°F constant-temperature gas oven. Samples of the cooked LD, BF and SM were scored by a ten-member trained sensory panel for the following characteristics: flavor desirability and overall palatability (8 = extremely desirable; 1 = extremely undesirable), muscle fiber tenderness (8 = extremely tender; 1 = extremely tough) and juiciness (8 = extremely juicy; 1 = extremely dry). Warner-Bratzler shear force measurements for each muscle were obtained in duplicate on four .5 in. cores from cooked chops which had cooled to 70°F. Cooking loss and degree of doneness (10 = extremely rare; 1 = extremely well-done) were monitored on leg and loin chops.

RESULTS AND DISCUSSION

Care was taken to assure that carcasses did not differ in weight, yield grade or quality grade and that cuts were cooked in a manner to minimize differences in cooking loss and degree of doneness (Table 2). Accordingly, differences in lean color, shrink loss and variables associated with palatability and the progress of rigor mortis are assumed to be due to treatment and not due to inherent differences in carcasses or cooking techniques. The muscle color of conventionally chilled lambs was a dark cherry red; however, muscle color (LD) of lambs which were conditioned at +120° was a very light cherry red and the lean was soft and watery. The LD of ES lambs was darker and lower ($P<.05$) in overall acceptance ratings than that from lambs in other treatments.

Rapid chilling, electrical stimulation and other methods of altering the biochemical progress of rigor mortis have been predicated on reduced carcass shrink loss and reduced energy and labor requirements during chilling and subsequent shipping (2). Percentage carcass shrink at 24-hr postmortem was lowest for carcasses conditioned at -30°F, and highest for carcasses conditioned at +120°F and +90°F; however, at 72-hr postmortem, carcasses which were electrically stimulated were higher in shrink loss than carcasses merely chilled at -30°F (Table 2). No consistent trend exists among treatment temperatures for cooking loss, although in 3 of 7 comparisons, loin chops had less cooking loss than leg steaks. Although differences existed in percentage carcass shrink and cooking loss, total juice loss was not different over the range of treatment temperatures, indicating that a fairly constant percentage (∿33%) left the muscle tissue at some point in the processing and cooking cycle. Expressible juice (4) data indicate that carcasses conditioned to have a fast rate of temperature decline and consequently a slower rate of pH decline (0° and -30°F) were higher in water holding capacity than carcasses which had a slow temperature decline and rapid pH decline (Table 3). The LD of lambs conditioned at 0° and -30°F also possessed greater water holding capacity than did the BF or SM of lambs conditioned via the same treatments which similarly implicates rate of temperature and pH decline since mass differences in leg and loin could produce large differences in rate of chill between cuts of different mass and thickness.

Carcass temperatures were monitored for 24 hr postmortem. Carcasses reached a critical temperature (43°-52°F) for cold shortening at: 2 hr (-30° and ES), 3 hr (-30°), 4 hr (0°F), 5½ hr (+30°F) and 12-13 hr for (+60°, +90° or +120°F). Carcasses which were electrically stimulated and stored for 2 hr at -30° chilled more rapidly ($P<.05$) than similarly chilled carcasses. The loin of carcasses which were electrically stimulated had frozen at 3 hr postmortem. Carcasses which were conditioned at high temperatures (+120° and +90°F) were in full rigor when removed from the conditioning chamber at 4 or 6 hrs, indicating that these carcasses were subjected to "rigor shortening." Carcasses chilled at +60°F were not subjected to rigor shortening conditions and did not reach critical temperatures conducive to cold shortening until 16 hr postmortem when ATP and other energy reserves would be low.

Although alternative processing methods may offer distinct advantages in decreasing shrink and reducing processing time, sensory characteristics (Table 4) indicated that the efficacy of certain processing procedures may be overshadowed by decreases in tenderness. Conditioning carcasses at high temperatures (+120° and +90° appears to induce sensory panel toughness and increase shear force in each of the three msucles studied. Carcasses which were conditioned at +60°F were highest in sensory panel tenderness and lowest in shear force requirement for the LD, BF and SM in comparison to lambs conditioned via other methods. Conditioning temperature did not ($P>.05$) affect sensory panel flavor or juiciness ratings among muscles studied.

Conditioning lamb carcasses at +60°F for 8 hr appears to be the optimum conditioning system for reducing energy consumption and increasing tenderness without substantial increases in processing time; however, increased microbial growth and decreased WHC could be processing problems. Electrical stimulation and subsequent freezing does not appear to be advantageous since freezing of stimulated carcasses does not appear to prevent carcass shrink. Although electrical stimulation greatly speeds processing time, energy expenditures during freezing cannot be justified by savings in carcass shrink. Electrical stimulation could, however, be used in combination with delayed chilling (+60°F) and might possibly reduce the delayed chill period, speed processing time and increase tenderness.

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TABLE 1. EXPERIMENTAL DESIGN

Item	Treatment (°F)						
	+120	+90	+60	+30	0	-30	-30+ES[a]
Temperature (°F)	+120 (±5)	+90 (±5)	+60 (±4)	+30 (±4)	0 (±3)	-30 (±3)	-30 (±3)
Conditioning[b] period (hr)	4	6	8	24	0	2	2
Relative humidity (±5%)	70	70	65	80	35	30	30
Number of lambs	12	12	12	12	12	12	12

[a]Electrical stimulation (120 volts, 5 amps, 50 one-second impulses).

[b]Carcasses were conditioned for the specified time period and then stored at +30°F for the remainder of the 72-hr storage period.

TABLE 2. CARCASS TRAITS FOR LAMBS CONDITIONED AT DIFFERENT TEMPERATURES AND COOKING CHARACTERISTICS FOR LOIN AND LEG CHOPS

Item	Treatment (°F)						
	+120	+90	+60	+30	0	-30	-30+ES
Carcass weight, (lb)	56[f]	58[f]	60[f]	54[f]	52[f]	56[f]	52[f]
U.S.D.A. yield grade[a]	3.8[f]	3.8[f]	3.4[f]	3.4[f]	3.2[f]	3.4[f]	3.3[f]
U.S.D.A. quality grade[a]	12.1[f]	12.0[f]	11.8[f]	11.6[f]	11.3[f]	12.3[f]	11.2[f]
Loin chop, lean color[b]	8.8[f]	5.6[gh]	6.3[g]	5.6[gh]	6.3[g]	5.6[gh]	5.2[h]
Loin chop, overall appearance[c]	7.4[f]	6.3[g]	5.5[g]	6.3[g]	5.4[g]	5.4[g]	4.2[h]
Carcass shrinkage-24 hr (%)	4.7[f]	4.4[f]	3.0[g]	3.6[fg]	3.3[g]	2.1[h]	2.5[gh]
Carcass shrinkage-72 hr (%)	5.7[fg]	5.2[fg]	5.2[fg]	6.3[f]	6.0[f]	4.6[g]	6.1[f]
Loin chop, cooking loss (%)	28.2[f]	26.1[fg]	27.4[f]	28.5[f]	24.8[g]	29.0[f]	26.3[fg]
Leg chop, cooking loss (%)	28.6[f]	29.6[f]	26.8[f]	29.5[f]	28.4[f]	28.6[f]	30.1[f]
Combined weight loss (%)[d]	34.1[f]	33.7[f]	32.3[f]	35.3[f]	32.6[f]	33.4[f]	34.3[f]
Loin chop, degree of doneness[e]	4.1[f]	4.2[f]	3.9[f]	4.3[f]	4.0[f]	3.9[f]	4.1[f]
Leg chop, degree of doneness[e]	4.3[f]	4.1[f]	4.0[f]	4.3[f]	4.0[f]	4.1[f]	4.2[f]

[a]USDA (1969) standards. A yield grade of 3.0 indicates 45.5% of carcasses weight as boneless closely trimmed major cuts. A quality grade of 12 is high-Choice; a quality grade of 11 is average-Choice.

[b]9 = very bright cherry red; 1 = very dark red or purple.

[c]8 = extremely desirable; 1 = extremely undesirable.

[d]Combined weight loss = carcass shrinkage (72 hr) plus average cooking loss of loin and leg chops

[e]10 = extremely rare; 1 = extremely well-done.

[fgh]Means in the same row bearing a common superscript letter are not different (P>.05).

TABLE 3. HISTOLOGICAL, PHYSICAL AND CHEMICAL TRAITS FOR LAMBS IN EACH TREATMENT

Item	Treatment (°F)						
	+120	+90	+60	+30	0	-30	-30+ES
Expressible juice, LD (%)[a]	67[f]	59[ef]	63[f]	53[e]	40[d]	38[d]	53[e]
Expressible juice, BF (%)[a]	63[e]	58[e]	61[e]	53[de]	48[d]	45[d]	53[de]
Expressible juice, SM (%)[a]	65[e]	59[e]	65[e]	54[de]	51[d]	48[d]	56[e]
72 hr pH value, LD	5.82[d]	5.64[e]	5.60[e]	5.71[e]	5.69[e]	5.69[e]	5.71[e]
72 hr pH value, BF	5.93[d]	5.80[e]	5.74[e]	5.73[e]	5.78[e]	5.85[e]	5.82[e]
72 hr pH value, SM	6.17[d]	5.95[e]	5.88[e]	5.98[e]	5.88[e]	5.98[e]	5.90[e]
Rate of pH decline, LD (x 10-4)[b]	363[d]	348[de]	408[d]	290[e]	249[e]	162[f]	416[d]
Rate of pH decline, BF (x 10-4)[b]	312[d]	324[d]	314[d]	207[e]	145[f]	133[f]	271[d]
Rate of ATP decline, LD[c]	1.346[e]	.550[f]	.576[f]	.907[ef]	.227[f]	.613[f]	2.043[d]
Rate of ATP decline, BF[c]	1.756[d]	.780[f]	.810[f]	1.070[ef]	1.316[e]	1.416[e]	1.457[e]

[a]Grau and Hamm (1953)

[b]Units (x 10^{-4}) per 1 hr from 1st to 24th hr postmortem.

