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RESEARCH REPORTS

Sheep and Goat, Wool and Mohair--1981

The Texas Agricultural Experiment Station
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The Texas A&M University System

THE TEXAS AGRICULTURAL EXPERIMENT STATION / Neville P. Clarke, Director
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THE USE OF TOXICANTS TO REDUCE PREDATION ON SHEEP AND GOATS

J. Juan Spillett, Dale A. Wade, Jerry H. Scrivner
Gregg L. Servheen and Terry Blankenship

SUMMARY

Two research projects are being conducted by the Texas A&M University System to obtain information needed to register Compound 1080 with the Environmental Protection Agency for use in the toxic collar to protect sheep and goats from coyote predation. Major criteria being addressed include: (1) danger to humans, because of the lack of an antidote for 1080 poisoning; (2) reported lack of selectivity of 1080 in regard to the poisoning of mammals and birds; and (3) potential hazards to non-target species by either primary or secondary poisoning resulting from use of 1080 in the toxic collar

Results to date include: (1) The 1080 toxic collar can be used safely by ranchers, and it is an effective predator control method under certain conditions. However, more effective control is achieved by use of the collar with other methods. (2) Coyotes are extremely susceptible to 1080 poisoning. On a bodyweight basis, we have found that the LD 100 dosages of 1080 for raccoons (3+ mg/kg) and opossum (50+ mg/kg) range from about 15 to 200 times greater, respectively, than for coyotes (0.18 mg/kg). (3) There has been no indication in nearly two years of field testing that non-target species have or may be poisoned by either primary or secondary poisoning as a result of using the 1080 toxic collar.

A third research project also is being conducted to obtain information on the potential effects of bait-delivered toxicants on both target and non-target wildlife populations. Selected attractants, baits, and baiting methods are being evaluated in order to develop effective baiting systems Tracer chemicals will be incorporated into the baits during the coming year in order to evaluate the potential effects of bait-delivered toxicants on wildlife populations.

INTRODUCTION

Texas sheep and goat numbers have declined from 10 million sheep in the 1950's and 4 million goats in the mid-1960's to 2.4 and 1 million, respectively, in 1980 (3). During 1978, Texas producers lost an estimated $13 million due to sheep, lamb, goat and kid losses attributable to predators, and coyotes were the major cause of the problem (4).

The public deserves an objective evaluation of the facts surrounding the issue of predator damage control, and animal damage control policies should be based upon these facts (5). Effective and cost-efficient predator control methods need to be developed.

EXPERIMENTAL PROCEDURES

The Texas A&M University System (TAMU), Denver Wildlife Research Center (DWRC) of the U.S. Fish and Wildlife Service, and the Texas Department of Agriculture (TDA) are cooperatively making arrangements for 1080 toxic collar studies to be conducted on a maximum of 10 ranches in Texas which represent different ecological and management situations. Seven of these sites will be used to determine the safety of the toxic collar under rancher-use, and three sites will be intensively monitored by TAMU personnel to determine safety and efficacy of the 1080 toxic collar as a predator control method and the potential hazards to non-target species. Radio transmitters will be attached to collars on intensive study sites, so that collared animals or collars can be readily monitored and located.

Lethal dose levels (LD 100s) of Compound 1080 for selected non-target species such as raccoons, opossums and skunks are being determined under controlled conditions at Texas A&M University in cooperation with College of Veterinary Medicine personnel. Tissue samples have been taken from coyotes killed both with an LD 100 and a potentially maximum dosage of Compound 1080 which could be obtained from a toxic collar by a depredating coyote. Veterinary Medicine personnel will determine 1080 residue levels in these tissue samples as soon as analyses methodology can be perfected. Such data will help determine whether or not there is a potential danger of non-target species being killed by secondary poisoning as a result of feeding on carcasses of coyotes killed by 1080.

Different bait-delivery methods are being systematically used in the field to evaluate selected baits and attractants for delivering chemicals to coyotes. Transects (with stations consisting of a cleared 1-meter-diameter circular plots located at 0.3-mile intervals) are being used in conjunction with infra-red sensor cameras to record visits and reactions of both target (coyote) and non-target wildlife species. Tracer chemicals eventually will be included in the baits. Population samples should indicate proportions of target and non-target populations which potentially would be affected if toxicants were used in the baits instead of tracer chemicals.

RESULTS AND DISCUSSION

Use of the 1080 toxic collar presently is being evaluated on four Texas ranches. Results thus far indicate the collar can be safely used by ranchers and is an effective predator control method under certain conditions. However, use of the 1080 toxic collar is not a panacea and more effective control of predation is achieved by the combined use of the collar and other methods (6). In addition, the economic costs/benefits of using the 1080 toxic collar presently are being evaluated.

TAMU has established that the LD 100 for coyotes tested is 0.18 mg of Compound 1080/kg live weight, rather than the previously reported 0.20 mg (1) or 0.16 mg (2). Further, results to date indicate that the LD 100 for raccoons and opossums is 3+ and 50+ mg of Compound 1080/kg live weight, respectively. Thus, it would take a number of lethal doses of Compound 1080 for coyotes to adversely affect an average-sized raccoon or opossum.

Analyses of tissue samples from coyotes experimentally poisoned with Compound 1080 have been delayed because of equipment problems and difficulties encountered by Veterinary Medical personnel in finding an internal standard which will provide the means for accurately quantifying Compound 1080 residue levels in animal tissues.

Field evaluations of selected baits, attractants and bait-delivery methods were not initiated until March 1981. Results to date on such are not definitive.

LITERATURE CITED

1. Atzert, Stephen P. 1971. A review of sodium monofluoroacetate (Compound 1080): Its properties, toxicology, and use in predator and rodent control. U.S. Fish and Wildlife Service Special Scientific Report - Wildlife No. 146. 34 pp.

2. Connolly, Guy E. 1980. Use of Compound 1080 in livestock neck collars to kill depredating coyotes. A report on field and laboratory research. U.S. Department of the Interior, Fish and Wildlife Service. 205 pp.

3. Nunley, Gary. 1980. Emergency use request of Compound 1080 bait stations in Texas for the control of coyotes (Canis latrans) as per Section 18 of FIFRA. Submitted to the Environmental Protection Agency, Sept. 1980. 33 pp. (typewritten)

4. Texas Crop and Livestock Reporting Service. 1979. Texas sheep and goat death losses and marketing practices. Texas Department of Agriculture and U.S. Department of Agriculture. 12 pp.

5. Wade, Dale A. 1980. Predator damage control, 1980: Recent history and current status. Presented at 9th Vertebrate Pest Conference, Mar. 4-6, Hilton Hotel, Fresno, CA. IN PRESS

6. Wade, Dale A. and Guy Connolly. 1980. Coyote predation on a Texas goat ranch. Texas Agriculture Progress. 26:12-16.

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The authors would like to acknowledge the assistance and support of Drs. Donald S. Davis (Department of Veterinary Pathology), E. Merl Bailey and Bennie J. Camp (Department of Veterinary Physiology and Pharmacology) in conducting analyses and for the use of facilities in the College of Veterinary Medicine at Texas A&M University. Thanks also is expressed to personnel of the Texas Rodent and Predatory Animal Control Service, specifically Messrs. Donald Hawthorne, Gary Nunley and Gary Simmons, State, Assistant State, and District Supervisors, respectively, for providing experimental animals. Cooperation of the Texas Department of Agriculture personnel (particularly, Messrs. David Ivie and Alvin Ashorn, Director and Assistant Director, respectively, of the Agriculture and Environmental Science Division) is appreciated. Last, but not least, we would like to thank cooperating ranchers, namely Charles and Faye Howard, Jr. of Meridian, L.D. Monroe of Roscoe, and Joe L. Jackson of Ranger for their cooperation and assistance.

OBSERVATIONS ON THE EFFECT OF ELECTRIC FENCING ON COYOTES AND OTHER WILDLIFE

Maurice Shelton

SUMMARY

An experiment was conducted on the Walker Brothers ranch in McMullen County attempting to fence out coyotes through the use of a seven wire electric fence. The fence, as originally constructed, tended to have the opposite effect of concentrating coyotes and other types of wildlife. Futher details are provided in the text of this report.

INTRODUCTION

In another report in this collection (TAES PR-3507, 1978) mention was made of an attempt to use electric fencing in the South Texas Plains to contain livestock and, it was hoped, to exclude coyotes. The electric fencing did a satisfactory job of containing the livestock, but it was not successful in controlling coyote predation. As a matter of fact there was a tendency for the electric fencing to have the opposite effect to that expected.

EXPERIMENTAL PROCEDURE

The fence, as initially constructed, consisted of smooth wires with approximately the following spacing from ground level: 6, 6, 6, 8, 8, 10 and 10 inches. Alternate wires were charged with 5000 volts (Gallagher charger) beginning with the bottom wire. This made for a total of four charged wires and three grounded wires. Plastic posts and droppers (stays) were used, but these were spaced sufficiently far apart (approximately 45 feet) that even with tension on the wires there was little physical deterrent to small animals (smaller than the cows) passing through the wires and electric shock provided the primary deterrent. The goats used in the experiment were given a period of training prior to being placed in the pasture, and they did not pass through the fence. The fence was constructed enclosing an approximately 200 acre trap on the Walker Brothers ranch in McMullen County in September, 1979. This is in an area of extremely high coyote density (1). From the outset it was apparent that this fence was not having the desired effect in deterring coyotes, as they were digging under. In January, 1980 a barb wire was added at ground level to reduce digging under, and digging or sliding under was greatly reduced by the addition of this wire. However, animals (coyotes and other types of wildlife) continued to pass through the fence. In February, 1980 a charged trip-wire was added approximately six inches six inches off ground level and approximately eight inches outside the fence.

RESULTS AND DISCUSSION

Fifty-two Spanish-type goats were placed in the pasture in September, 1979, and one year later only 20 remained, and no young had been raised. In general the losses were attributed to coyote predation. Losses to coyotes are known to have occurred, but it is not possible to attribute each individual loss to coyotes. Coyotes are known to have passed through the fence. A number were trapped or shot from inside the pasture. In addition on three occasions the experimental pasture and an adjacent pasture was flown by helicopter, at which time counts were made of the animals present, and any coyotes in the experimental pasture were removed. The adjacent pasture contained approximately 1000 acres. The results of these counts are shown in Table 1, along with the number of coyotes removed from the experimental pasture from initiation of the experiment to the date indicated. A total of 15 coyotes were removed from inside the experimental pasture within approximately one year's time. This confirms that the fence was not keeping coyotes out and appears to confirm unusual high coyote density for the area. Although there is little doubt that there is a high coyote density in the area involved, the number removed over time may be more a function of influx than of actual density at a given time. Knowlton (1) suggested six per square mile in the South Texas area in the fall of the year.

At two of the three times the pasture was flown, the coyote density was greater inside the pasture than adjacent areas without regard to the number which had been removed in the interim. Observations appear clearly to support the fact that coyotes were approaching the fence and starting through the wires, at which time they received a charge of electricity. Their natural impulse was to go forward and pass through the fence, but as a result of the charge received they then became reluctant to go back through the fence, thus in effect becoming trapped inside. For instance it can be seen in Figure 1 that coyotes scratched and clawed at the ground a short distance from the fence, but apparently did not approach the fence. Readers should also be reminded that the experimental area was covered with rather dense brush, and coyotes could remain inside the pasture for extended periods of time unobserved.

The data also appears to suggest that this was happening with other types of wildlife, especially javelina. This tendency to concentrate wildlife appeared to become less with subsequent counts. This is no doubt explained by the fact that the fence was altered and improved, and also possibly that the resident wildlife populations tended to become acquainted with the fence. On occasions when the pasture was flown by helicopter, attempts were made to drive the javelina out of the experimental pasture. With some this was successful, while others refused to pass through the fence even when pressed to do so.

The most obvious conclusion from this experience is that even electrified fences should provide some degree of physical barrier to coyote passage. The charged wires would then serve to deter attempts such as digging or climbing to defeat the fence. Theoretically once the predators learned to fear the fence they would avoid subsequent attempts at passage.

It should be pointed out that in open pastures and relatively small pastures, such as most farms have, the problem encountered would be of minimal significance, as any coyotes which became trapped inside could be relatively easily removed.

The second point of interest about this experience is that the concentrating effect appeared to work sufficiently well that it might be used to facilitate coyote removal or management. Further studies on this possibility are indicated.

LITERATURE CITED

1. Knowlton, F. F. 1972. Preliminary interpretation of coyote population mechanics with some management implications. Journal of Wildlife Management 36:396.

ACKNOWLEDGEMENTS

The writer would like to acknowledge the assistance of the Walker Brothers (Steve, Tom and Mike) on whose ranch this work was conducted.

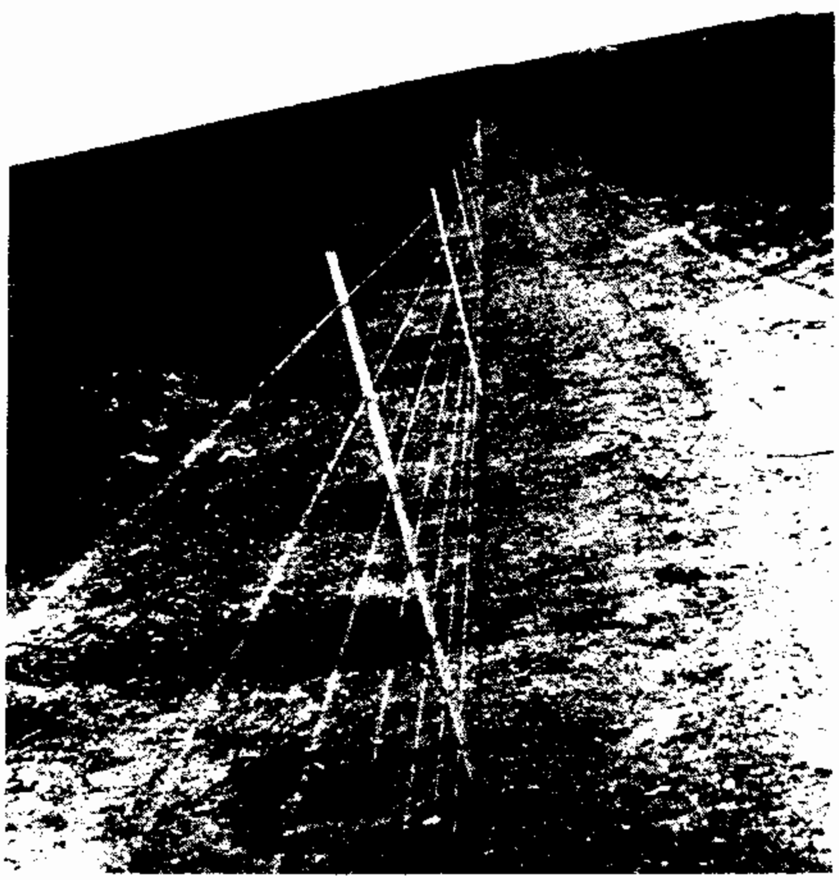

TABLE 1. RESULTS OF AERIAL COUNTS OF WILDLIFE PRESENT, GOATS REMAINING AND COYOTES REMOVED

	Experimental Trap		Adjacent Pasture	
	Total	Per Acre	Total	Per Acre
Species				
		February 1980		
Goats (52 initially)	37		0	
Coyotes				
Present	1	.005	0	.000
Removed to date	11			
Deer	12	.060	13	.013
Javelina	11	.055	0	.000
Wild pigs	0	.000	0	.000
		July 1980		
Goats	22		0	
Coyotes				
Present	2	.010	1	.001
Removed to date	14			
Deer	8	.040	15	.015
Javelina	7	.035	7	.007
Wild pigs	1	.005	0	.000
		December 1980		
Goats	20			
Coyotes				
Present	0	.000	3	.030
Removed to date	15			
Deer	9	.045	13	.013
Javelina	5	.025	12	.012
Wild pigs	0	.000	0	.000

BITTERWEED ADAPTATION IN SHEEP*

M. C. Calhoun, B. C. Baldwin, Jr. and F. A. Pfeiffer

SUMMARY

Sheep which were repeatedly challenged with a uniform subacute bitterweed dose (0.25% of live weight daily for four consecutive days) and allowed to recover between each challenge appeared to develop a tolerance for bitterweed. Depressions in feed intake and elevations in serum concentrations of urea nitrogen, creatinine, glutamic-oxalacetic transaminase and gamma glutamyl transpeptidase became less with each successive challenge and were taken as evidence of adaptation to bitterweed.

INTRODUCTION

Recent research indicates sheep may adapt to bitterweed (Hymenoxys odorata) (1,4,5). In one study grazing ewes were observed to consume safely several times the reported lethal amount of bitterweed continuously for several days (4). This observation was made at the end of the normal growing season for bitterweed (March and April) in a group of ewes which had been on bitterweed for several months. Thus, it was felt that adaptation may have occurred with repeated exposure. Bitterweed plants harvested from this site contained about 1.25% hymenoxon (the principal toxic constituent of bitterweed) and were toxic when force-fed to sheep in confinement. In another study approximately twice as much bitterweed was required to reinduce signs of poisoning in sheep previously made sick by a chronic bitterweed dose (1 gm/kg body weight per day for about 47 days) (5).

The purpose of this research was to determine if adaptation could be experimentally demonstrated by repeated exposure of sheep to bitterweed.

EXPERIMENTAL PROCEDURE

Twenty Rambouillet lambs with an initial weight of 77.6 ± 1.6 lb were used in this study. They were placed in individual pens and fed a diet based on sorghum grain and alfalfa meal.[1/] Subsequently they were all administered bitterweed (0.25% of live weight per day for four consecutive days) via rumen tube as previously described (2).

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* This research was supported in part by the Natural Fibers and Food Protein Commission of Texas.

[1/] The percentage composition of the experimental diet was: grain sorghum (milo), 52.0; alfalfa meal, 40.0; sugarcane molasses, 7.0 and vitamin-mineral premix, 1.0.

Blood samples were collected initially and 24 hours following the last bitterweed dose. Changes in the following serum constituents: urea nitrogen, creatinine, glutamic-oxalacetic transaminase, and gamma glutamyl transpeptidase were used to assess the extent of bitterweed poisoning.

Following this the sheep were paired according to their relative bitterweed tolerance scores (3) and assigned at random within pairs to either no bitterweed or a chronic, low-level bitterweed feeding period (0.05% of live weight per day for 20 days). To accomplish this, ground bitterweed was mixed with the feed and feed intake was restricted to 2% of live weight to insure that all feed offered was consumed and each sheep received the desired amount of bitterweed. The sequence of subacute and chronic bitterweed administration and recovery periods is given in Table 1.

Immediately following the 4th subacute challenge 13 bitterweed naive sheep were given a subacute bitterweed dose and their response was compared with those sheep repeatedly given bitterweed.

RESULTS AND DISCUSSION

The responses to repeated subacute bitterweed exposure were essentially the same regardless of chronic bitterweed treatment. Because of this the data for the two groups of sheep have been pooled and are presented together.

Feed intakes for a 12-day period during each successive subacute challenge are summarized in Figure 1. The period covers from four days before to four days after each four day challenge. Bitterweed depressed feed intake each time the sheep were challenged. However, the extent of this depression tended to be less and the sheep started back on feed faster with each successive challenge.

Feed intake has been reported to be the most sensitive criteria for assessing bitterweed poisoning in laboratory studies (2). Since the effects of bitterweed on feed intake became less with each successive challenge it is evident the sheep were becoming less sensitive to the bitterweed dose being used.

The possibility that sheep adapt to bitterweed on repeated exposure is also supported by the results obtained from measurements of several serum constituents. Final values for urea nitrogen (Figure 2), creatinine (Figure 3), glutamic-oxalacetic transaminase (Figure 4) and gamma glutamyl transpeptidase (Figure 5) were all lower with each successive challenge. Comparison of the responses obtained after the 4th bitterweed challenge with those of the 13 bitterweed naive sheep (controls) also support the possibility of adaptation.

The strong evidence for adaptation presented in this report would explain the field observation of grazing ewes safely consuming several times the reported lethal amount of bitterweed continuously for several days (4).

LITERATURE CITED

1. Baldwin, B.C. Jr. and M.C. Calhoun. 1979. Dietary Protein and Subacute Bitterweed Poisoning in Sheep. Tex. Agr. Exp. Sta. Prog. Rpt. 3571.

2. Calhoun, M.C., D.N. Ueckert, C.W. Livingston, Jr. and B.C. Baldwin, Jr. 1981. Association between bitterweed dose, voluntary feed intake and some blood serum constituents of sheep. Submitted to Am. J. Vet. Res.

3. Calhoun, M.C. and B.C. Baldwin, Jr. 1980. Sheep Tolerance to Bitterweed Poisoning - Variation Between Animals. Tex. Agr. Exp. Sta. Prog. Rpt. 3695.

4. Calhoun, M.C., D.N. Ueckert, L.B. Merrill, B.J. Camp and B.C. Baldwin, Jr. 1980. Effect of 2,4-D on Hymenoxon Levels and Toxicity of Bitterweed. Tex. Agr. Exp. Sta. Prog. Rpt. 3696.

5. Post, L.O. and E.M. Bailey, Jr. 1980. The Effect of Dietary Supplements on Chronic Bitterweed (Hymenoxys odorata) Poisoning in Sheep.

TABLE 1. SCHEDULE OF BITTERWEED ADMINISTRATION AND CHANGES IN LEVEL OF FEEDING

Dates	Time (days)	Period	Bitterweed Treatment	Feeding Level
(1980) 5/20 to 5/23	4	Subacute	0.25% of live weight/day for four days	*Ad libitum*
5/24 to 6/8	16	Recovery	None	First 8 days *Ad libitum* then maintenance level
6/9 to 6/28	20	Chronic	1/2 of sheep - 0.05% of live weight/day for 20 days, 1/2 none	2% of live weight/day
6/29 to 7/6	8	Recovery	None	Increased 0.55 lb/day to *Ad libitum*
7/7 to 7/10	4	Subacute	0.25% of live weight/day for four days	*Ad libitum*
7/11 to 7/27	17	Recovery	None	First 8 days *Ad libitum* then maintenance level
7/28 to 8/16	20	Chronic	1/2 of sheep - 0.05% of live weight/day for 20 days, 1/2 none	2% of live weight/day
8/17 to 8/24	8	Recovery	None	Increased 0.55 lb/day to *Ad libitum*
8/25 to 8/28	4	Subacute	0.25% of live weight/day for four days	*Ad libitum*
8/29 to 9/21	24	Recovery	None	*Ad libitum*
9/22 to 9/25	4	Subacute	0.25% of live weight/day for four days	*Ad libitum*

FIGURE I

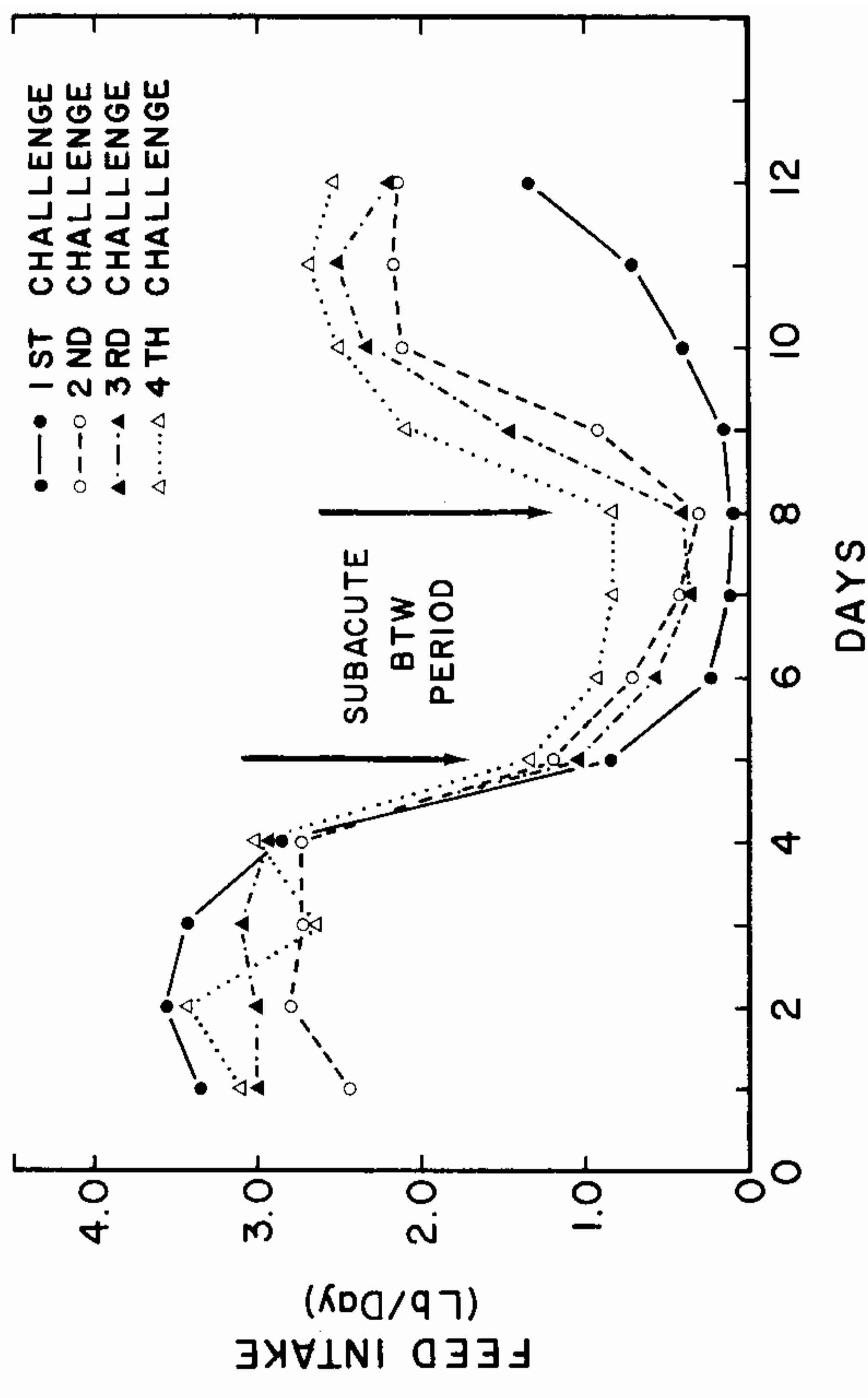
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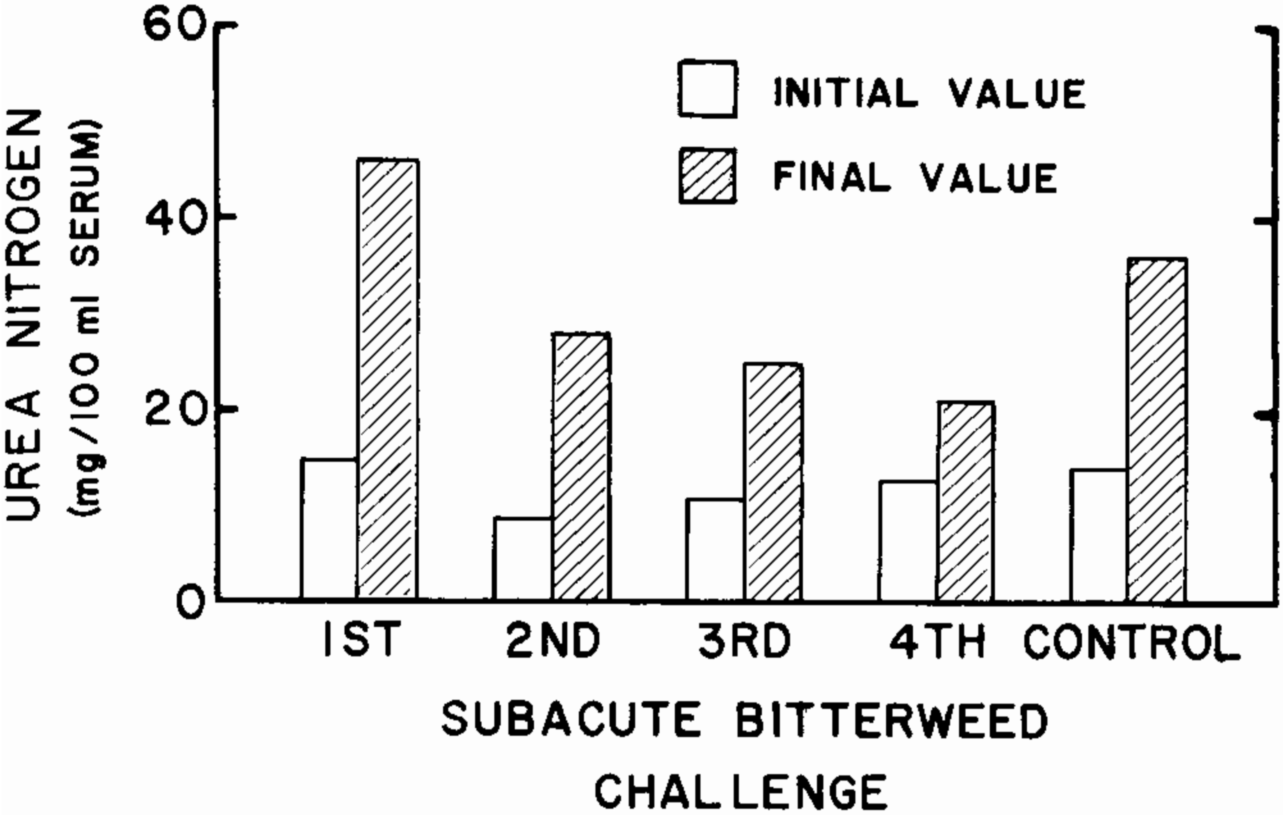
FIGURE 2