[c]µmoles of ATP hydrolyzed per 1 hr from 1st to 3rd hr postmortem.

[def]Means in the same row bearing a common superscript letter are not different (P>.05).

TABLE 4. SENSORY PANEL RATINGS AND SHEAR FORCE VALUES FOR LAMBS IN EACH TREATMENT

Treatment	Sensory panel ratings: Juiciness[d]	Flavor[d]	Tenderness[d]	Overall[d] palatability	Shear force (lb)
	Longissimus dorsi				
+120	4.7[a]	5.5[a]	3.4[c]	3.7[b]	15.7[a]
+90	4.8[a]	5.7[a]	5.2[b]	5.0[a]	10.6[b]
+60	5.1[a]	5.4[a]	6.8[a]	5.4[a]	6.8[c]
+30	5.7[a]	5.5[a]	6.1[a]	5.8[a]	7.7[bc]
0	5.2[a]	5.8[a]	6.2[a]	5.3[a]	8.4[bc]
-30	5.1[a]	5.8[a]	6.6[a]	5.9[a]	7.1[c]
-30+ES	5.0[a]	6.0[a]	6.4[a]	5.5[a]	6.6[c]
	Biceps femoris				
+120	4.5[a]	5.3[a]	4.0[c]	4.1[b]	12.6[a]
+90	5.1[a]	6.1[a]	5.5[b]	5.7[a]	8.8[b]
+60	4.5[a]	5.6[a]	6.8[a]	5.7[a]	6.6[c]
+30	4.5[a]	5.2[a]	6.1[a]	5.1[a]	7.1[c]
0	4.8[a]	6.0[a]	6.0[a]	5.5[a]	9.5[b]
-30	4.8[a]	5.7[a]	6.1[a]	5.6[a]	7.7[bc]
-30+ES	4.6[a]	6.1[a]	6.3[a]	5.8[a]	9.7[b]
	Semimembranosus				
+120	4.3[a]	5.5[a]	4.0[b]	4.2[b]	11.7[a]
+90	4.9[a]	5.6[a]	4.3[b]	4.6[ab]	10.8[a]
+60	4.6[a]	5.4[a]	5.9[a]	5.0[a]	7.5[c]
+30	4.6[a]	5.4[a]	5.4[ab]	5.1[a]	8.2[bc]
0	4.8[a]	5.9[a]	4.8[b]	5.0[a]	12.6[a]
-30	4.9[a]	5.5[a]	4.7[b]	4.8[a]	9.7[b]
-30+ES	4.8[a]	5.8[a]	5.3[ab]	5.3[a]	10.8[a]

[abc]Means in the same column and for the same muscle bearing a common superscript are not different ($P>.05$).

[d]8 = extremely juicy, extremely desirable in flavor, extremely tender and extremely desirable overall; 1 = extremely dry, extremely undesirable in flavor, extremely tough and extremely undesirable overall.

EFFECT OF ELECTRICAL STIMULATION ON PALATABILITY OF LAMB AND GOAT MEAT

J. W. Savell, G. C. Smith, Z. L. Carpenter and T. R. Dutson*

INTRODUCTION

One method for increasing tenderness and/or preventing cold shortening exists in the form of electrical stimulation of the carcass shortly following slaughter. It is suggested that electrical stimulation could be used to prevent cold-shortening or to increase the rate of conditioning of carcasses (1, 3, 4). Substantial increases in tenderness of lamb as a result of the use of electrical stimulation have been previously reported (3). Electrical stimulation would not disrupt product flow through a plant, requires little time and does not affect the appearance of the carcass.

Previous studies of this technique have used electrical currents of 250 to 3600 volts. The present study was conducted to investigate the use of a commercially available low-voltage stunning device to electrically stimulate lamb and goat carcasses.

EXPERIMENTAL

Fourteen lambs and 11 goats were exsanguinated[1], dressed, split into sides, and the left side of each carcass was subjected to electrical stimulation within 1 hr post-exsanguination. The source of stimulation was an "Electro-Sting" electrical stunner, Model No. 160, Type ESS. The left side of each lamb and goat was placed on a cutting table, and the hog stunning attachments was aligned in each of three positions: (1) one electrode was located on the outside of the leg and the other electrode was located on the middle of the loin; (2) one electrode was placed on the sirloin end of the loin and the other on the shoulder end of the loin; (3) one electrode was placed on the middle of the loin and the other in the middle of the shoulder. Each of these 3 sections of the carcass was electrically stimulated for four 8-sec intervals, with the central area (position 2) receiving one additional 4-sec stimulation, for a total of 100 sec. The current of the electrical impulse was single phase, 100 volts, 5 amps and 50 cycles.

Individual chops (1.0 in. thick) were removed from the leg, loin and shoulder, wrapped in polyethylene-coated paper, frozen (-30°F), stored (-10°F). The chops were cooked from the frozen state in a 350°F electric oven to an internal temperature of 167°F. One leg chop (biceps femoris and semimembranosus) and two chops from the loin (longissimus) were evaluated by a trained 8-member sensory panel and one chop from each leg, loin and shoulder (longissimus) were utilized for shear force determinations by use of the Warner-Bratzler shear.

RESULTS

Means and standard deviations for certain carcass traits for the two species are in Table 1. Palatability ratings, shear force values and sarcomere lengths for longissimus, biceps femoris and semimembranosus muscles from lamb carcasses are reported in Table 2. There were significant differences

[1]Drained of blood.

*Respectively, graduate assistant, professors, and associate professor, The Texas Agricultural Experiment Station (Department of Animal Science).

among loin samples in favor of the electrically-stimulated sides for connective tissue amount and overall tenderness ratings ($P<.01$) and for overall palatability ratings and shear force values ($P<.05$). No significant differences ($P>.25$) were observed between samples from treated and untreated sides for flavor, juiciness or sarcomere length. Samples from the legs of electrically-stimulated sides were significantly different from those of control sides in only two traits; juiciness ($P<.10$) and Warner-Bratzler shear force values of the _biceps femoris_ muscle ($P<.05$). All other traits for the leg and shear force values for the longissimus muscle from the shoulder were not significantly ($P>.25$) different between treated and untreated sides.

Comparisons of palatability ratings, shear force values and sarcomere lengths for samples from goat carcasses are presented in Table 3. For the loins, electrical-stimulation resulted in significant increases in ratings for connective tissue amount and overall tenderness ($P<.01$), overall palatability and sarcomere length ($P<.05$); and significant decreases in shear force values ($P<.01$) when samples from treated sides were compared to those from untreated sides. For the legs, electrical-stimulation resulted in significant increases in connective tissue amount rating ($P<.05$), juiciness ($P<.15$) and overall palatability ($P<.10$); and significant decreases in shear force values for the _semimembranosus_ muscle ($P<.05$). No significant differences ($P>.25$) were observed between treated and control sides for shear force of the _longissimus_ muscle from the shoulder region.

DISCUSSION

In the present study only one instance of significant increases in sarcomere length occurred (goats, Table 3) while both species exhibited significant increases of greater than 20% in tenderness of the _longissimus_ muscle. One possible explanation for the enhanced tenderness without increase in sarcomere length involves enzymatic processes. A more rapid drop in pH occurred with high temperature conditioning which agrees with earlier work (2, 5). With a lower pH at a high temperature, disruption of the lysosomal membrane and the concurrent release of acid hydrolases into the muscle tissue occurs (5). Storage of carcasses at an elevated temperature not only stimulates the release of lysosomal enzymes but also increases the activity of these enzymes during the conditioning period because the combined effect of high temperatures and low pH optimizes conditions for these enzymes (5). The rapid lowering of pH while temperatures were still high may have caused the release of the lysosomal enzymes. Since the goat carcasses had little subcutaneous fat and/or muscle mass, cold-shortening may have occurred (6) in the untreated sides whereas electrical stimulation could have caused a shorter delay phase of rigor, a more rapid onset phase and a concomitant "locking" of the fibers before the effects of cold could cause as much contraction to occur as was possible in the control sides.

The effect of electrical stimulation on tenderness improvement was not consistent throughout the carcass. Results of shear force measurements indicated that electrical stimulation resulted in substantial improvements in tenderness in the loin region (_longissimus_ muscle) while sporadic results from differences in the electrical stimuli received by each muscle. Either factor or a combination of both factors could explain the inconsistent results in tenderization observed in these data.

CONCLUSION

Based on the results of this experiment: (1) electrical stimulation can be utilized as a method for increasing the tenderness of certain muscles from lamb and goat carcasses. (2) A relatively inexpensive and easily obtained commercial stunning device can be used effectively for electrical stimulation of carcasses.

ACKNOWLEDGMENTS

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TABLE 1. MEANS AND STANDARD DEVIATIONS FOR CERTAIN CARCASS TRAITS

Trait	Lamb (n=14)		Goat (n=11)	
	Mean	S.D.	Mean	S.D.
Carcass weight, lb.	68.3	10.6	39.8	4.2
USDA quality grade[a]	12.9	1.3	6.1	1.3
USDA yield grade	3.12	0.70	2.65	0.35
Fat thickness-12th rib, in.	0.13	0.04	0.02	0.01
USDA leg conformation[a]	12.1	1.1	5.3	1.1

[a]Coded as follows: Avg. Prime = 14, Avg. Choice = 11, Avg. Good = 8 Avg. Utility = 5. All goats were graded using grade standards for lamb carcasses.

TABLE 2. COMPARISON OF PALATABILITY RATINGS, SHEAR FORCE VALUES AND SARCOMERE LENGTHS FOR LAMB CARCASSES

Trait	Electrically-stimulated		Untreated (control)		Level of Probability[a]	Difference[b] (%)
	Mean	C.V.	Mean	C.V.		
Loin						
Flavor rating[c]	6.0	4.10	6.0	7.85	N.S.	0.00
Juiciness rating[c]	4.8	20.96	4.8	12.50	N.S.	0.00
Tenderness ratings						
Connective tissue amount[d]	7.0	6.81	6.4	8.45	P<.01	9.38
Overall tenderness[c]	6.7	8.05	6.0	12.97	P<.01	11.67
Overall palatability[c]	6.0	7.39	5.4	12.43	P<.05	11.11
Shear force (longissimus), lb.	6.3	26.20	8.4	38.33	P<.05	25.00
Sarcomere length (μm)	1.83	5.72	1.80	3.06	N.S.	1.67
Leg						
Flavor rating	5.7	8.61	5.7	11.16	N.S.	0.00
Juiciness rating	5.9	11.90	5.4	13.16	P<.10	9.26
Tenderness ratings						
Connective tissue amount	5.9	13.31	6.1	15.72	N.S.	-3.28
Overall tenderness	5.4	20.48	5.3	26.05	N.S.	1.89
Overall palatability	5.3	16.88	5.1	19.99	N.S.	3.92
Shear force (biceps femoris), lb.	10.4	28.27	13.0	25.15	P<.05	20.00
Shear force (semimembranosus), lb.	11.6	28.77	12.2	32.50	N.S.	4.91
Shoulder						
Shear force (longissimus), lb.	7.9	33.34	7.9	34.63	N.S.	0.00

[a] Probability that the difference between treatments is statistically significant based on the paired-t analysis, P>.25 was reported as N.S.

[b] Percentage difference computed as electrically-stimulated minus untreated for palatability ratings and sarcomere length; percentage difference for shear force value computed as untreated minus electrically-stimulated divided by untreated.

[c] Means based on 8-point rating scales (8=extremely flavorful, juicy or tender).

[d] Means based on an 8-point rating scale (8=none).

TABLE 3. COMPARISON OF PALATABILITY RATINGS, SHEAR FORCE VALUES AND SARCOMERE LENGTHS FOR GOAT CARCASSES

Trait	Electrically-stimulated		Untreated (control)		Level of Probability[a]	Difference[b] (%)
	Mean	C.V.	Mean	C.V.		
Loin						
Flavor rating[c]	5.6	12.10	5.4	9.67	N.S.	3.70
Juiciness rating[c]	4.9	12.93	5.1	11.26	N.S.	-3.92
Tenderness ratings						
Connective tissue amount[d]	5.5	17.40	4.6	13.60	P<.01	19.57
Overall tenderness[c]	4.5	24.87	3.5	21.12	P<.01	28.57
Overall palatability[c]	4.6	21.99	3.8	20.84	P<.05	17.39
Shear force (longissimus), lb.	10.4	25.36	13.7	29.22	P<.01	24.08
Sarcomere length (μm)	1.85	8.90	1.76	5.25	P<.05	5.11
Leg						
Flavor rating	5.6	5.53	5.5	10.25	N.S.	1.81
Juiciness rating	5.6	8.15	5.3	12.08	P<.15	5.66
Tenderness ratings						
Connective tissue amount	5.0	13.62	4.6	11.45	P<.05	8.69
Overall tenderness	4.2	20.91	3.8	23.03	N.S.	10.53
Overall palatability	4.4	17.26	4.1	17.01	P<.10	7.32
Shear force (biceps femoris), lb.	18.2	32.46	20.2	27.35	P<.15	9.90
Shear force (semimembranosus), lb.	15.4	27.34	19.8	25.99	P<.05	22.22
Shoulder						
Shear force (longissimus), lb.	16.0	32.54	15.5	27.73	N.S.	-3.22

[a]Probability that the difference between treatments in statistically significant based on the paired-t analysis, P>.25 was reported as N.S.

[b]Percentage difference computed as electrically-stimulated minus untreated for palatability ratings and sarcomere length; percentage difference for shear force value computed as untreated minus electrically-stimulated divided by untreated.

[c]Means based on 8-point rating scales (8=extremely flavorful, juicy or tender).

[d]Means based on an 8-point rating scale (8=none).

CENTRALIZED RETAIL FABRICATION OF LAMB LOINS

J. D. Tatum, G. C. Smith and Z. L. Carpenter *

With the identification of more effective systems for maintaining fresh lamb quality during distribution cycles, more attention is focused on the implementation of a centralized processing concept. Presently, approximately 74% of the lamb produced in the U.S. leaves the packer in whole carcass form, 11% as saddles and the remaining 15% as primals, although a three-to five-year projection indicates a trend toward the use of a centralized breaking concept (1). Advantages frequently cited for a centralized breaking concept include (A) reduced transportation costs, (B) more efficient use of labor and by-products, (C) greater merchandising flexibility, (D) improved inventory control and (E) simplification of retail operations (2, 3,4). A relatively recent concept involves the fabrication and packaging of retail cuts prior to distribution, thereby facilitating additional reductions in labor and equipment costs at the retail level. This report summarizes research determining the effects of pre-cutting, reforming and vacuum packaging lamb loins prior to distribution and subsequent retail display.

EXPERIMENTAL PROCEDURE

Sixty-four whole lamb loins were obtained to compare systems for lamb distribution. Thirty-two loins were fabricated into retail chops and reformed into subprimals prior to vacuum packaging, while the remaining loins were vacuum packaged in their intact form. The packaged cuts were placed in cardboard boxes and transported 988 miles in a refrigerated trailer with a thermostat setting of 32°F. Following shipment, the loins were stored for 7, 14, 21 or 28 days in a 32°-35°F cooler. Upon removal from storage, the product was evaluated for muscle color, surface discoloration, subcutaneous fat appearance, odor and overall desirability. Retail loin chops were observed for a period of 4 days under simulated retail display conditions. The retail cuts were evaluated for muscle color, surface discoloration, peripheral discoloration, subcutaneous fat appearance, odor and overall desirability.

RESULTS

A comparison of ratings for muscle color and surface discoloration of retail loin chops from intact loins and pre-cut, reformed loins is presented in Table 1. Muscle color did not differ significantly between intact and pre-cut, reformed loins. Among loins stored for periods longer than 7 days, pre-cut loins sustained significantly ($P<.05$) greater surface discoloration than did intact loins. In addition, significant increases in surface discoloration were observed among pre-cut loins as storage time increased.

Odor and overall desirability ratings for retail loin chops from intact loins and pre-cut, reformed loins are included in Table 2. Pre-cut, reformed loins stored for periods in excess of 7 days had a higher ($P<.05$) incidence of off-odor and were significantly less desirable than were intact loins stored for comparable periods of time. General increases in off-odor

*Respectively, instructor and professors, The Texas Agricultural Experiment Station (Department of Animal Science).

and decreases in overall desirability were observed as storage time increased. It should be noted that the overall desirability ratings for precut loins, stored for periods longer than 7 days, were within an undesirable range following 4 days of retail display.

DISCUSSION

The distribution cycle for fresh lamb in the U.S. ranges from 1 to 10 days, with the majority reaching the consumer 5 to 7 days following slaughter (1). Results of the present investigation indicate that vacuum packaged, pre-cut, reformed loins can be stored for periods up to 7 days without substantial reductions in product quality. Distribution cycles involving storage beyond 7 days, however, resulted in retail cuts which were unacceptable in appearance and odor. Consequently, if extended storage intervals are anticipated, the use of centralized retail fabrication of fresh lamb loins is not recommended.

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TABLE 1. COMPARISON OF MEAN VALUES FOR MUSCLE COLOR AND SURFACE DISCOLORATION OF LOIN CHOPS FROM INTACT LOINS AND PRE-CUT, REFORMED LOINS

Storage interval (days)	Day of retail display	Wholesale cut[f] Intact loins	Wholesale cut[f] Pre-cut, reformed loins
	Muscle Color[a]		
7	1	6.1[c]	6.4[c]
14	1	6.7[c]	5.9[c]
21	1	6.1[c]	6.1[c]
28	1	6.2[c]	6.1[c]
	Surface Discoloration[b]		
7	1	6.3	6.5[c]
14	1	6.6[c]	5.5[d]
21	1	6.3[c]	5.8[d]
28	1	6.2[c]	5.9[d]
7	4	5.3[c]	5.3[c]
14	4	5.6[c]	4.3[de]
21	4	5.6[c]	4.8[cd]
28	4	4.7[d]	4.1[e]

[a]Means based on a 9-point scoring system (9=very light cherry red, 1=black).

[b]Means based on a 7-point scoring system (7=no surface discoloration, 1= complete surface discoloration).

[cde]Means in the same vertical column, within each section, bearing different superscripts, differ significantly (P<.05).

[f]Means on the same horizontal row, underscored by a common line, do not differ (P<.05).

TABLE 2. COMPARISON OF MEAN VALUES FOR ODOR AND OVERALL DESIRABILITY OF LOIN CHOPS FROM INTACT LOINS AND PRE-CUT, REFORMED LOINS

Storage interval (days)	Day of retail display	Wholesale Cut[f] Intact loins	Wholesale Cut[f] Pre-cut, reformed loins
		Odor[a]	
7	4	3.8[c]	3.8[c]
14	4	2.9[d]	3.6[c]
21	4	4.0[c]	3.1[d]
28	4	3.0[d]	2.4[e]
		Overall desirability[b]	
7	1	7.0[c]	6.9[c]
14	1	6.7[c]	5.2[e]
21	1	6.1[d]	4.9[e]
28	1	6.1[d]	5.9[d]
7	4	5.7[c]	5.5[c]
14	4	5.5[c]	3.9[d]
21	4	5.3[c]	4.0[d]
28	4	4.6[d]	4.2[d]

[a]Means based on a 4-point scoring system (4=no detectable off-odor, 1=extreme off-odor).