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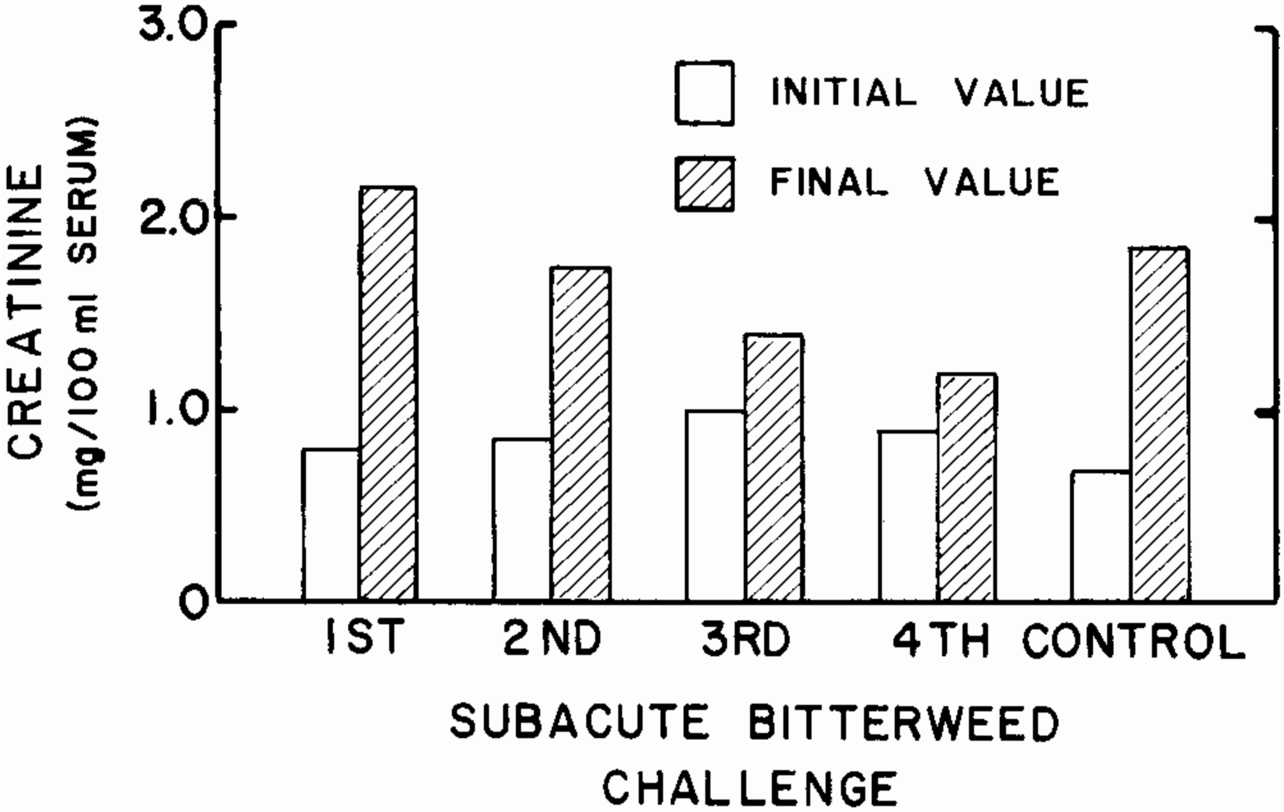

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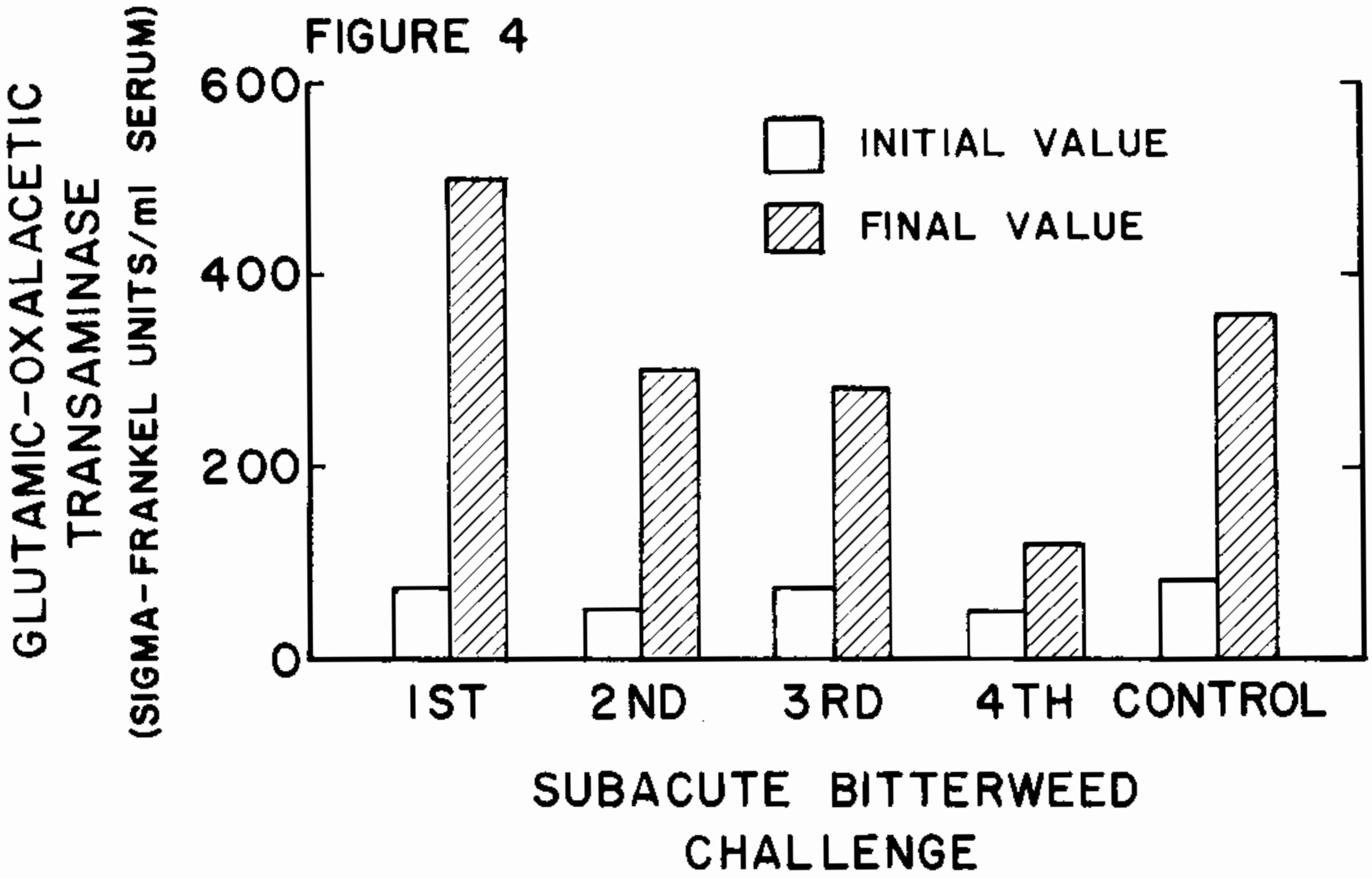

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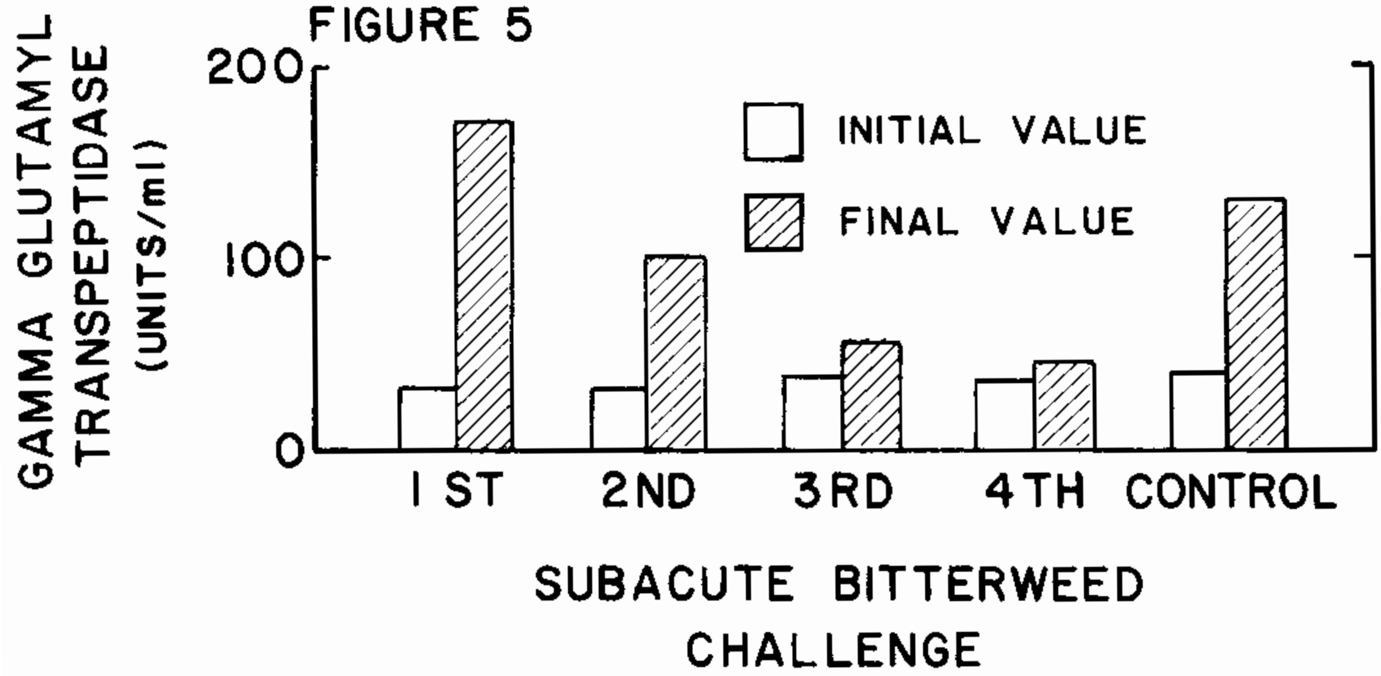

THE EFFECT OF NATURAL PROTEIN ON BITTERWEED POISONING IN SHEEP*

B. C. Baldwin, Jr. and M. C. Calhoun

SUMMARY

The results of this study indicate some protection against bitterweed (Hymenoxys odorata) poisoning is available when using sources of natural protein in higher than normal amounts in the diet. This was indicated when Rambouillet wethers were fed diets containing either 10% or 20% crude protein with cottonseed meal (41%) as the primary source of natural protein and challenged daily for six days with bitterweed at a level equivalent to 0.15% live body weight.

INTRODUCTION

The value of feeding a protein supplement to sheep on bitterweed-infested pasture is a controversial issue. Some ranchers have observed that added dietary protein appears to aggravate the problem; however, a recent study indicates the problem may instead be aggravated by sources of non-protein nitrogen such as urea included in supplements (1). Another study suggests that sources of natural protein such as cottonseed meal tend to reduce the toxic effect of subacute bitterweed poisoning (2). It has also been shown that the combined effect of natural protein and an inorganic sulfur source such as sodium sulfate in the diet is beneficial in acute bitterweed poisoning (3).

This study was designed to test further the protective ability of natural protein against subacute bitterweed poisoning by comparing two diets with different protein levels using cottonseed meal (41%) as the source of natural protein.

EXPERIMENTAL PROCEDURES

Twenty Rambouillet wether lambs, average weight 99.8 pounds, were selected for this study. They were housed individually in 4' x 6' raised pens with expanded metal floors.

Fourteen lambs selected for bitterweed challenge were paired in order of susceptibility to bitterweed poisoning (4). Then each pair was randomized to treatments (5). The six remaining lambs were used as a

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* This research was supported in part by the Natural Fibers and Food Protein Commission of Texas. Appreciation is expressed to Dr. Bennie J. Camp (Professor, Department of Veterinary Physiology and Pharmacology, College Station, Texas) for determination of hymenoxon concentration of bitterweed.

control group and also randomized to treatments. The treatments were complete rations which contained either 10% or 20% crude protein (Table 1). Cottonseed meal was used to adjust the crude protein in the rations.

All lambs were on their respective treatments one week before the bitterweed challenge period, and the treatments were fed *ad libitum* with the feeders being replenished each morning after the leftover feed from the previous day had been picked up. As the challenged lambs reduced their feed intake during the bitterweed challenge period, the feed given to the control lambs was reduced an equal amount. This was done to allow the assessment of differences in the blood parameters that might be associated with feed reduction that could be misinterpreted as a reaction to bitterweed intoxication.

The bitterweed challenge consisted of a six-day period with each lamb daily receiving, bitterweed equivalent to 0.15% live weight on an air-dry basis. Dried bitterweed,[1/] ground through a 1 mm screen, and mixed with enough water to pass through a stomach tube was used to challenge the lambs.

Blood samples were taken via jugular venipuncture starting on the first day of the bitterweed challenge period and subsequently on days 4,7, 10 and 13. All samples taken during the challenge period were taken prior to administering the bitterweed dose.

The following measurements were used to determine the effect of natural protein on the response to bitterweed poisoning: feed intake, extracellular blood thiols (-SH), hematocrit (% red blood cells), serum urea nitrogen (SUN), serum glutamic-oxalacetic transaminase (S-GOT) and serum gamma-glutamyl transpeptidase (GGTP).

A paired t-test was used to evaluate the effect of natural protein on response to bitterweed toxicity (5).

RESULTS AND DISCUSSION

Feed intake (Figure 1) was reduced the first bitterweed challenge day, and continued to be reduced for both treatment groups through the fifth day. At that time the lambs on the higher protein treatment showed a slight increase in feed consumption and these lambs went back on feed faster after bitterweed dosing ceased than the lambs on the low protein treatment. The differences between the treatment groups were significant for days 6 and 8 ($P<.05$).

[1/] Bitterweed used was a composite of plants collected from an irrigated field two miles west of Garden City, Texas during April and May of 1978. It was dried in a forced draft oven at < 150° F. The average hymenoxon concentration of this collection was .96% (air-dry basis).

The challenged lambs on the 10% crude protein treatment showed higher hematocrits (Figure 2) throughout the experiment. This also was true of the control groups, which would indicate some of the differences observed were due to the protein levels and not the reaction to bitterweed. There was observed a more rapid decline in hematocrits in the higher protein level group ($P<.001$) on day 7. This could be associated with the earlier return of that group to feed and water, indicating less dehydration and lower hematocrits.

The initial levels of extracellular blood thiols were greater for lambs receiving the 20% crude protein diet ($P<.05$) (Table 3). Bitterweed administration decreased blood thiols. The pattern of response during the bitterweed challenge period was similar regardless of protein level in the diet and minimum levels were observed on the 7th day for both the 10 and 20% crude protein treatments. Feed restriction produced similar changes in blood thiol levels. Thus the major factors affecting thiol concentrations appeared to be protein level in the diet and feed intake.

Serum urea nitrogen values (Figure 4) were initially higher ($P<.01$) in the lambs on the 20% crude protein treatment, and this group showed no response to the bitterweed challenge. The lambs on the 10% crude protein treatment, however, showed a large response to bitterweed. This difference in SUN activity suggests a beneficial protein effect for the lambs on the higher level of crude protein.

Serum glutamic-oxalacetic transaminase activity (Figure 5) showed a bitterweed response in both groups; however, no protein effect was observed.

The serum gamma-glutamyl transpeptidase activity (Figure 6) seemed to show some protein effect indicated by the discontinued rise in enzyme activity on the fourth day in the 20% crude protein group; however, there was no significant difference between the groups.

The results observed in this study are consistent with those observed in a previous study (2) and collectively indicate increased levels of dietary protein provides some protection from subacute bitterweed intoxication. However, the beneficial value is small and not consistent for all criteria measured. The use of increased levels of natural proteins can only be recommended as a possible aid for ranchers to use as part of an overall program of supplemental feeding and grazing management to reduce bitterweed poisoning losses. The detrimental effect of non-protein nitrogen sources, such as urea, on bitterweed-poisoned sheep needs to be remembered, and urea should not be used in supplements given to sheep on bitterweed pasture.

LITERATURE CITED

1. Post, L.O. and E.M. Bailey, Jr. 1980. The effects of dietary supplements on chronic bitterweed (*Hymenoxys odorata*) poisoning in sheep. Tex. Agr. Exp. Sta. Prog. Rpt. 3698.

2. Baldwin, B.C. Jr., and M.C. Calhoun. 1979. Dietary protein and subacute bitterweed poisoning in sheep. Tex. Agr. Exp. Sta. Prog. Rpt. 3571.

3. Bridges, G.W. 1977. A study of the use of feed supplements for the prevention of experimental bitterweed (*Hymenoxys odorata*) poisoning in sheep. M.S. Thesis. Texas A&M University.

4. Calhoun, M.C. and B.C. Baldwin, Jr. 1980. Sheep tolerance to bitterweed poisoning--variation between animals. Tex. Agr. Exp. Sta. Prog. Rpt. 3695.

5. Steel, R.G.D. and J.H. Torrie. 1980. Principle and procedures of statistics. McGraw-Hill, New York.

TABLE 1. COMPOSITION OF RATIONS

Ingredients (%)	10% Crude Protein	20% Crude Protein
Milo (dry-rolled)	55.35	23.05
Cottonseed hulls	29.90	28.00
Cottonseed meal (41%)	7.75	40.20
Molasses	4.00	4.00
Salt	0.50	0.50
Calcium carbonate	1.50	3.25
Vitamin-mineral premix[1/]	1.00	1.00
	100.00	100.00

[1/] Vitamin-mineral premix ingredients: Sulfur (10%), Potassium chloride (19%), Zinc sulfate (0.27%), Salt (65.48%), Molasses (1.5%), Vitamin A 30,000 IU/g (0.73%), Vitamin D_2 200,000 IU/g (0.02%), Aureofac® 50 (3.0%).