[b]Means based on an 8-point scoring system (8=extremely desirable, 1=extremely undesirable).

[cde]Means in the same vertical column, within each section, bearing different superscripts, differ significantly (P<.05).

[f]Means on the same horizontal row, underscored by a common line, do not differ (P<.05).

PACKAGING METHODS FOR THE DISTRIBUTION OF LAMB CUTS

L. C. Hall, G. C. Smith, Z. L. Carpenter and F. Christopher*

Lamb loins, reformed lamb loins, and precut, prepackaged lamb chops were vacuum packaged and assigned to storage intervals of 7, 14 or 21 days. Additionally, some precut, prepackaged lamb chops were stored in atmospheres of either 20% CO_2 + 80% N_2, or 40% CO_2 + 60% N_2 and assigned to storage intervals of 7, 14 or 21 days. At the termination of each storage interval, gas analyses of packages and psychrotrophic plate counts, and percentage weight loss values were obtained.

Overall appearance was evaluated on retail cuts over a 5-day period. The percentages of carbon dioxide increased and those of oxygen decreased over storage in packages containing vacuum packaged lamb loins, reformed lamb loins and precut, prepackaged lamb chops. Percentage weight loss values were generally higher for chops stored as precut, prepackaged lamb chops than for vacuum packaged lamb loins. Psychrotrophic bacterial counts obtained from precut, prepackaged lamb chops in modified atmospheres were generally significantly lower than counts obtained from vacuum packaged lamb loin. Precut, prepackaged, lamb chops generally had significantly lower overall appearance ratings than chops from vacuum packaged loins. Chops from reformed lamb loins generally had significantly higher overall appearance ratings than chops from vacuum packaged loins.

INTRODUCTION

One of the key considerations in lamb distribution methods is that areas of production are often a considerable distance from areas of consumption. A substantial amount of the lamb consumed in the United States is still shipped from packer to retailer as carcass lamb, particularly in areas where lamb is more readily consumed. However, in areas where lamb consumption is limited, the shipment of lamb carcasses is a less desirable method of distribution. A new method of distribution of fresh meats known as the centralized breaking-point concept is becoming more popular. This system involves the breaking and fabricating of carcasses into primal, subprimal, or even retail cuts at a centralized location with subsequent shipment to retail outlets. Volz and Marsden (1963) listed advantages of the centralized breaking-point distribution system as: (a) more efficient merchandising of cuts at optimum locations, (b) better inventory control, (c) improved stocking policies, and (d) reduction in transportation costs due to nearly one-third less weight. The vacuum packaging of lamb primal cuts is presently gaining popularity over carcass shipments because of the previously mentioned economic reasons and that vacuum packaging reduces weight losses incurred during shipment and less space is required for shipment than lamb carcass shipments.

It may be possible for primal cuts to be cut into retail cuts, reformed, resembling the primal cut, and vacuum packaged. Shipment of lamb utilizing this concept would enable the package to be opened and the retail cuts placed onto trays and overwrapped, thus eliminating the usual sawing and trimming operation

*Respectively, graduate assistant, professors, and graduate assistant, The Texas Agricultural Experiment Station (Department of Animal Science).

at the retail level.

Research efforts are now being aimed at distribution methods involving the shipment of precut, prepackaged, lamb chops. This method would involve the fabrication of carcasses and primal cuts into retail cuts that would be wrapped ready for retail display at a distribution center and packaged in a modified atmosphere. The shipment of these retail cuts would lead to a substantial savings on labor at the retail outlet since chops could be removed from atomsphere packages and immediately displayed.

Correspondingly, the objective of the present study was to compare vacuum packaged lamb loins to reformed lamb loins, vacuum packaged, precut, prepackaged lamb chops, and precut prepackaged lamb chops stored in one of two modified atmospheres.

EXPERIMENTAL PROCEDURE

Eighteen lamb loins were divided into two groups. Loins assigned to group 1 were vacuum packaged as primal cuts. Loins assigned to group 2 were cut into 2.5 cm chops, placed back together cut surface to cut surface and vacuum packaged as reformed loins. In addition, 81 lamb chops (2.5 cm in thickness) were cut, placed in styrofoam trays and overwrapped with oxygen permeable film (Choicewrap). The precut, prepackaged lamb chops were randomly divided into 3 equal groups. Chops assigned to group 1 were vacuum packaged. Chops assigned to groups 2 and 3 were placed in atmospheres of either 20% CO_2 + 80% N_2 or 40% CO_2 + 60% N_2. All vacuum and atmosphere packaging was performed by use of the CVP atmosphere packaging machine in polyethylene-nylon-surlyn laminated film (oxygen transmission rate: 69cc/m^2/24 hrs.; carbon dioxide transmission rate: 260cc/m^2/24 hrs.). Four loins were microbiologically sampled and cut into chops for initial evaluations. Cuts assigned to each of the 5 packaging treatments were randomly assigned to 1 of 3 storage intervals (7, 14 or 21 days).

At the termination of each storage interval, a 5cc gas sample was drawn into a syringe and immediately injected into a gas chromatograph for analyses of the gases CO_2, O_2, and N_2.

Each package was then opened and stripped of packaging material. Three cuts from each packaging treatment were microbiologically sampled by swabbing a 12.9 cm^2 area utilizing a dacron swab and a sterile aluminum template. Dilutions were made with 0.1% sterile peptone broth. A psychrotrophic plate count was obtained by the spread plate technique with standard plate count agar with subsequent incubation of plates for 10 days at 7°C. Following microbiological sampling, primal lamb loins were weighed and cut in chops (2.5 cm in thickness), placed in styrofoam trays and overwrapped with oxygen permeable film (Choicewrap) for retail display. Reformed lamb loins were weighed, and 3 chops from each reformed loin were placed in styrofoam trays and overwrapped with oxygen permeable film (Choicewrap). All chops stored as precut, precut, prepackaged chops in vacuum packages or in either of the two modified atmospheres were weighed. Precut, prepackaged chops that had been used for microbiological analyses were discarded. The remaining chops were placed in styrofoam trays and overwrapped with oxygen permeable film (Choicewrap).

All retail cuts were then placed under simulated retail case conditons. Subjective evaluations were made by a 3-member trained sensory panel at 24-hr. intervals for 5 consecutive days for total desirability, using an 8-point scale (8=extremely desirable; 1=extremely udesirable).

Analyses of data were accomplished using one-way analysis of variance comparing vacuum packaged lamb loins, or their corresponding retail chops (control), to chops from each of the other packaging treatments, independently, within each of the 3 storage intervals. One-way analysis of variance was performed on data within each packaging treatment over the 4 storage intervals. When significant ($P<.05$) main effects were observed in the analysis of variance, mean separation was accomplished by SNK (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

The relative weight percentages of carbon dioxide, oxygen, and nitrogen from packages of lamb are presented in Table 1. Gas analysis of samples withdrawn from packages containing vacuum packaged loins, reformed loins, and vacuum packaged, precut, prepackaged chops generally exhibited a slow increase in the weight percentage of carbon dioxide with a slow decrease in the weight percentage of oxygen over 21 days of storage. The increase in the percentage of carbon dioxide may account for the inhibitory effect of vacuum packaging on the growth of aerobic spoilage bacteria. The origin of carbon dioxide may be from respiration of meat tissues, respiration of bacteria, release of carbon dioxide from the meat tissues, or any combination of these sources. Gas analysis of samples withdrawn from packages containing precut, prepackaged chops in the modified atmospheres generally showed a slight decrease in the weight percentage of carbon dioxide and an increase in the weight percentage of oxygen over 21 days of storage.

The percentage mean storage weight loss for lamb cuts is presented in Table 2. Chops packaged as precut, prepackaged chops usually had significantly higher percentage weight loss values than vacuum packaged loins. After 21 days of storage, weight loss values for cuts from all packaging treatments were significantly higher than weight loss values from vacuum packaged loins. Few significant differences were noted over storage. The fact that weight loss values were high for precut, prepackaged chops may present problems on retail display, namely unattractive packages due to excessive purge formation and the problem of maintaining constant weight of precut, prepackaged chops.

Psychrotrophic bacteria counts on lamb at the termination of storage are presented in Table 3. Counts obtained from precut, prepackaged chops stored under gaseous atmospheres were significantly lower than counts obtained from vacuum packaged loins after 7, 14 and 21 days of storage. Psychrotrophic counts of vacuum packaged lamb loins and chops and reformed loins showed steady significant increases after 7 days of storage; however, a significant increase in counts did not occur until after 14 days of storage for precut, prepackaged chops stored in a 40% CO_2 - 60% N_2 Atmosphere.

Mean values for overall appearance of retail lamb chops are presented in Table 4. Overall appearance ratings for precut, prepackaged chops were consistently lower than ratings for chops from vacuum packaged loins. The largest decrease in ratings for overall appearance of precut, prepackaged chops occurred between packaging (initial) and 7 days of storage. Chops from reformed lamb loins received significantly higher overall appearance ratings than did chops from vacuum packaged loins in 9 of 15 comparisons.

CONCLUSIONS

Based on the findings of the present study:

1) The packaging, storage, and distribution of lamb cut as reformed lamb loins seems to be an improvement over the vacuum packaging of lamb primals or subprimals primarily from the retail caselife standpoint. Correspondingly the fabrication and trimming of lamb chops at a centralized distribution center could possibly lead to reduced labor at retail outlets.