FIGURE 1

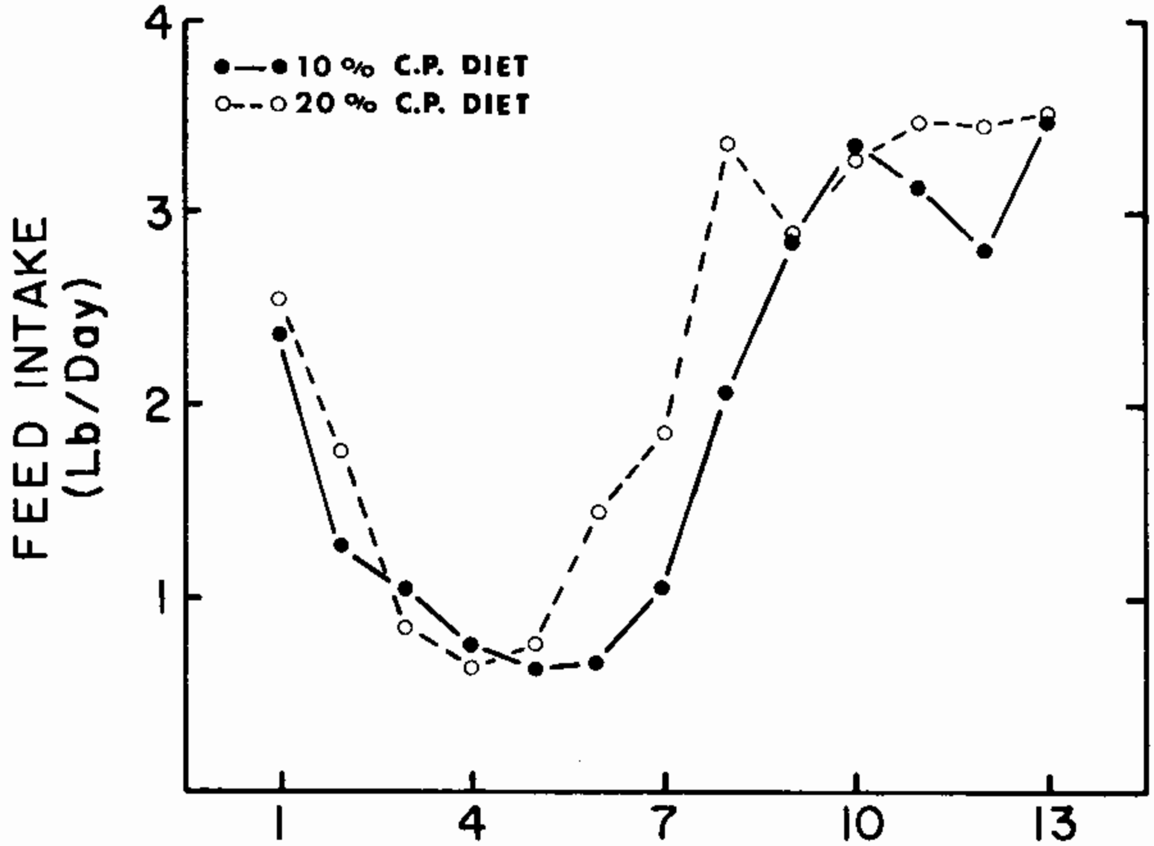


FIGURE 2

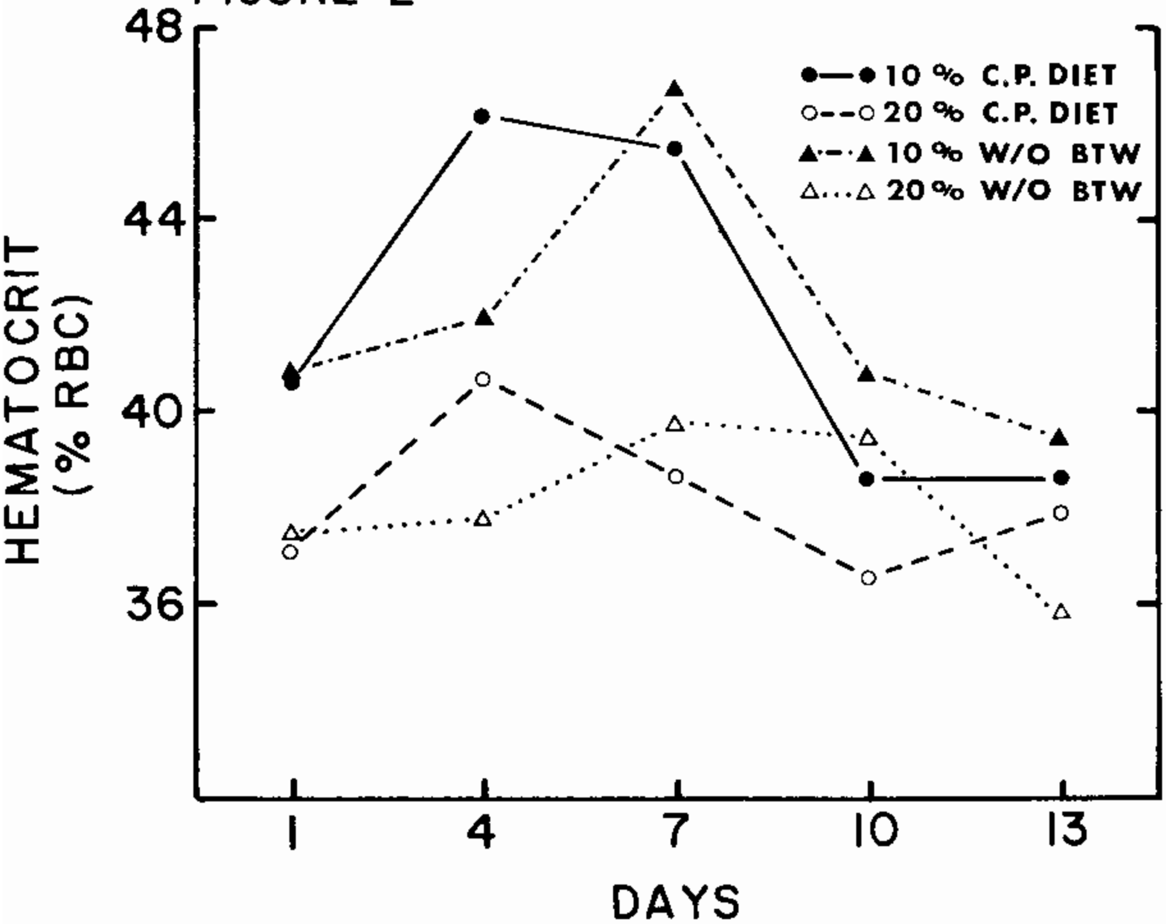


FIGURE 3

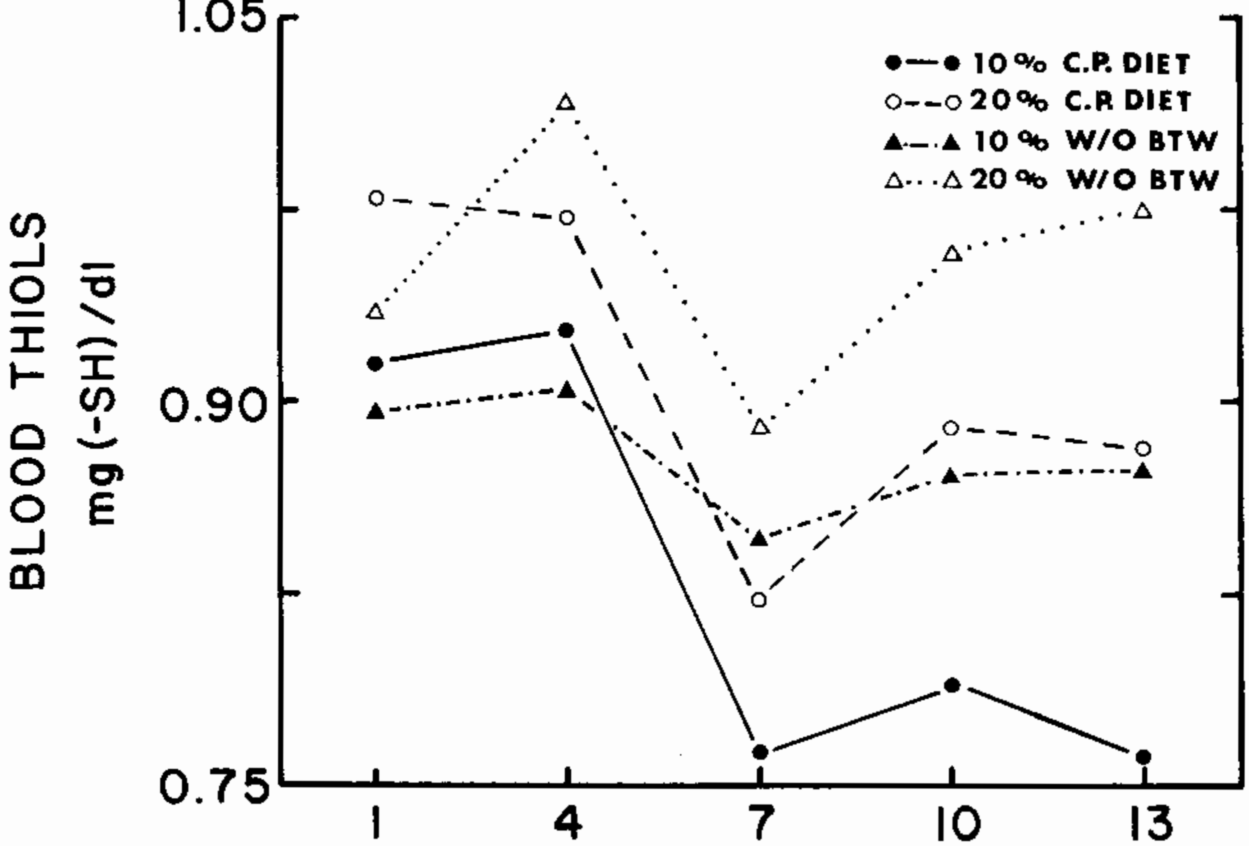


FIGURE 4

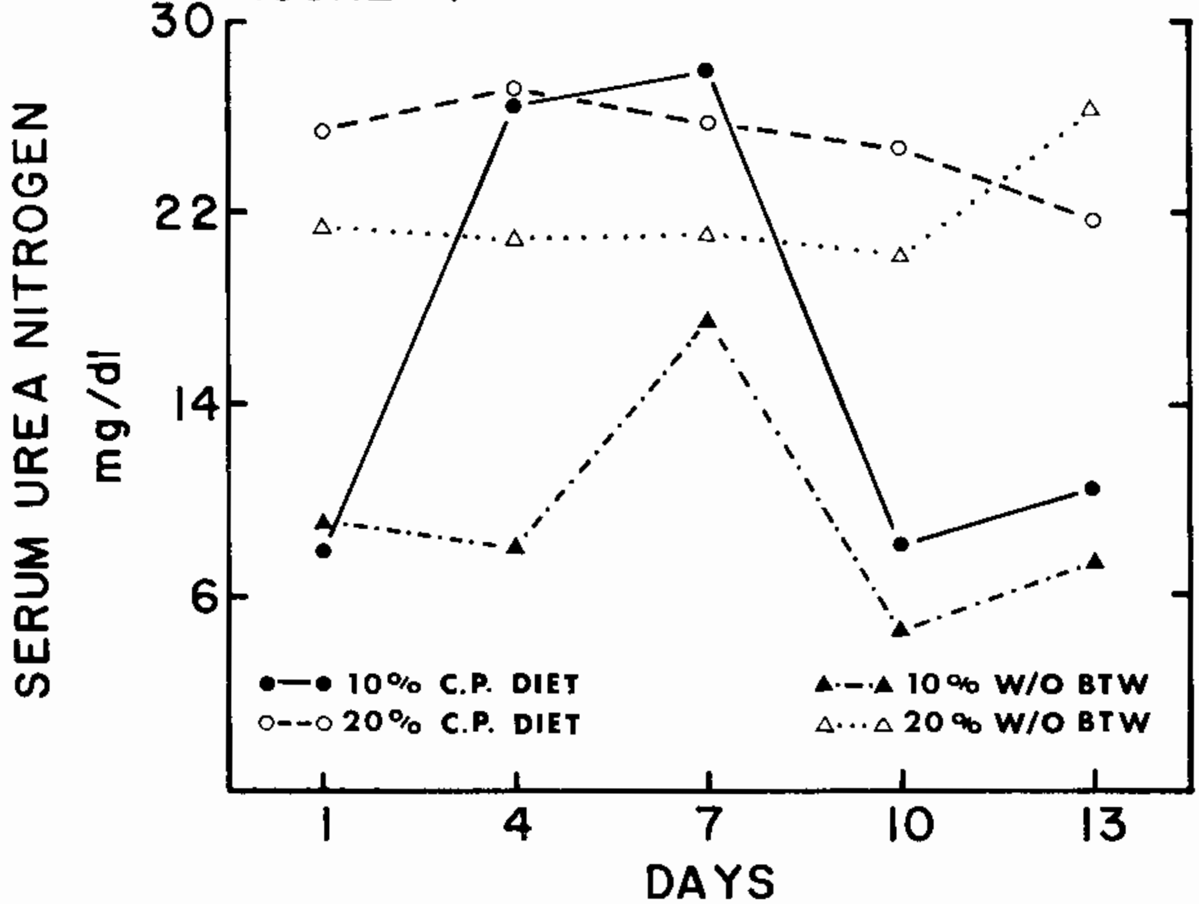


FIGURE 5

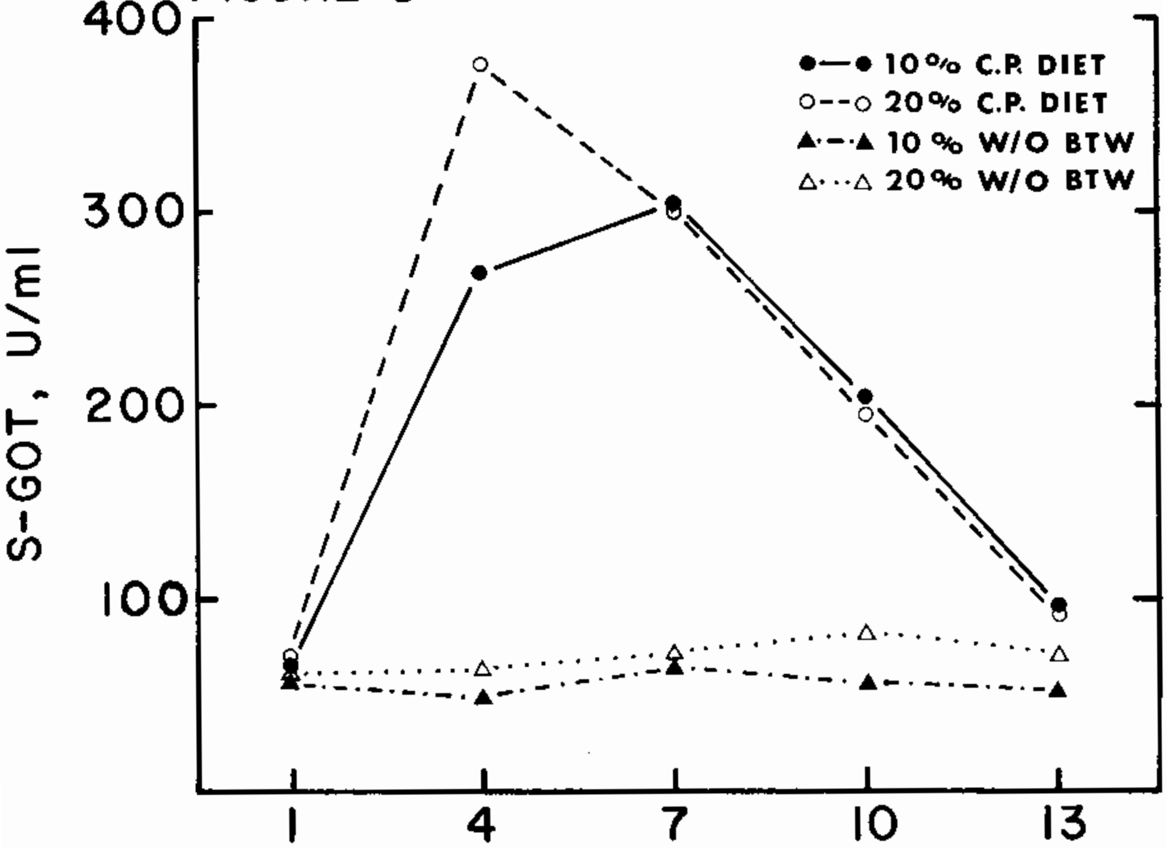
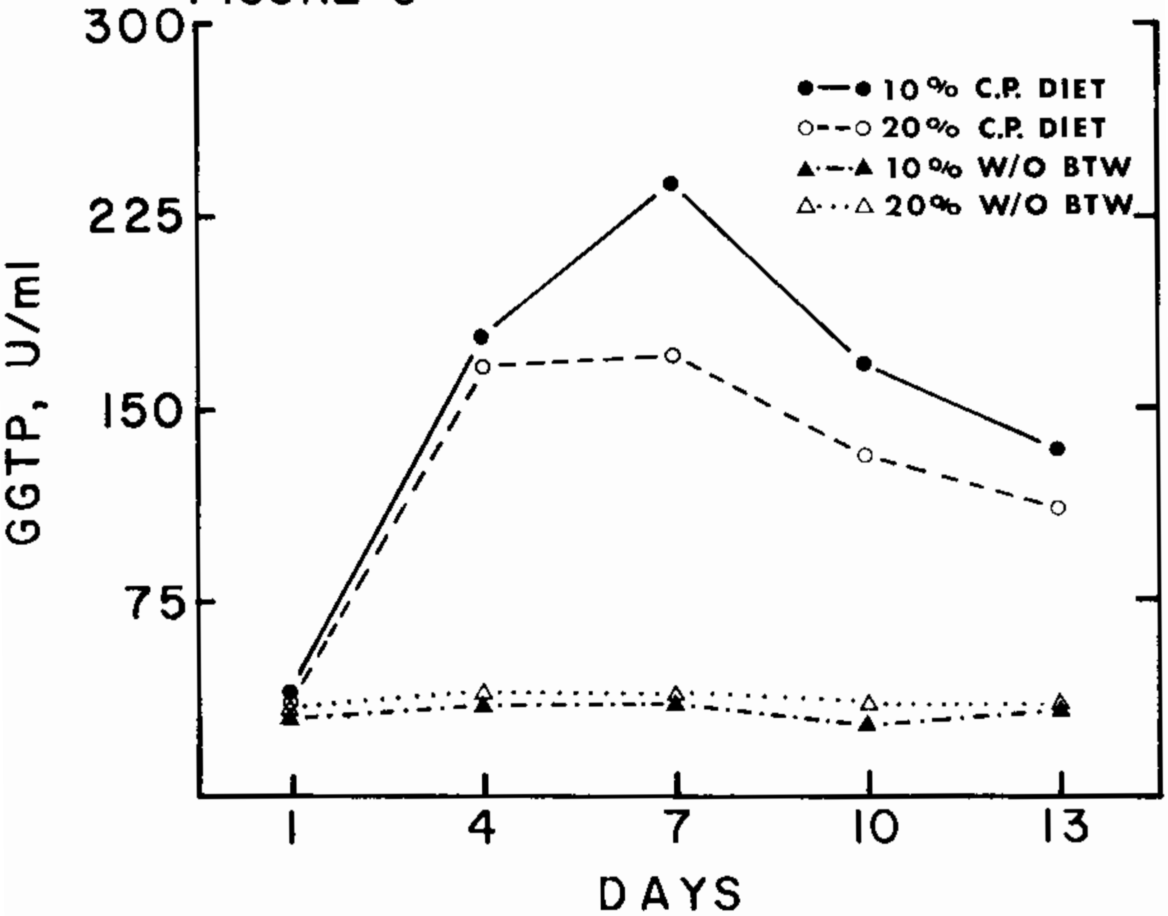


FIGURE 6



RECENT BITTERWEED RESEARCH

M. K. Terry, H. L. Kim and E. M. Bailey

SUMMARY

Hymenolane, a chemical isolated from bitterweed, is apparently non-toxic in sheep. The hamster appears to be a good laboratory model for hymenoxon, in spite of being relatively resistant. Four urinary metabolites of hymenoxon were identified. The mechanism of detoxification of hymenoxon was not elucidated, but a diagnostic method for confirmation of exposure of sheep to bitterweed was developed.

INTRODUCTION

Previous results have raised questions as to whether the toxicity of bitterweed is proportional only to its hymenoxon content, or whether there might be some other constituent of bitterweed that would contribute to the toxicity. One such constituent, hymenolane, was particularly suspected of enhancing the toxicity of hymenoxon. To address such questions, a single-administration oral toxicity test was conducted in sheep, with three dosage levels of each of the following materials: hymenoxon with hymenolane, hymenoxon alone, and whole bitterweed. Equivalent dosages of the bitterweed were determined on the basis of its hymenoxon content, as quantitated by gas chromatography.

EXPERIMENTAL PROCEDURE

The toxic response was evaluated according to lethality and histopathology in those sheep that died, and by levels of selected serum components and loss of body weight in survivors. It was determined that acute intoxication caused by whole bitterweed is qualitatively indistinguishable from intoxication caused by hymenoxon. In particular, hymenolane exhibited no synergistic effect on the acute oral toxicity of hymenoxon. In all three treatments, lethality was associated with high levels of hymenoxon. (See Table 1). These results suggest that hymenoxon is the only toxic principle of significance in bitterweed. A 48-h single-dose oral LD_{50} of approximately 75 mg/kg was determined for hymenoxon in the sheep.

In immature hamsters, biweekly oral administration of hymenoxon at several dosage levels for two months produced weight loss, depression and histopathologic lesions (acute and subacute) similar to those observed in sheep intoxicated with bitterweed/hymenoxon. In spite of the hamster's relative resistance to hymenoxon -- the acute oral LD_{50} was calculated to be 620 mg/kg -- the hamster was found to be an acceptable laboratory animal model for ovine hymenoxon intoxication.

Basal activities of hepatic microsomal aniline hydroxylase were compared in sheep previously determined to be either bitterweed-susceptible or bitterweed-resistant, and no significant difference was found between the susceptible and the resistant sheep. This study suggests that the cytochrome P_{450}-dependent mixed-function oxidase system does not have a central role in the metabolic detoxification of hymenoxon.

Four urinary metabolites of hymenoxon were found by gas chromatography-mass spectrometry. Two of these, epimers of 4-detoxy-11, 13-dihydrohymen-oxon, were isolated as the 2,3-dehydro derivatives by preparative gas chromatography and were characterized by sepctral methods. The transformations undergone by the parent compound to form these metabolites are biologically significant, consisting of two reductions which theoretically should render the metabolites essentially non-reactive toward biomolecules. The GC-MS may be employed as a diagnostic method for the confirmation of exposure of sheep to bitterweed.

TABLE 1---Acute Mortality of Sheep in Response to Treatments

Treatment	Number Dead/Number in Group
Low dosages:	
Hymenoxon 50 mg/kg + hymenolane 25 mg/kg	0/3
Hymenoxon 50 mg/kg given alone	0/3
Whole bitterweed equiv. to hymenoxon 45 mg/kg	0/3
Middle dosages:	
Hymenoxon 75 mg/kg + hymenolane 37.5 mg/kg	1/3
Hymenoxon 75 mg/kg given alone	2/3
Whole bitterweed equiv. to hymenoxon 67.5 mg/kg	0/3
High dosages:	
Hymenoxon 100 mg/kg + hymenolane 50 mg/kg	2/2
Hymenoxon 100 mg/kg given alone	2/2
Whole bitterweed equiv. to hymenoxon 90 mg/kg	2/3

EFFECT OF SUPPLEMENTAL FEEDING ON REPRODUCTIVE RATE IN YEARLING ANGORA FEMALES

J.E. Huston

SUMMARY

A study involving eighty-four yearling Angora females was conducted to determine the effects of supplemental feed on reproductive rate during three periods of the reproductive cycle. Whereas feeding during breeding has negligible effects, feeding during late gestation had a major effect on reproductive rate.

INTRODUCTION

It is well recognized that the reproductive rate in Angora goats is usually below their potential (1). Concentrations of nutrients in range forage fall below requirements by Angora females during late summer and remain low until spring (2). A study was conducted during the fall and winter of 1980-81 to determine the response in Angoras to supplemental feed at different periods of the reproductive cycle.

EXPERIMENTAL PROCEDURE

Eighty-four yearling Angora females were assigned to eight experimental groups at fall shearing. The groups were equalized according to weight. Three periods were identified for supplemental feeding of the different groups (Table 1). Breeding season was from September 15 to November 30. All goats were grazed in a common pasture, and feeding was accomplished by individually penning and feeding the appropriate animals three times per week. The supplemental feed was comprised of 57% sorghum grain, 41% cottonseed meal and 2% molasses and contained approximately 24% crude protein. Feeding level was 700 g/goat/feeding.

RESULTS AND DISCUSSION

Relatively large differences were observed among the treatment groups, especially in reproductive rate (Table 2). Weight changes appeared to be related to feeding but were large only during Period 2. Reproductive rate increased with increasing feeding time (Treatments 1, 2, 3 and 5). Feeding during Period 3 had a greater increasing effect than feeding during Periods 1 and 2. Table 3 shows the summarized results of feeding during Periods 1, 2 and 3, with the effects of feeding during the other periods held constant. Feeding prior to and during breeding had a negligible effect on net reproductive rate. Feeding during early gestation (Period 2) had a greater effect on reproduction. However, the greatest effect of feed on reproduction was during late gestation and early lactation (Period 3).

Results of this study indicate that under the condition of this study, all goats had a high conception rate. Most of the losses in reproduction were either from abortions during mid-pregnancy or perinatal death. Feeding during these critical periods effectively reduced losses. Efforts were made to record losses of fetuses or kids at birth, but few were observed. It is suggested that low reproductive rates that are often attributed to low conception efficiency result from fetal losses late in gestation and can be substantially reduced by supplemental feeding beginning approximately 2 months before kidding.

LITERATURE CITED

1. Shelton, Maurice and Jack L. Groff. 1974. Reproductive efficiency in Angora goats. TAES Bul. 1136.

2. Huston, J.E., B.S. Rector, L.B. Merrill and B.S. Engdahl. 1981. Nutritional value of range plants in the Edwards Plateau region of Texas. TAES Bul. 1357.

TABLE 1. EXPERIMENTAL TREATMENT ASSIGNMENTS FOR YEARLING ANGORA FEMALES IN A SUPPLEMENTAL FEEDING STUDY

Experimental Groups	Feeding Periods[1]		
	1 (9/15 - 10/15)	2 (10/16 - 1/15)	3 (1/16 - 3/20)
1	-	-	-
2	+	-	-
3	+	+	-
4	+	-	+
5	+	+	+
6	-	+	-
7	-	+	+
8	-	-	+

[1]The -'s and +'s indicate that the groups were either unfed or fed during the respective periods.

TABLE 2. EFFECTS OF SUPPLEMENTAL FEEDING AT THREE PERIODS ON WEIGHT AND REPRODUCTIVE RATE IN YEARLING ANGORA FEMALES

Experimental Groups	Treatment Code[1]	Weight Change During Period 1	2	3	Total Weight Change	Kidding Rate: Observed Births	Live Kids
1	- - -	-2	6	1	5	.58	.42
2	+ - -	-2	5	1	4	.75	.62
3	+ + -	1	10	-4	7	.78	.67
4	+ - +	1	3	4	8	.90	.80
5	+ + +	2	11	0	13	1.00	1.00
6	- + -	-1	11	-2	8	.80	.70
7	- + +	-2	14	-1	11	1.12	1.12
8	- - +	-2	3	6	7	1.00	.89

[1]Table 1.

TABLE 3. EFFECTS OF SUPPLEMENTAL FEED DURING DIFFERENT PERIODS OF THE REPRODUCTIVE CYCLE ON REPRODUCTIVE RATE IN YEARLING ANGORA FEMALES

Period of Treatment Comparison	Reproductive Rate (live kids/female in flock) Unfed (-)	Fed (+)
Period 1	.74	.78
Period 2	.67	.86
Period 3	.59	.95

THE RELATION OF CERTAIN BLOOD PARAMETERS TO ABORTION IN ANGORA GOATS

Maurice Shelton, Gary Snowder, Max Amoss and J. E. Huston

SUMMARY

Abortion remains a problem for goats in general and more especially Angora goats. A study was conducted utilizing 24 aged Angora does which had been diagnosed as pregnant by use of ultrasound. These were placed on a low quality diet and weekly determinations were made for blood glucose, progesterone, estrogen and cortisol. These values were evaluated in respect to the dates on which abortion occurred. Blood glucose and progesterone values tended to decrease with advancing pregnancy or approaching abortion. Blood progesterone values appear to be in the normal range as compared to literature values, and are not thought to provide a primary explanation for abortion. On the other hand low blood glucose values appear to be associated with impending abortion, and values of 30 mg/100 ml or less could be used to predict abortion. Low blood glucose values did not provide an explanation for all the observed abortions. It is suggested that hyperadrenalism might provide an explanation for others. In practical terms it appears to be important that does be adequately fed and managed to prevent poor nutrition or disruption of feed intake from contributing to abortion. Protection against abortion due to hyperadrenalism should be concentrated in identifying habitual aborters. Normally these should be removed from the flock, but in times of high mohair prices they may be kept to produce fiber. In this case it is important to assure that there is no possibility of stud males being kept from them. There should be no great danger of unfavorable genetic contribution if they are left in a commercial doe flock, as perennial aborters would leave very few offspring.

INTRODUCTION

Low reproductive efficiency is a problem with Angora goats. Abortion has been identified as one cause of low kid crops. Most flocks experience a low level of abortion, but at times or in some flocks losses can become catastrophic. Other types of goats are known to be subject to abortion which, like that of the Angora, is apparently not explained by infection, suggesting that this weakness is a characteristic of the species. However, losses with other types are less frequently observed, and the differences between these and the Angora may provide a partial explanation for this problem. One of the differences between Angoras and non-Angoras is the generally small size of the former and the nutrient drain associated with mohair production. Losses are generally thought to be associated with periods of stress. The present study was undertaken to measure various blood parameters which might reflect nutritional status, degree of stress and reproductive status based on levels of circulating hormones associated with gestation and parturition.

EXPERIMENTAL PROCEDURE

A group of aged Angora does, which had been purchased at local auctions, were available from another study conducted in the fall of 1979 (see TAES PR-3703). On February 7, 1980, the does (24 head) which could be diagnosed as pregnant by use of an ultrasonic device were placed on a study concerned with abortion. The original protocol called for placing the does on rations containing two different energy levels and collecting blood samples at weekly intervals on which blood sugar (glucose), progesterone, estrogen and cortisol would be determined. Blood glucose is a measure of energy available to the animal. Progesterone and estrogen are hormones associated with reproduction. Cortisol is a hormone produced by the adrenal gland. Abortions were to be recorded and compared with blood values obtained on the dates closest to that on which the abortion was observed. Feed treatments were not successful or appear not to have influenced the results, because some of the does started aborting immediately (i.e. one aborted while being weighed on the experiment). Also the does sorted out the ration ingredients to the extent that the original ration treatments were not successfully imposed. Generally the does were in medium condition when the test started and lost weight during the test period. All does either aborted or gave birth to weak kids and only two does dropped live kids and only one of these raised her offspring. The ration treatments were not considered to have been successfully applied and have been ignored in presenting the results. The collection of blood samples was terminated on April 17 after all does had aborted or kidded.

RESULTS AND DISCUSSION

The blood parameter measurements shown in Table 1 and Figure 1 are expressed relative to the date of abortion (including birth of live kids). Since the does were not all present for the same time prior to or following abortion the numbers contributing to the various mean values are not the same. The actual number of determinations is recorded in Table 1. These data show a gradual decline in blood sugar and progesterone in the weeks preceding parturition. There is a marked drop in progesterone following parturition. This is entirely normal and expected since progesterone in the goat originates from the corpus luteum which regresses promptly following abortion or kidding. The rise in progesterone beginning at approximately three weeks past abortion apparently results from some of the earlier-aborting does initiating estrual cycling following regression of the corpus luteum. This is also the apparent explanation for the post-abortion rise in estrogen. The declining progesterone levels in the weeks prior to parturition apparently follows the normal pattern (3) and is not thought to be a primary cause of abortion. Even with the reduced values observed, the level of progesterone present should be adequate to support pregnancy. The estrogen levels prior to abortion apparently originate with the placenta, and the precipitous drop following parturition naturally follows from the expulsion of the placenta. Workers from South Africa (2) have suggested elevated estrogen levels as the direct cause of abortion in those does which abort in response to stress in the 90 to 110-day stage of gestation. This study does not necessarily confirm this, but the absence of the obvious relationship may be due to the collection of weekly samples missing the peak, and to the fact that some abortions were past 110 days of gestation. In this study the most obvious changes associated with the time of abortion are the low blood glucose and/or elevated cortisol levels. In this study 18 of the 24 does had blood glucose levels below 35 mg/100 ml at the last determination before abortion occurred. Of the remaining six, one aborted before a glucose determination was made. Five showed cortisol values in connection with abortion. Only one animal which aborted failed to show evidence of either a low blood glucose or a high cortisol level (see Table 2). This study plus earlier reports (1) appears to confirm that in general the Angora goat aborts in response to nutritional stress which may be predisposed by a hearty nutrient drain for fiber production, low nutrition intake, interrupted foraging, etc. This type of abortion tends to be concentrated in the period from 90 to 120 days, and it is much less evident thereafter.

Workers in South Africa (2) have presented a tentative explanation in that the fetal adrenal becomes hyperactive as a result of the low blood glucose, and at this stage of fetal development the output of the fetal adrenal has estrogenic properties or serves as an estrogen precursor. Since estrogen is a potent abortifacient the fetus is expelled in a live or fresh state.

Data from this study does not confirm or deny that estrogen is the primary abortifacient, but does tend to confirm that hypoglycemia is a predisposing factor, or conversely that low blood glucose values could be used to predict impending abortion. Thus theoretically this type of abortion could be almost completely overcome by insuring an adequate and continuous nutrient intake, but it may well be that with some animals fiber production has a sufficiently high priority for nutrient use that they will suffer nutritional stress in late pregnancy even under good conditions. These data appear to suggest supplemental feeding of pregnant does.

Not all abortions can be explained by low blood glucose. Many may be explained by hyperadrenalism of either fetal or parental origin. Animals which abort in response to hyperadrenalism will usually expel a fetus which has been dead for several days and may be edematous or partially autolized. This type of abortion may result from a period of nutritional or other stress in the later stage of gestation or from an habitually aborting doe. A small percent of the does in most flocks will become habitual aborters. At the present time it is not known if this is due to an inborn genetic defect or if there is a tendency for an initial stress aborter to become a habitual aborter via a mechanism which is not presently understood. At the present time a firm recommendation should be made to identify those which are habitual aborters. They should certainly be culled from flocks in which breeding males are kept. Occasionally these does may produce a live kid, and this animal should not be kept for breeding purposes. If numbers are to be culled from commercial flocks the habitual aborter should be a prime candidate. However, if mohair is high priced they might be kept for the hair they produce. In a commercial flock the occasional offspring left by the habitual aborter is not likely to have a significant adverse effect on the flock as a whole.

LITERATURE CITED

1. Shelton, M. and J. Groff. 1974. Reproductive efficiency in Angora goats. Texas Agricultural Experiment Station Bu. 1136.

2. Wentzel, D. and K. S. Viljoen. 1975. The habitually aborting Angora doe. VI. Induction of abortion by the administration of exogenous oestrogens. Agroanimalia 7:41-44.

3. Wentzel, D., J. C. Morgenthal and C. H. Van Niekerk. 1975. The habitually aborting Angora doe. III. Luteal function in normal and aborter does. Agroanimalia 7:15-22.