2) The packaging of precut, prepackaged lamb chops stored in either vacuum packages or in modified atmospheres appears to have no advantages relative to retail caselife or in aiding in the reduction of weight losses.

ACKNOWLEDGMENTS

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TABLE 1. RELATIVE WEIGHT PERCENTAGES OF CARBON DIOXIDE, OXYGEN AND NITROGEN FROM PACKAGES OF LAMB STRATIFIED ACCORDING TO PACKAGING TREATMENT AND STORAGE INTERVAL

Storage interval (days)	Type of gas	Packaging treatment				
		Loins		Precut, Prepackaged Chops		
		Vacuum packaged	Reformed loins	Vacuum packaged	20% CO_2 80% N_2	40% CO_2 60% N_2
Initial	CO_2	1.1[d]	2.1[d]	1.4[b]	16.3[a]	28.6[a]
	O_2	21.7[a]	21.1[a]	21.6[a]	4.1[b]	3.9[b]
	N_2	77.2[c]	76.8[c]	77.1[b]	79.6[a]	67.4[b]
7	CO_2	4.5[c]	4.7[c]	1.4[b]	15.1[a]	29.3[a]
	O_2	15.5[b]	16.0[b]	19.1[b]	5.8[b]	3.6[b]
	N_2	80.0[b]	79.3[bc]	76.2[c]	79.1[a]	67.1[b]
14	CO_2	6.6[b]	6.8[b]	0.5[c]	13.8[a]	28.8[a]
	O_2	9.7[c]	11.4[c]	21.4[a]	6.3[b]	5.1[b]
	N_2	83.7[a]	81.9[b]	78.1[a]	79.9[a]	66.1[b]
21	CO_2	8.9[a]	9.2[a]	8.5[a]	10.9[b]	16.7[b]
	O_2	9.2[c]	2.1[d]	13.4[c]	11.4[a]	12.8[a]
	N_2	81.9[ab]	88.8[a]	78.1[a]	77.6[b]	70.4[a]

[abcd]Means of the same gas type in the same column bearing a common superscript do not differ (P>.05).

TABLE 2. PERCENTAGE MEAN STORAGE LOSS[a] FOR LAMB CUTS STRATIFIED ACCORDING TO PACKAGING TREATMENT AND STORAGE INTERVAL

Storage interval (days)	Packaging treatment[b]				
	Loins		Precut, Prepackaged Chops		
	Vacuum packaged	Reformed Loins	Vacuum packaged	20% CO_2 80% N_2	40% CO_2 60% N_2
7	0.61^{c}	1.06^{c}	0.71^{c}	1.50^{d}	2.27^{c}
14	0.69^{c}	0.65^{c}	0.00^{c}	1.96^{d}	2.84^{c}
21	0.39^{c}	1.03^{c}	0.76^{c}	3.45^{c}	3.25^{c}

[a]Percentage weight loss during storage.

[b]Means within a common storage interval that are underlined are significantly different ($P<.05$) from means obtained from vacuum packaged loins.

[cde]Means in the same column bearing a common superscript do not differ ($P>.05$).

TABLE 3. MEAN VALUES FOR PSYCHROTROPHIC BACTERIA COUNTS[a] OF LAMB AFTER STORAGE STRATIFIED ACCORDING TO PACKAGING TREATMENT AND STORAGE INTERVAL

Storage interval (days)	Packaging treatment[b]				
	Loins		Precut, Prepackaged Chops		
	Vacuum packaged	Reformed loins	Vacuum packaged	20% CO_2 80% N_2	40% CO_2 60% N_2
Initial	2.87^{f}	2.97^{e}	2.97^{e}	2.97^{e}	2.97^{d}
7	3.55^{e}	3.55^{de}	2.96^{e}	2.54^{e}	2.75^{d}
14	5.38^{d}	5.91^{d}	6.17^{d}	4.80^{d}	2.60^{d}
21	7.75^{c}	7.75^{c}	7.28^{c}	6.65^{c}	5.82^{c}

[a]Counts ($\log_{10}$) per 6.45 cm^2.

[b]Means within a common storage interval that are underlined are significantly different ($p<.05$) from means obtained from vacuum packaged loin.

[cde]Means in the same column bearing different superscripts differ ($P<.05$).

TABLE 4. MEAN VALUES FOR OVERALL APPEARANCE[a] OF RETAIL LAMB CHOPS STRATIFIED ACCORDING TO PACKAGING TREATMENTS, STORAGE INTERVAL AND DAY OF RETAIL DISPLAY

Day of retail display	Storage interval (days)	Packaging treatment[b]				
		Loins		Precut, Prepackaged Chops		
		Vacuum packaged	Reformed loins	Vacuum packaged	20% CO_2 80% N_2	40% CO_2 60% N_2
1	Initial	6.5^{c}	6.5^{cd}	6.5^{c}	6.5^{c}	6.5^{c}
	7	4.5^{de}	$\underline{5.9}^{d}$	$\underline{2.6}^{e}$	$\underline{3.5}^{d}$	$\underline{2.6}^{d}$
	14	5.1^{d}	$\underline{7.0}^{c}$	$\underline{2.9}^{d}$	$\underline{2.8}^{e}$	$\underline{2.4}^{d}$
	21	3.8^{e}	$\underline{6.5}^{cd}$	$\underline{2.1}^{e}$	$\underline{2.0}^{f}$	$\underline{2.0}^{d}$
2	Initial	6.1^{c}	6.1^{c}	6.1^{c}	6.1^{c}	6.1^{c}
	7	4.3^{e}	$\underline{5.8}^{cd}$	$\underline{2.8}^{e}$	$\underline{3.0}^{d}$	$\underline{1.9}^{e}$
	14	5.3^{d}	$\underline{6.6}^{c}$	$\underline{4.1}^{d}$	$\underline{3.1}^{d}$	$\underline{3.5}^{d}$
	21	3.4^{f}	$\underline{5.9}^{d}$	$\underline{2.0}^{f}$	$\underline{2.3}^{d}$	$\underline{2.3}^{e}$
3	Initial	4.5^{d}	4.5^{d}	4.5^{c}	4.5^{c}	4.5^{c}
	7	5.7^{c}	$\underline{6.7}^{c}$	$\underline{3.6}^{d}$	$\underline{3.6}^{d}$	$\underline{2.7}^{d}$
	14	4.2^{d}	$\underline{5.3}^{d}$	$\underline{3.3}^{d}$	$\underline{2.7}^{d}$	$\underline{2.9}^{d}$
	21	3.4^{e}	4.6^{d}	$\underline{2.2}^{e}$	$\underline{2.7}^{d}$	$\underline{2.5}^{d}$
4	Initial	4.6^{c}	4.6^{cd}	4.6^{c}	4.6^{c}	4.6^{c}
	7	3.9^{c}	$\underline{5.6}^{c}$	3.0^{d}	3.0^{d}	$\underline{2.5}^{d}$
	14	4.2^{c}	5.0^{cd}	$\underline{3.2}^{d}$	$\underline{2.9}^{d}$	$\underline{2.9}^{d}$
	21	3.7^{c}	3.5^{d}	$\underline{2.6}^{d}$	$\underline{2.6}^{d}$	$\underline{2.3}^{d}$
5	Initial	4.9^{c}	4.9^{cd}	4.9^{c}	4.9^{c}	4.9^{c}
	7	3.9^{c}	$\underline{5.5}^{c}$	3.2^{d}	3.4^{d}	$\underline{2.2}^{d}$
	14	3.5^{c}	5.0^{cd}	2.8^{d}	$\underline{2.3}^{d}$	2.7^{d}
	21	3.4^{c}	3.5^{d}	2.7^{d}	$\underline{2.4}^{d}$	$\underline{2.0}^{d}$

[a] Means based on an 8-point scale (8=extremely desirable; 1=extremely undesirable).

[b] Means within a common storage interval and day of retail display that are underlined are significantly different ($P<.05$) from means obtained from chops from vacuum packaged loins.

[cdef] Means in the same column and same day of display bearing a common superscript do not differ ($P>.05$).

PREDICTION OF WOOL PRODUCTION BASED ON WOOL FOLLICLE CHARACTERISTICS

R. W. Kott and J. W. Bassett*

Wool producing ability in sheep is generally estimated by evaluating various fleece characteristics. This evaluation may be a time consuming and expensive process or a subjective appraisal lacking accuracy. These fleece characteristics are also greatly affected by environment and age, thus making it difficult to accurately determine an individual's actual or genetic wool producing ability.

Two distinct arrangements of wool follicles were observed (3,4) in vertical skin sections taken from adult Merino sheep which had been selected for high or low wool production. These two follicle arrangements were referred to as "straight" or "tangled" types, respectively.

A numerical description for the degree of follicle bending has been devised (6). It describes the continuous variation between the two extreme follicle types in quantitative terms and is expressed as follows:

$$\text{follicle bending} = \frac{\text{follicle arc length}}{\text{follicle cord length}}$$

This study was designed to determine a method for predicting wool producing ability in sheep by evaluating measurable wool follicle and body characteristics.

MATERIALS AND METHODS

One hundred and one Rambouillet rams on the annual performance test at the Texas Agricultural Research Station at Sonora were used in this study. The test period began October 1, 1975, and continued through February 18, 1976, a period of 140 days. While on test, all rams were fed a commercially prepared pellet *ad libitum*.

All rams were weighed and shorn at the beginning and end of the trial. Prior to shearing at the end of the test, staple length was measured on the side of each ram, and a small (approximately 10 gm) sample of wool was taken from a similar site. This sample was scoured, adjusted to 12 percent moisture. and percent yield was subsequently calculated.