TABLE 1. Weekly Determinations of Certain Blood Parameter Estimates Expressed Relative to Date of Abortion or Premature Parturition

ESTROGEN - pg/ml	551.6	522.4	521.3	543.9	524.6	462.1	524.1	A	151.9	129.3	130.6	273.9	330.6
% of Initial	1.00	.95	.95	.99	.95	.84	.95		.28	.23	.27	.50	.60
CORTISOL - mg/dl	2.32	2.57	2.75	2.33	2.12	2.08	2.63	B	2.48	3.00	1.81	2.00	1.40
% of Initial	1.00	1.11	1.19	1.00	.91	.90	1.13		1.07	1.29	.78	.86	.60
PROGESTERONE - pg/ml	6818	6529	6078	5556	6376	4969	4324	O	348	436	629	1618	2649
% of Initial	1.00	.93	.89	.81	.94	.73	.63		.05	.06	.09	.24	.39
BLOOD SUGAR - mg/100 ml	44.93	42.41	42.23	41.15	40.50	38.24	30.25	R	41.88	40.92	42.00	44.12	43.92
% of Initial	1.00	.94	.94	.92	.90	.85	.67		.93	.91	.93	.98	.98
Number in Group By Weeks	10	11	13	16	20	22	22	T	22	11	6	2	2

TABLE 2. Blood Glucose or Blood Cortisol Values of Does Tentatively Diagnosed as Aborting In Response to Hypoglycemia or Hyperadrenalism

	Units	Values Expressed in Weeks Prior to or Following Parturition							
Mean Glucose Values for Does Possibly Aborting in Response to Low Blood Glucose	mg/100 ml	46.1 (7)	43.0 (8)	42.2 (10)	40.5 (12)	39.8 (15)	37.7 (17)	27.0 (17)	40.1 (14)
Mean Cortisol Values in Does Possibly Aborting in Response to Adrenal Hyperactivity	mg/dl	2.5 (1)	2.9 (1)	4.6 (2)	2.0 (3)	3.2 (3)	2.8 (4)	4.7 (5)	3.5 (4)

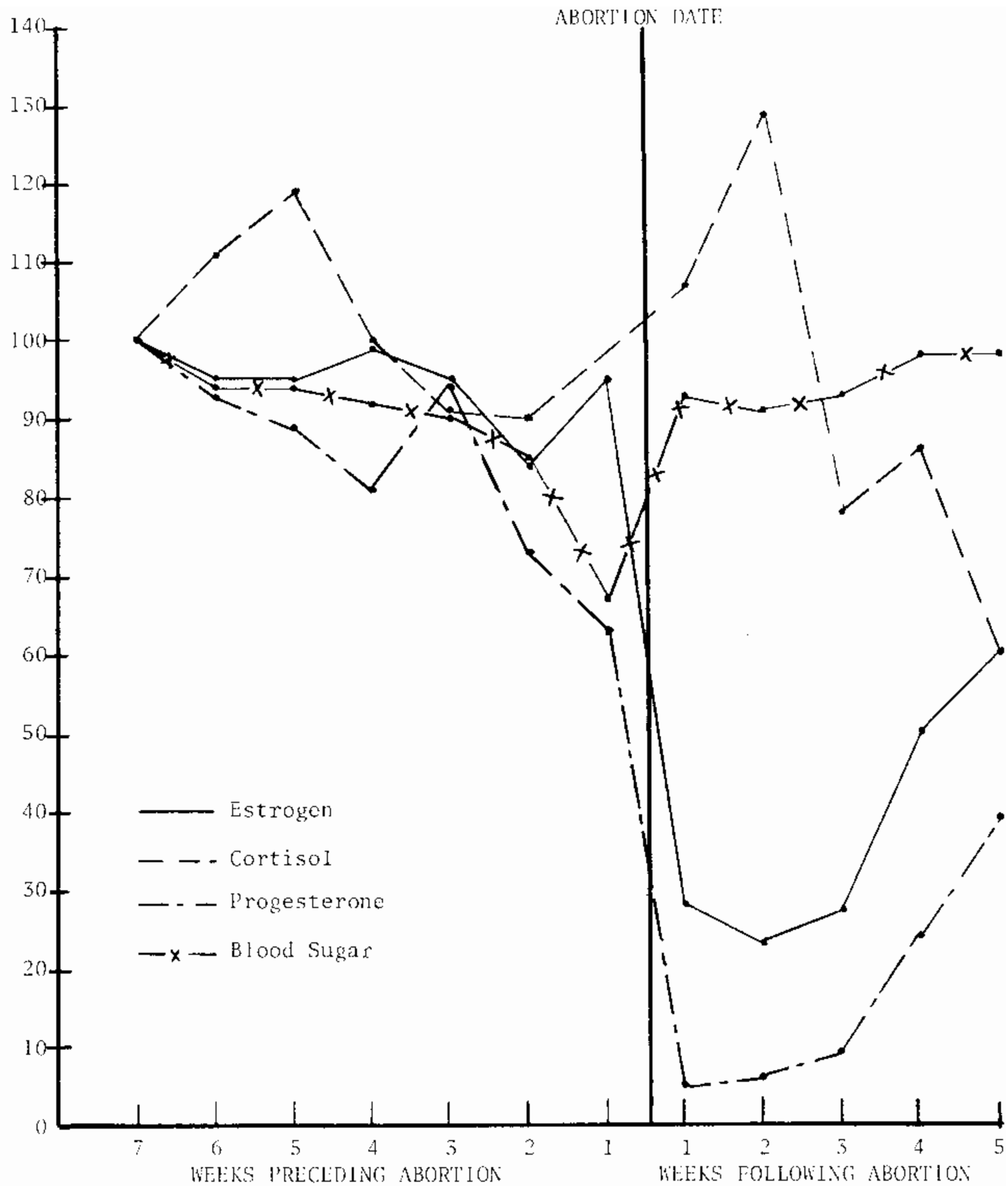


FIGURE 1. THE RELATION OF CERTAIN BLOOD PARAMETERS OF DOES TO DATE OF ABORTION

WEEKLY DETERMINATIONS EXPRESSED AS % OF INITIAL VALUES

KIDDING SYSTEMS FOR ANGORA DOES

Carl Menzies, Maurice Shelton, George Ahlschwede and Don Spiller

SUMMARY

Angora does were kidded in confinement in small traps (15 to 60 acres), and in pastures (approximately 640 acres) during 1978, 1979 and 1980 to evaluate the effect of these management systems on kid production. Even though the spring kidding seasons these three years were relatively mild, does kidded in confinement raised more kids than others. Average kid crops over the three years were 87%, 71 % , and 64 % , respectively, for does kidded in confinement, traps, and pastures. The cost of increased labor, feed, and capital must be compared with the value of kids raised to determine the economic value of the systems.

INTRODUCTION

Low kid crops, relative to the high reproductive potential, have prevented a buildup in numbers of Angora goats and has adversely affected income from goats. Economical techniques that will improve kid crops are needed. Nutritional deficiencies, predators, inclement weather, and diseases are major causes of low kid crops. Improved mohair prices and increasing numbers of predators make practices that previously were too costly now appear economically feasible. It was once quite common for ranchers to shed or stake kid does; however, such practices were abandoned by most ranchers when hair prices dropped and labor became scarce and more costly. This study was initiated to provide data to compare three management systems for kidding does in the Edwards Plateau.

EXPERIMENTAL PROCEDURE

During kidding seasons of 1978, 1979, and 1980, part of the Angora doe flock on the Hill Ranch in Edwards County was divided into three treatment groups (Confinement, Trap and Pasture). The kidding season test period varied from 41 to 44 days and started on February 27 in 1978, March 12 in 1979 and March 26 in 1980. Does in the confinement group were sheared slick while capes were left on does in the other two groups not having access to shelter.

The does kidded in confinement were kept in the drylot with access to shelter. They were fed a ration consisting primarily of suncured alfalfa pellets but were fed additional sorghum grains at times. At least twice daily, does were checked, and those which had kidded were placed with their kids in a mothering stall where they remained for one to several days depending on the well-being of the kids and the demand for stalls. Upon removal from stalls, does and kids were combined in a separate drylot group with access to shelter.

A special portable unit of stalls was constructed. This unit has eight stalls approximately 4' x 4' (four on each side divided by a partition and a central watering pipe). The floor is constructed of rolled expanded metal. Some problems were encountered with small kids getting their feet through the openings in the expanded metal.

The Trap groups were kidded in small 15 to 60-acre traps. This prevented does from getting very far from their kids. The Pasture does were kidded in 400 to 640-acre pastures. Both groups had no shelter and were self-fed a 15 to 20% crude protein salt-limited feed.

RESULTS AND DISCUSSION

Reproductive performance, feed, and estimated labor requirements are reported by years in Tables 1, 2 and 3. A summary of the three years is reported in Table 4. Even though the weather was relatively mild during the kidding season these three years, does kidded in the barn raised 87% kid crops, compared to 71% in traps and 64% in pastures. No known predation occurred.

More feed and labor was required to maintain does in confinement than those given no special care at kidding and self-fed supplemental feed in traps or pastures. Approximately 30 minutes daily was required to care for the small groups of does kidded in confinement, compared to the short time required to check self-feeders in traps and pastures. However, does in traps and pastures had to be gathered so that capes could be removed.

These three years of data compare these kidding systems under a certain set of conditions, which for these years consisted of mild weather and little or no predation. Spells of cold wet weather and predation by eagles, coyotes or other predators could drastically lower the kid production obtained in traps or pastures. Assuming the availability of ranch facilities and favorable prices, these results support the desirability of more intense management at kidding. Each producer will have to estimate the improved production believed to be possible from extra inputs of feed, labor and facilities and balance this against the costs. A general estimate of economics of these systems using the kid production obtained and extra costs associated with each system used in this test is given in Table 5. Using these data collected under the existing conditions, kidding in traps or in confinement would have been about equally more profitable than kidding in pastures.

Producers need to prepare for high kid crops throughout the year, as many practices other than just management at kidding affect kid production. It should be pointed out in this study using mixed aged does that only 84% (117) of the 139 does which were assigned to the confinement group actually kidded. Attention must be directed to culling, proper nutrition throughout the year and an overall good flock health plan in order to obtain good kid crops.

TABLE 1. REPRODUCTIVE PERFORMANCE, FEED, AND LABOR REQUIREMENTS (44 days, 2/27 to 4/12, 1978)

	Confinement	Trap	Pasture
Does Assigned	42	42	41
Does Surviving	42	42	40
Does Kidding	35		
Kids Born	37		
Kids Raised	35	28	24
Kidding % of Does Assigned	83.3	66.7	58.5
Feed per Doe, Lbs.	116	36[a]	25[a]
Estimated Labor, Hrs.	22	5	5

[a]Supplemental feed while on pasture.

TABLE 2. REPRODUCTIVE PERFORMANCE AND FEED REQUIREMENTS (43 days, 3/13 to 4/25, 1979)

	Confinement	Trap	Pasture
Does Assigned	49	50	50
Does Surviving	48	49	50
Does Kidding	42		
Kids Born	49		
Kids Raised	45[a]	41	33
Kidding % of Does Assigned	91.8	82	66
Feed per Doe, Lbs.	130	23[b]	20[b]

[a]Includes 3 kids raised on milk replacer.
[b]Supplemental feed while on pasture.

TABLE 3. REPRODUCTIVE PERFORMANCE AND FEED REQUIREMENTS (41 days, 3/26 to 5/6, 1980)

	Confinement	Trap	Pasture
Does Assigned	48	46	46
Does Surviving	47	42	42
Does Kidding	40		
Kids Born	47		
Kids Raised	41[a]	29	31
Kidding % of Does Assigned	85.4	63	67.4
Feed per Doe, Lbs.	123	59[b]	39[b]

[a]Includes 5 kids raised on milk replacer.
[b]Supplemental feed while on pasture.

TABLE 4. SUMMARY DATA, 1978, 1979, 1980

	Confinement	Trap	Pasture
Does Assigned	139	138	137
Does Surviving	137	133	132
Does Kidding	117		
Kids Born	133		
Kids Raised	121[a]	98	88
Kidding % of Does Assigned	87	71	64
Feed per Doe, Lbs.	123	39[b]	28[b]

[a]Includes 3 kids in 1979 and 5 kids in 1980 that were raised on milk replacer.
[b]Supplemental feed while on pasture.

TABLE 5. ESTIMATED ECONOMICS (100 head, 40-day period)

	Confinement	Trap	Pasture
Value of kids raised @ $45[a]	$3,915.00	$3,195.00	$2,880.00
Shearing off capes @ 60¢	$ - 0 -	$ 60.00	$ 60.00
Supplemental feed[b]	$ 840.00	$ 180.00	$ 180.00
Labor[c]	$ 157.50	$ 35.00	$ 35.00
Depreciation on facilities and equipment	?	?	?
Value of kids above kidding costs	$2,917.50	$2,920.00	$2,605.00

[a]Based on average kid crops raised over three-year study and $45 per head value.
[b]Confinement 3.0 lbs/head/day at $140 per ton; Trap and Pasture self-fed salt limited (.50 lb/day consumption), 20% crude protein feed at $180/ton. No value included for cost of pasture for does kidded in traps or pastures.
[c]Estimated labor at $3.50 per hour - 45 hours for Confinement, 10 hours for Trap and Pasture.

FACTORS INFLUENCING TESTES SIZE OF YEARLING RAMBOUILLET RAMS

Gary D. Snowder, Maurice Shelton and Don Spiller

SUMMARY

Scrotal circumference measures were taken on 909 yearling Rambouillet rams over a 3-year period. Testes measures were analyzed along with data from performance tests. Body weight was found to have the highest correlation to testes size. The most useful equation predicting testes size in centimeters was 9.0214 +.1123 body weight -.0001 (body weight)^2. Significant differences ($P<.01$) between sire groups and flocks were found. Multiple birth rams had significantly larger testes than single born rams. Age of dam, head type, and month of birth did not influence testes size. Correlations among testes measures, body weights, and wool traits are presented. Little or no relation was found between testes size and wool traits.

INTRODUCTION

The size of the testes in rams is a good estimate of the capacity of testicular tissue to produce spermatozoa (2). Knight (1) showed that in rams the testicular tissue produced about $20x10^6$ sperm/gm per day, regardless of the size of the testes. Therefore, larger testes can be expected to produce more sperm per day. This strong relationship between testes size and spermatozoa production suggests that testicular size should be considered in ram selection not only because it may reflect their breeding potential, but because it is possibly related to fertility in the ewes sired by them. However, ovine testicular size is influenced by several factors, including season (4), protein and energy content of diet, and level of feed intake (3). This study was conducted to examine other factors which may influence testes size and to identify relationships of ram performance test traits to testes size.

EXPERIMENTAL PROCEDURE

A total of 909 Rambouillet rams over a 3-year period was measured for testes circumference at the end of approximately 140 days on test at the Sonora Research Station. An initial testes circumference measure was taken the third year on 301 rams after 30 days on feed. Testicular circumference of individual testes were measured by a scrotal tape slipped over the scrotum containing only one testis and pulled around the greatest diameter of the scrotal contents. An average of the left and right testes circumference was used.

Statistical analysis of the data included correlations of initial and final testes circumference on growth and wool measures. The effects of horn type, flock, birth type, age of dam, ram age and weight were determined by analysis of variance, multiple range tests and regression analysis.