Immediately after shearing at the end of the test, each fleece was weighed and put in an individual sack and sent to the Wool and Mohair Laboratory at College Station. Upon arrival, a squeeze machine reading was obtained for each fleece. The fleeces were then individually scoured, adjusted to 12 percent moisture and clean fleece weight determined. All wool records were adjusted to

*Respectively, former graduate assistant and professor, The Texas Agricultural Experiment Station, College Station.

365 days.

Two skin biopsy samples were taken from the right mid-side of each ram at the beginning of the test. This procedure was accomplished by using a pair of forceps to pinch and lift the skin from which a section was removed, using a razor blade. These biopsy samples were then placed in a 10% formal-saline solution for storage.

The biopsy samples were then histologically prepared and evaluated using the procedure outlined by Nay (2). A number of sections vertical to the surface of the skin were prepared. These sections were approximately 0.5 to 1.0 mm thick and were subsequently stained in .5% Nile blue sulfate and mounted in Kaiser's aqueous mountant. Using a low power microscope, the sections were scanned for follicles which were intact and visible in their entire length. The first 10 suitable follicles encountered were measured. The length of the follicle cord, the follicle arc and the follicle depth were estimated using an eyepiece micrometer (figure 1). From these measurements, the degree of follicle bending was calculated. All follicle measurements used in the statistical analysis were an average of measurements taken by two independent observers.

RESULTS AND DISCUSSION

Most fleeces and follicle characteristics were related (Tables 1 and 2). Clean fleece weight, grease fleece weight, side sample estimated clean fleece weight and squeeze machine reading were significantly ($P<.001$) correlated with each other and with both follicle cord and follicle depth. These fleece characteristics were also related to the percent follicle bending, however, to a lesser degree than either follicle cord or follicle depth. The correlations between the different fleece characteristics were comparable to those reported earlier (1), while those between fleece and follicle characteristics were slightly higher than earlier research (5) indicated.

The only significant ($P<.05$) discrepancy between observers was in the measurement of follicle arc, indicating that measurements of the other follicle characteristics are fairly repeatable. The difference between observers in the measurement of follicle arc could possibly be attributed to an inability to accurately measure this characteristics using current techniques.

Both follicle cord and follicle depth were significantly ($P<.01$) affected by the age of the ram with the older rams generally having the longer follicle cord and depths (Table 3). No other major differences were found between the follicle characteristics as a result of age variation. These results suggest that follicle arc, and consequently follicle bending, are less affected by age than either follicle cord or follicle depth.

A series of regression equations using the follicle characteristics to predict clean fleece weight are shown in Table 4. All follicle characteristics except follicle cord contributed little to the predictive value of the equations and were eliminated from the analyses. The resulting equation was

$$Y = -.8627 + 3.0822x$$

where Y = estimated clean fleece (Kg)
x = follicle cord length (mm)

Follicle cord was combined with the weight and age of the ram at the beginning of the test to form the following equation:

$Y = -1.1916 + 2.2677x_1 + .0195x_2 + .1083x_3$

where Y = estimated clean fleece weight (Kg)

x_1 = follicle cord length (mm)

x_2 = weight of the ram at the beginning of the test (kg)

x_3 = age of the ram at the beginning of the test (months)

All three variables in this equation made significant ($P<.001$) contributions to its predictive power. The correlation between the actual clean fleece weight and the estimated clean fleece weight using this equation was 0.71 ($P<.001$). The predictive power of this equation is greater than any other equation developed in this study.

The results of this study indicated that there is a definite difference in the wool follicles of different rams and that this difference is related to wool production. This entire relationship is not known, and the data presented in this study do not predict, as accurately as desired, clean fleece weights from follicle measurements. It may be possible, however, to add follicle measurements or scores to the information which is obtained from various fleece characteristics to more accurately predict clean fleece production at an earlier age.

SUMMARY

Skin biopsy samples were taken from one hundred and one Rambouillet rams to determine the relationship between various follicle, fleece and body characteristics. All follicle characteristics were measured by two independent observers. Clean fleece weight was significantly ($P<.01$) correlated with grease fleece weight, staple length, side sample estimated clean fleece weight, squeeze machine reading, follicle cord length, follicle depth and percent follicle bending. The only significant ($P<.05$) difference between observers was in the measurement of follicle arc. Date of birth had a significant ($P<.01$) effect on both follicle cord length and follicle depth. A multiple regression equation including follicle cord length, the weight and age of ram at the beginning of the test was developed to predict clean wool production. Correlation between the predicted and actual clean fleece weight was .71.

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TABLE 1. CORRELATION COEFFICIENTS BETWEEN FLEECE CHARACTERISTICS

Characteristics	Squeeze machine reading	Side sample estimated clean fleece weight	Staple length	Grease fleece weight
Clean fleece weight	-.79***	.86***	.39***	.85***
Grease fleece weight	-.76***	.82***	.17*	
Staple length	-.056	.35***		
Side sample estimated clean fleece weight	-.71***			

*P < .05
***P < .001

TABLE 2. CORRELATION COEFFICIENTS BETWEEN FOLLICLE AND FLEECE CHARACTERISTICS

Characteristics	Follicle arc	Follicle cord	Follicle depth	Percent follicle bending
Clean fleece weight	.03	.58***	.59***	-.18**
Grease fleece weight	.04	.48***	.48***	-.14*
Staple length	-.15*	.39***	.39***	-.31***
Side sample estimated clean fleece weight	-.08	.54***	.55***	-.28***
Squeeze machine reading	-.10	-.41***	-.41***	.06

*P < .05
**P < .01
***P < .001

TABLE 3. MEANS OF FOLLICLE AND FLEECE CHARACTERISTICS BY MONTHS OF BIRTH

Month of birth	Clean fleece weight (kg)	Follicle cord (mm)	Follicle depth (mm)
November	5.565[a]	1.997[a]	1.943[a]
December	5.216[ab]	1.893[ab]	1.843[ab]
January	4.975[bc]	1.881[ab]	1.815[b]
February	4.759[bc]	1.841[b]	1.799[b]
March	3.684[c]	1.913[ab]	1.864[ab]
April	3.684[d]	1.718[d]	1.673[d]

[abcd]Means in the same column with unlike superscripts differ significantly (P < .01).

TABLE 4. REGRESSION COEFFICIENTS FOR CLEAN FLEECE WEIGHTS (Kg)

Equation	Intercept	Follicle cord	Follicle arc	Follicle bending	Follicle depth	R^2
1	-1.8862	4.0362	-4.8276	.0843	-.3859	.3575
2	-1.7949	3.6165	-4.5655	.0787		.3573
3	- .7974	3.0879	- .3880			.3564
4	- .8609	3.0757				.3557

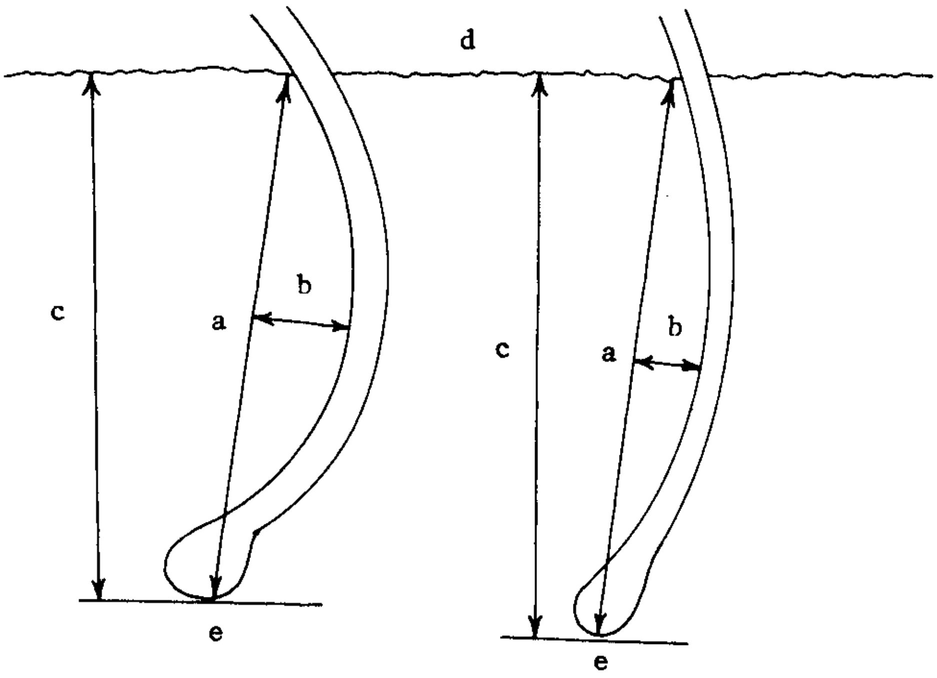

Figure 1. Measurement of follicle characteristics. a. follicle cord; b. follicle arc; c. follicle depth; d. surface of the skin; e. lower end of the follicle bulb.

FIBER QUALITY OF PERFORMANCE TEST RAMS COMPARED WITH THEIR OFFSPRING

J. W. Bassett, B. F. Craddock, Maurice Shelton and C. A. Taylor, Jr.

The fiber diameter of wool samples taken from rams on performance test at The Texas A&M University Agricultural Experiment Station at Sonora have been reported each year since the test started in 1948. Samples have been taken from the mid-side area of the rams prior to shearing at the completion of the test or at the last weigh-day 4 weeks prior to going off test. Measurements of the fiber diameter of these samples has been by personnel of Texas A&M University Agricultural Experiment Station, Wool and Mohair Laboratory at College Station, using micro-projection techniques at a magnification of 500X.

The American Rambouillet Sheep Breeders Association has set a maximum fiber diameter of 24.94 microns, 60's spinning count, for rams to be eligible for certification as they come off an approved performance test. This is a coarser diameter than would normally be expected for the breed. Texas Agricultural Experiment Station (1963) data indicate that rams on the performance test produce fibers that were 1.4 to 3.5 microns (1 - 2 spinning counts) coarser than a similar group of rams which were on range or pasture. This has been part of the rationale for acceptance of the coarser fiber diameter.

In recent years there has been some concern that fiber diameter on performance test rams has been getting coarser. It was felt that another look should be taken at fiber diameter of the rams and at the fiber diameter of their offspring.

EXPERIMENTAL PROCEDURE

An analysis was made of performance test results over the past 19 years to determine the extent to which fiber diameter has changed. The relationship between age of ram coming off test and fiber diameter was also determined.

In addition, an attempt was made to determine the extent to which fiber diameter of a ram coming off test is indicative of the fiber diameter of his offspring, more specifically, his female offspring. Finewool ewes at the Texas Range Station at Barnhart have been sired by performance-tested rams for many years. Side samples were obtained from the Barnhart ewes in May 1976 for fiber diameter measurements. These measurements were then compared with the sire fiber diameter at the time the sire finished the performance test.

A total of 14 finewool rams had fleeces coarser than 24.94 microns at the completion of the 1976-77 performance test. Fleece mid-side samples had been obtained from all rams at the start of the test. Fiber diameter of these samples was measured for the coarse rams and a randomly selected sample of rams representing each finer spinning count.

*Respectively, professor and research associate, The Texas Agricultural Experiment Station at College Station;and professor, The Texas Agricultural Research Station at San Angelo; and research associate, The Texas Agricultural Research Station at Sonora.

In addition to the above comparisons, a group of 10 rams were placed on pasture during the test period to measure their performance as compared to a comparable group in the feeding pens.

RESULTS AND DISCUSSION

Ram Test Fiber Diameter

The average fiber diameter of rams from the 1957-58 test through the 1976-77 test are shown in Table 1. These data are grouped by age of ram going on test. The averages do not indicate that there has been any major increase in fiber diameter over the years. The coarsest fiber diameter for rams born prior to December was in 1975-76, but the second coarsest was 1962-63, and the finest was in 1974-75. The second age group, those born in December and January, was coarsest in 1961-62, second coarsest in 1976-77 and finest in 1968-69. The youngest group of rams, born after January 31st were coarsest in 1959-60 and finest in 1974-75. Averages do not tell the whole story, however, and the data in Table 1 indicate that there has been a higher percent of rams failing to meet the 60's or finer requirement during the past two years than previously.

While the data in Table 1 are not completely uniform relative to fiber diameter and age relationship, in general, the older rams have the coarser fleeces at the completion of the test. Table 2 gives the micron measurements associated with the official U.S.D.A. spinning count grades.

Ram and Ewe Offspring Relationship

The relationship of sire fiber diameter and ewe offspring fiber diameter is shown in Table 3. There is a large difference in the number of offspring available from each ram, and only those rams with a minimum of 4 daughters are listed. In only one case is the daughter average coarser than the sire's performance test fiber diameter, and this was only .02 micron, which is too small a difference to be accurately measured. There was very little difference in average fiber diameter of the ewe offspring. The two coarsest rams showed the greatest differences between sire and daughter fiber diameters. Overall, for the 18 rams listed, the daughter's fleeces averaged 2.98 microns finer than their sires' fleeces at the end of the ram test. Another 14 sires were represented by offspring within the Barnhart flock, but many of these had only one daughter. When these additional 14 rams and their 22 daughters are added, the difference between sire and daughter fiber fineness is -2.60 microns.

Rams Coarser Than 60's, 1976-77 Test

The average difference between fiber diameter of the 14 rams failing to meet certification standards at the end of the test period and their fleeces at the start of the test are shown in Table 4. Average measurements of a limited number of samples in each of the acceptable spinning counts are also given. The average difference between initial and final fiber diameter measurements are about the same for rams with wool grades of 62's, 60's or coarser than 60's, while there is less difference between initial and final measurements in the rams with finer wools. Only 2 of the 14 rams with fiber diameters coarser than 60's had a 64's diameter measurement at the start of the test.

Pasture-Feedlot Comparison

The fiber diameter of rams on pasture as compared to a comparable group on the feeding test are shown in Table 5. Here again, the feedlot rams have a fiber diameter that is 2.6 microns and two spinning counts coarser than those rams on pasture.

SUMMARY

The data support the position that finewool rams on a full-feed situation will produce a fleece which is 2 to 3 microns (approximately 2 spinning counts) coarser than it would under range conditions. This increase in coarseness, which is primarily a nutritional influence, is then not reflected in the fleeces of the female offspring who are kept for replacement ewes.

Rams which go on test with fleeces coarser than 64's are more likely to be among those rams failing to meet Rambouillet certification standards with regard to fiber diameter.

Table 1. Effect of Year and Age on Fiber Diameter

Test year	Number of rams	Average fiber diameter — Month of birth: Prior to December	December/ January	After January	Coarser than 60's at end of test, %
1976-1977	179	23.51	23.26	21.75	7.86
1975-1976	101	24.45	22.94	22.17	9.90
1974-1975	129	21.21	22.08	20.50	2.30
1973-1974	129	22.03	22.17	21.67	0.00
1972-1973	134	22.37	22.14	21.88	0.00
1971-1972	105	22.67	22.14	21.76	0.00
1970-1971	113	23.67	23.19	22.60	*
1969-1970	109	23.32	22.86	22.17	*
1968-1969	133	-----	21.94	21.82	0.75
1967-1968	118	23.19	22.98	22.06	3.39
1966-1967	100	23.05	21.95	22.85	4.00
1965-1966	106	22.76	22.03	21.49	0.00
1964-1965	107	22.71	22.00	20.93	1.87
1963-1964	121	23.06	22.52	22.11	*
1962-1963	113	23.70	23.17	22.03	4.42
1961-1962	108	22.94	23.35	21.68	*
1960-1961	128	22.45	23.06	21.55	*
1959-1960	112	-----	22.40	23.54	*
1958-1959	94	23.77	22.21	20.96	0.00
1957-1958	83	22.04	22.83	22.89	*
Average Microns		22.91	22.51	21.93	
Average Spinning Count		62's	62's	64's	

*Not available

Table 2. Wool Grades

Blood grades	Spinning count	Microns
Fine	Finer than 80's	<17.70
Fine	80's	17.70-19.14
Fine	70's	19.15-20.59
Fine	64's	20.60-22.04
1/2 blood	62's	22.05-23.49
1/2 blood	60's	23.50-24.94
3/8 blood	58's	24.95-26.39
3/8 blood	56's	26.40-27.84
1/4 blood	54's	27.85-29.29
1/4 blood	50's	29.30-30.99
Low 1/4 blood	48's	31.00-32.69
Low 1/4 blood	46's	32.70-34.39
Common & braid	44's	34.40-36.19
Common & braid	40's	36.20-38.09
Common & braid	36's	38.10-40.20
Common & braid	Coarser than 36's	>40.20

Table 3. Effect of Sire on Fiber Diameter

Sire I.D. number	Fiber diameter, μ	Ewe Offspring Number	Age, years	Fiber diameter, μ	Difference, microns
8009	18.5	4	2.0	18.52	+0.02
7923	19.2	19	2.7	19.09	-0.11
8113	20.5	6	2.0	19.68	-0.82
A1937	21.1	12	5.0	19.64	-1.46
8095	21.5	4	2.0	18.15	-3.35
B106	21.8	16	3.5	19.64	-2.16
7812	22.0	13	4.0	18.56	-3.44
7892	22.0	8	3.0	20.14	-1.86
7627	22.0	6	5.2	18.85	-3.15
B125	22.2	15	3.0	20.26	-1.94
B319	22.3	4	2.0	17.67	-4.62
7927	22.6	4	3.0	17.65	-4.95
7779	22.7	6	3.8	19.21	-3.49
7777	22.9	9	4.0	19.28	-3.62
7515	23.0	8	6.0	18.93	-4.07
7618	23.0	4	5.8	19.21	-3.79
8846	24.2	5	3.6	18.32	-5.88
7519	24.6	8	4.5	19.60	-5.00

Table 4. Fiber Diameter at the Start and End of Test Period

Number of rams	End of test, avg. Microns	End of test, avg. Spinning count	Start of test, avg. Microns	Start of test, avg. Spinning count	Difference
14	26.28	58's	23.17	62's	3.11
4	24.20	60's	21.02	64's	3.18
4	22.71	62's	19.20	70's	3.51
4	21.29	64's	19.48	70's	1.91
4	19.76	70's	18.82	80's	0.95

Table 5. Pasture Rams vs Test Rams

	Pasture	Test
Rams, number	10	22
Spinning count	80's	64's
Fiber diameter, microns	18.70	21.33
Difference, microns	2.63	

PR-3470

EFFECT OF FEEDING PROTECTED PROTEIN ON MOHAIR PRODUCTION IN ANGORA GOATS

B. F. Craddock and J. W. Bassett [1,2]

In the past few years much research has been conducted concerning abomasal infusions and chemical modifications of feed proteins and amino acids to render them resistant to microbial attack in the rumen and thus increase their nutritive value in the small intestines. In several studies involving sheep these methods have resulted in substantial increases in wool growth (1,3,5,6,7).

The average Angora doe is about one-half the size of a mature ewe but will normally produce a greater amount of clean fiber and produce it more efficiently (2). It would seem reasonable to expect that supplementation of a protected protein source might be very productive with Angora goats especially with the current prices of mohair. It was the purpose of this research to study the effect of encapsulated methionine as one form of protected protein on mohair and kid production in Angora goats.

METHODS AND PROCEDURE

Fifty-four Angora goats were randomly assigned to 6 treatment groups of 9 goats each to study the effects of encapsulated methionine on mohair production. Each treatment group consisted of one doe kid, one buck kid, one yearling doe, one 2-or 3-year-old doe and four does 4 years old or older. Feed was provided to each of the 6 treatments as follows: (1) 8 lb ground oats plus 72 g encapsulated methionine, (2) 6.4 lb ground oats plus 1.6 lb cottonseed meal, (3) 8 lb ground oats, (4) 4 lb ground oats plus 72 g encapsulated methionine, (5) 3.2 lb ground oats plus 0.8 lb cottonseed meal and (6) 4 lb ground oats. Treatments 1 to 3 were kept in drylot and fed approximately 20 lb sorghum hay per pen per day. Treatments 4 to 6 were grazed on native pasture. The goats in treatment 1 and 4 obtained approximately 8 g encapsulated methionine per head per day. This provided approximately 1 g of methionine per head per day into the blood since the encapsulated methionine contains 20% DL-methionine, and approximately 65% escapes degradation in the rumen and is available for absorption posterior (4). Prior to the start of the experiment all does were exposed to a buck for approximately one month. The goats were shorn at the beginning of the experiment and samples were taken from the shoulder, side and britch for the determination of initial fiber diameter. Body weights were taken at bimonthly intervals. The goats were on test for 10 months and were shorn at 4 months (first shearing) and 10 months (second shearing). Staple length and fiber diameter were measured monthly from the shoulder, side and britch. Approximately 250 fibers were measured for each diameter measurement, and the number of kemp and medullated fibers were counted. Grease fleece

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[1]Respectively, research associate and professor, The Texas Agricultural Experiment Station at College Station.

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weights, clean fleece weights and clean yield were obtained at the first and second shearings. The number of kids born, reared and died as well as the number of does that aborted were also recorded during the experiment.

RESULTS AND DISCUSSION

Average staple lengths, fiber diameters, grease and clean fleece weights and clean yield for the first shearing are given in Table 1. No significant differences in staple length were found within the drylot or pasture groups. In general, the drylot groups produced longer staple lengths than did the pasture groups, with treatments 1 and 3 (oats + methionine and oats) producing longer (P<.10) staple lengths than any of the pasture treatments.

No statistically significant differences were found in fiber diameter between treatments, although there were differences. Changes in fiber diameter from the beginning of the feeding period until shearing at 4 months for goats in drylot were +2.65, +1.68 and +0.98 microns for the groups fed oats + methionine, oats + cottonseed meal, and oats, respectively. Goats fed the same types of supplements on pasture had changes in fiber diameter of +0.56, -1.11 and -0.83 microns. Goats in drylot and on pasture both showed increases in fiber diameter during the first month on test, although the drylot animals showed an increase of 2.75 microns as compared to 1.00 microns for those on pasture. After the first month all goats had decreasing fiber diameters, but the drylot goats were still 0.75 microns coarser at 4 months than initially while the pasture goats were approximately 1.5 microns finer. This reflects fiber differences similar to those shown in the ram performance test where pasture rams had finer fleeces than drylot rams. Both groups receiving methionine were coarser than the other groups having a similar roughage source.

There were no significant differences in grease and clean fleece weights within the drylot and pasture groups. This can be partially explained by the large variation within each treatment group as a result of the wide variation in ages of animals. However, grease fleece weights for the drylot/methionine group were significantly greater (P<.05) than those for all pasture groups. Within the drylot groups, the methionine and cottonseed meal treatments showed increases in grease fleece weights of 30 and 11%, respectively, over the group receiving oats alone as a supplement. Within the pasture groups the methionine and cottonseed meal treatments showed decreases of 2 and 10% as compared to oats only.

Clean fleece weights followed a pattern similar to that of grease fleece weights. The drylot/methionine treatment group had significantly heavier clean fleece weights than the pasture/methionine and pasture/cottonseed meal groups, while none of the other differences were statistically significant. Both grease and clean fleece weights were consistently heavier for the drylot treatments when compared with the similar pasture treatments. There appeared to be a possible treatment interaction in that both methionine and cottonseed meal showed increases in grease and clean fleece weights above oats only in drylot, but showed decreases under pasture conditions.

Fiber parameters measured at the second shearing (6 months growth) are shown in Table 2. Fiber diameter measurements will be reported at a later date.

With only one exception, staple lengths are longer for drylot groups than for similar pasture groups. The drylot/methionine treatment showed the longest staple length for all three body areas.

No significant differences were found in grease and clean fleece weights at the second shearing. The differences which are shown are of the same order and magnitude as shown at the first shearing. Methionine and cottonseed meal treatments in drylot showed increases of 30 and 11% in grease fleece weights and 27 and 5% in clean fleece weights, respectively, as compared to oats only. Methionine and cottonseed meal treatments showed decreases in both grease and clean fleece weights when compared to oats only under pasture conditions.

Kid production data are shown in Table 2. Although these are limited data, they may indicate some reason for the differences in grease and clean fleece weights between drylot and pasture groups. Kid production within the drylot groups was very similar, but there were distinct differences within the pasture groups. The oats only group had two less kids born and raised only two kids as compared to five for the methionine and three for the cottonseed meal treatments. These differences in kid production cannot be atributed to the feed treatments because of the small numbers, but the nutritional requirements for does kidding and raising kids is such that it could have been a major factor influencing grease and clean fleece weight differences within the pasture groups.

SUMMARY

Fifty-four Angora goats were assigned to 6 treatment groups of 9 goats each in a preliminary study of the effects of encapsulated methionine on mohair production. Three groups were fed in drylot on sorghum hay supplemented with (1) oats plus encapsulated methinione, (2) oats plus cottonseed meal and (3) oats. The other three groups were grazed on native pasture and supplemented with (4) oats plus encapsulated methionine (5) oats plus cottonseed meal, and (6) oats. Fleece measurements were made at two shearings, the first shearing after 4 months fiber growth and the second shearing 6 months later. No significant differences were found in fleece measurements between treatments within either the drylot or pasture groups, but significant differences were found between treatments across groups. In general the drylot groups produced longer staple lengths, coarser fiber diameter (data from first shearing only) and heavier grease and clean fleece weights than Angora goats on native pasture. Within the drylot treatment groups, encapsulated methionine and cottonseed meal gave increases of approximately 30 and 11% in grease fleece weights and 30 and 7% in clean fleece weights, respectively, above the oats only group. Within the pasture treatments, the methionine and cottonseed meal treatments had decreases in grease and clean fleece weights as compared to oats only. Kid production between treatments within the pasture group was variable and could explain a part of the variation in fleece weights within this group as compared to the drylot group.

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Table 1. MEAN STAPLE LENGTH, FIBER DIAMETER, GREASE FLEECE WEIGHT, CLEAN FLEECE WEIGHT AND CLEAN YIELD FOR THE FIRST SHEARING

Item	Treatment					
	Drylot			Pasture		
	1	2	3	4	5	6
Staple length, in						
Shoulder	3.19^{c}	3.08^{cd}	3.22^{c}	2.94^{d}	2.89^{d}	2.93^{d}
Side	3.09	3.02	3.11	2.83	2.87	2.89
Britch	2.85^{c}	2.70^{cd}	2.78^{c}	2.53^{de}	2.32^{e}	2.46^{e}
Average	3.04	2.93	3.04	2.77	2.69	2.76
Initial fiber diameter, u						
Shoulder	31.83	32.48	33.09	32.79	34.37	34.26
Side	31.94	32.19	32.82	34.02	34.69	32.85
Britch	30.48	30.19	29.79	30.22	33.08	30.19
Average	31.42	31.62	31.90	32.34	34.05	32.43
Fiber diameter, u						
Shoulder	33.81	34.36	33.89	32.46	33.17	32.35
Side	34.85	34.02	34.02	34.67	33.85	32.49
Britch	33.55	31.52	30.74	31.56	31.79	29.96
Average	34.07	33.30	32.88	32.90	32.94	31.60
Grease fleece wt., lb	3.23^{a}	2.74^{ab}	2.48^{ab}	2.30^{b}	1.90^{b}	2.35^{b}
Clean fleece wt., lb	2.57^{a}	2.09^{ab}	1.94^{ab}	1.73^{b}	1.50^{b}	1.86^{ab}
Yield, %	79.57	76.28	78.23	75.22	78.95	79.15

^{ab}Means on the same line with different superscripts are significantly different ($P<.05$).

^{cde}Means on the same line with different superscripts are significantly different ($P<.10$).

Table 2. MEAN STAPLE LENGTH, GREASE FLEECE WEIGHT, CLEAN FLEECE WEIGHT, CLEAN YIELD AND KID PRODUCTION FOR THE SECOND SHEARING

Item	Treatment					
	Drylot			Pasture		
	1	2	3	4	5	6
Staple length, in						
Shoulder	5.27[a]	5.04[abc]	5.15[ab]	4.77[c]	4.86[bc]	5.01[abc]
Side	5.23[a]	4.96[ab]	5.02[ab]	4.70[b]	4.88[b]	5.00[ab]
Britch	4.81	4.68	4.57	4.53	4.53	4.76
Average	5.10	4.89	4.91	4.67	4.76	4.92
Grease fleece wt., lb	6.49	5.55	5.00	5.12	4.88	5.53
Clean fleece wt., lb	4.62	3.84	3.64	3.56	3.44	4.15
Yield, %	71.19	69.19	72.80	69.53	70.49	75.04
Kid production, hd						
Born	4	5	5	6	6	4
Reared	4	5	5	5	3	2
Died	0	0	0	1	2	1
Aborted	0	0	0	0	1	1

[abc]Means on the same line with different superscripts are significantly different ($P < .10$).