RESULTS AND DISCUSSION

A major portion of the variability of testes size between rams can be explained by the differences of age and weight of the rams. Table 1 shows the mean testes circumference of rams at different ages. There is a gradual increase in size as age increases. These differences due to age are significant ($P<.01$) with rams less than 13 months of age differing significantly from older rams ($P<.05$). Table 2 shows the increase in testes size as measured by the means of different weight groups in 20 pound increments from less than 110 pounds to greater than 290 pounds. In those rams where initial scrotal measures were taken there was a mean 49.9% increase in body weight and a 29.2% increase in scrotal measures. The relationships of age and body weight to testes size was examined by stepwise regression analysis. Body weight is a more accurate measure to predict testes size than age in young growing rams. The most useful equation ($r^2=.55$) in predicting testes size is a quadratic model:

$$\text{testes size (cm)} = 9.0214 + .1123X - .0001X^2$$

where X=body weight (lbs.)

The size of the testes seems to be influenced by several other factors. After adjusting the size of the testes for body weight to reduce the effects of differences of body size, testes size was affected by flock or breeder and sire effects. These significant differences ($P<.01$) between sire groups and individual flocks indicate selection for this trait might be effective. However, an attempt to measure the heritability of testes size by half-sib analysis yielded values greater than one, possibly due to the highly selected population of rams on test and to pretest environment. Multiple-born rams had larger testes ($P<.01$) than single-born rams. Testes circumference of single born rams ($n=264$) was 25.13 cm compared to 25.57 cm for multiple born rams ($n=125$).

Several variables were found not to be significantly related to testes size. Month of birth, regardless of age, did not affect size. Age of dam and head type, horned vs. poll, were not related to testes size.

Correlation coefficients between testes measures, body weight and wool measures are found in Table 3. No significant relationships of testes size to measures of belly wool, face covering and wrinkles were found and are therefore not reported. Correlations of initial and final testes measures with clean wool, staple length and fiber diameter were significant ($r=-.10-.25$), but of low magnitude. Even these low values can likely be explained by the relationship of body weight and testicular measurements. Average daily gain also shows only a small relationship to final testes size ($r=.21$). Initial testes size is not a strong indicator of final testes size ($r=.58$) as would be suspected since final weight and feed intake (3) play an important role.

Testes size is influenced by many factors found in this study including age, weight, sire, flock and birth type. Thus selection for testes size becomes rather complex. Incorporation of testes size into a selection index of a performance test for rams is questionable at the present time due to these environmental influences and to the lack to date of a demonstrated response in ewe fertility resulting from selection for testicular size.

LITERATURE CITED

1. Knight, T. W. 1977. Methods for the indirect estimation of testes weight and sperm numbers in Merino and Romney rams. New Zealand Journal Ag. Res. 20:291-296.

2. Lino, B. F. 1972. The output of spermatozoa in rams. Aust. J. Biol. Sci. 25:359-366.

3. Oldham, C. M., N. R. Adams, P. B. Gherards, D. R. Lindsay and J. B. Mackintosh. 1978. The influence of level of feed intake on sperm-producing capacity of testicular tissue in the ram. Aust. J. Ag. Res. 29:173-179.

4. Ortavant, R. 1958. Le cycle spermatagenetiqu chez le belier. D. Sc. Thesis, Universite de Paris.

TABLE 1. MEAN TESTES CIRCUMFERENCE AND BODY WEIGHT OF YEARLING RAMBOUILLET RAMS AT DIFFERENT MONTHS OF AGE.

AGE (mo.)	NUMBER	TESTES CIRCUMFERENCE (cm)	BODY WEIGHT (lbs.)
11	89	24.99	192.97
12	156	24.58	189.98
13	90	25.56	199.65
14	215	25.97	207.86
15	85	26.13	212.12
16	64	26.21	226.06
17	52	26.72	208.35

TABLE 2. MEAN TESTES CIRCUMFERENCE OF YEARLING RAMBOUILLET RAMS AT DIFFERENT BODY WEIGHTS

BODY WEIGHT (lbs.)	NUMBER	TESTES CIRCUMFERENCE (cm)
less than 110	8	18.43
111-130	22	20.96
131-150	50	21.86
151-170	52	22.79
171-190	55	24.71
191-210	99	25.73
211-230	147	26.57
231-250	88	27.50
251-270	39	28.40
271-290	5	28.05
greater than 290	2	30.65

TABLE 3. CORRELATION COEFFICIENTS BETWEEN TESTES MEASURES, BODY WEIGHT AND WOOL MEASURES

Measure	Initial Testes Size(cm)	Initial Body Weight(lbs.)	Final Testes Size(cm)	Final Body Weight(lbs.)	Change in Testes Size(cm)	Ave. Daily Gain	Clean Wool (lbs.)	Staple Length (in.)	Fiber Diameter (microns)
Initial Testes Size (cm)	1.00	.63	.58	.58	-.42	n.s.	.25	-.10	.21
Initial Body Weight(lbs.)		1.00	.46	.87	-.16	.20	.36	n.s.	.35
Final Testes Size (cm)			1.00	.46	.50	.21	.25	-.11	.16
Final Body Weight(lbs.)				1.00	-.11	.56	.37	-.09	.38
Change in Testes Size (cm)					1.00	.15	n.s.	n.s.	n.s.

n.s. - Correlation coefficients between variables are not significant ($P<.05$).

EFFECT OF FREQUENCY OF MONENSIN AND PROTEIN SUPPLEMENTATION ON THE DIGESTIBILITY OF A FORAGE DIET BY SHEEP

M. L. Shepard and M. C. Calhoun

SUMMARY

The effects of frequency of monensin* and protein supplementation were studied with sheep fed a sorghum hay diet and a 20% crude protein supplement at levels to maintain live weight. The supplement was fed as follows: (1) .33 lb daily, (2) .66 lb every second day, (3) .99 lb every third day, and (4) 1.32 lb every fourth day. The supplement given to one-half the sheep contained 150 g of monensin per ton. Without monensin, frequency of supplementation was without effect on digestibility of dry matter, organic matter, and ash. However, crude protein digestibility decreased as feeding frequency changed from daily to every fourth day. In contrast, when the supplement contained monensin, digestibilities of crude protein tended to increase as frequency changed from daily to every fourth day. Futhermore, monensin had a positive quadratic effect on the digestibility of dry matter, organic matter, and ash of a sorghum hay and supplement diet. Maximum response occurred when protein supplement plus monensin was fed every second day.

INTRODUCTION

Supplemental feeding of sheep is often necessary when they are grazing native ranges during winter or extended dry periods. Because of the expense of feeding on a daily basis, it is useful to know the effects of less frequent supplementation on animal performance. Monensin, a biologically active compound produced by Streptomyces cinnamonensis, has been shown to improve feed efficiency when fed to feedlot cattle (1, 6) and sheep (2, 3) and improve gains when fed to grazing cattle (4, 5). Since monensin is most effective when fed with high roughage diets, it should be a valuable addition to range supplements. However, animal response to monensin is very dose-dependent. Although small amounts, 5 to 30 grams/ton of the total ration, generally have a positive affect on animal performance, at higher levels feed intake and performance are decreased. Because of this, it is important to examine the effects of frequency of feeding when monensin is included in a pasture supplement.

The purpose of this study was to determine the effects of the frequency of protein and monensin supplementation on rumen-volatile fatty acid proportions and digestibility of a forage diet by sheep.

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*Monensin-sodium, a product of Eli Lilly and Company is an experimental compound and is not approved for use with sheep.

EXPERIMENTAL PROCEDURE

Eight rumen-fistulated Rambouillet wether lambs (93.9 + 7.9 lb) were placed in collection stalls in two 4x4 Latin Square designs. The treatments used in the first Latin Square were: (A) 25 mg monensin in .33 lb supplement every day, (B) 50 mg monensin in .66 lb supplement every 2 days, (C) 75 mg monensin in .99 lb supplement every 3 days, and (D) 100 mg monensin in 1.32 lb supplement every 4 days. The second Latin Square served as a control for the first, with the supplement containing no monensin.

Throughout the study all sheep were maintained on 2.2 lb/day of ground, second-cut sorghum hay (5.7% crude protein). In addition, a 20% crude protein supplement either without or with monensin (150 g/ton) was fed. The feeding level, sorghum hay plus supplement was designed to meet the sheep's maintenance requirements.

A 12-day preliminary period was used prior to each 12-day collection period. Fecal samples were collected daily at feeding time during each collection period and were pooled and frozen for later subsampling and analysis. Rumen fluid samples were collected daily through rumen cannulae four hours after feeding time and were individually analyzed using gas chromatography.

RESULTS AND DISCUSSION

Although the sheep in this study were restricted to a maintenance diet, some weight gains occurred. Gains by animals which received monensin averaged 8.5 lb over the entire study compared to 11.0 lb for animals which did not receive monensin. Weight gains on this maintenance diet were probably due to a reduced activity level since the sheep were confined in metabolism stalls during the study.

Analyses of composite supplement samples for each collection period indicate that monensin levels in the supplement averaged 98.8 grams/ton, which was less than the intended 150 g/ton. The dry matter and chemical composition of the sorghum hay and supplement and the calculated nutrient values for the complete diet are presented in Table 1.

In this study responses to frequency of supplementation depended on whether monensin was present in the supplement. When monensin was excluded from the protein supplement, frequency of supplementation was without effect on digestibility of dry matter, organic matter and ash ($P>.10$). However, with the exception of ash, digestibility tended to be greater with daily supplementation and there was a linear decrease in digestibility of crude protein ($P<.10$) as feeding frequency changed from daily to every four days (Figure 1). With the exception of protein digestibility, the effect of frequency was small enough to suggest that supplementing every two, three or four days is as effective as daily supplementing if nutritional requirements are fulfilled. The negative effect that less frequent feeding had on the utilization of protein probably is large enough to require consideration when the amount of protein available in forage is marginal. In contrast, including monensin in the supplement resulted in positive quadratic responses for dry matter, organic matter, and ash (Figure 1). Maximum digestibilities were obtained when supplement was provided every second day. Digestibility of crude protein tended to increase as frequency of supplementation changed from daily to every four days when monensin was added to the supplement. However, these increases were not significant (P>.10) (Figure 1).

The effects of frequency of protein supplementation on molar percentages of acetic, propionic, and butyric acids and the acetate-to-propionate ratios in rumen fluid were similar regardless of whether or not monensin was added to the supplement (Figure 2).

The molar percent of acetic acid in rumen fluid was highest when a protein supplement was fed every four days; however, differences between means were not significant. There was also no significant response for butyric acid due to frequency of supplementation. Molar percent propionic acid exhibited a quadratic response which peaked when sheep received the supplement every three days. The ratio of acetic to propionic acid also exhibited a quadratic response with the minimum value at three days.

Monensin decreased the molar percent of acetic acid from 53.1 to 51.5; however, this difference was not significant (P>.10). Propionic acid was increased (P<.01), butyric acid was decreased (P<.01), and the ratio of acetic to propionic acid was decreased (P<.05) (Figure 2).

The major effect of monensin in this study was on protein digestibility. This may be due to monensin-induced decreases in ruminal protein degradation and deamination, which allows more dietary protein to bypass the rumen and be digested and absorbed in the intestines. Such effects could improve the efficiency of protein utilization.

The fact that monensin in the daily supplement did not improve digestibility over the daily supplement without monensin, whereas there appeared to be a response when supplement was given every two days is difficult to explain, particularly since daily supplementation with monensin increased the molar percent of propionic acid and decreased the molar percent of butyric acid and the ratio of acetic to propionic acid (Figures 1 and 2). These shifts in rumen-volatile fatty acids are generally assumed to reflect a more efficient type of rumen digestion. A possible explanation is the fact that this information was obtained from a limited number of animals, i.e., each value represents the average response of only four sheep. Overall it appears that the best procedure would be to feed a monensin-containing supplement every two days.

LITERATURE CITED

1. Boiling, J.A., N.W. Bradley and L.D. Campbell. 1977. Monensin levels for growing and finishing steers. J. Anim. Sci. 44:867.

2. Calhoun, M.C. and B.C. Baldwin, Jr. 1980. Crude protein level, roughage level and monensin in feedlot lamb rations. Tex. Agr. Exp. Sta. Prog. Rpt. 3708.

3. Calhoun, M.C., L.H. Carroll, C.W. Livingston, Jr. and Maurice Shelton. 1979. Effect of dietary monensin and coccidial oocyst numbers, on feedlot performance and carcass characteristics of lambs. J. Anim. Sci. 49:10.

4. Oliver, W.M. 1975. Effect of monensin on gains of steers grazed on Coastal Bermudagrass. J. Anim. Sci. 41:999.

5. Potter, E.L., C.O. Cooley, L.F. Richardson, A.P. Raun and R.P. Rathmacher. 1976. Effect of monensin on performance of cattle fed forage. J. Anim. Sci. 43:665.

6. Raun, A.P., C.O. Cooley, E.L. Potter, R.P. Rathmacher and L.F. Richardson. 1976. Effect of monensin on feed efficiency of feedlot cattle. J. Anim. Sci. 43:670.

TABLE 1. DRY MATTER AND CHEMICAL COMPOSITION OF HAY AND SUPPLEMENT AND CALCULATED NUTRIENT VALUES OF THE COMPLETE DIET

Criterion	Sorghum Hay	20% CP Supplement	Complete Diet[1/]
Dry Matter, %	90.8 ± .4	90.1 ± .3	90.7
Ash, %	7.8 ± .2	10.1 ± .4	8.1
Crude Protein, %	5.7 ± .8	18.9 ± .4	7.6
Neutral detergent fiber, %	61.1 ± 1.1	20.3 ± .6	55.3
Lignin, %	7.5 ± .4	5.6 ± .1	7.2
Phosphorus, %	.09 ± .004	.86 ± .03	0.20
Calcium, %	.48 ± .02	.87 ± .06	0.54
Potassium, %	1.42 ± .08	1.0 ± .03	1.36
Magnesium, %	.10 ± .007	.29 ± .004	0.13

[1/] Nutrient composition of complete diets was calculated from values determined for the sorghum hay and supplement. The relative proportions in the diet were 85.7% hay and 14.3% supplement. The supplement also contributed 0.5% salt, 0.15% sulfur, 12 ppm manganese, 30 ppm zinc, 445 IU/lb of vitamin A activity and 26 IU/lb of vitamin D activity in the complete diet.

FIGURE 1. EFFECT OF MONENSIN AND FREQUENCY OF PROTEIN SUPPLEMENTATION ON APPARENT DIGESTIBILITY COEFFICIENTS FOR DRY MATTER, ORGANIC MATTER, ASH AND CRUDE PROTEIN.

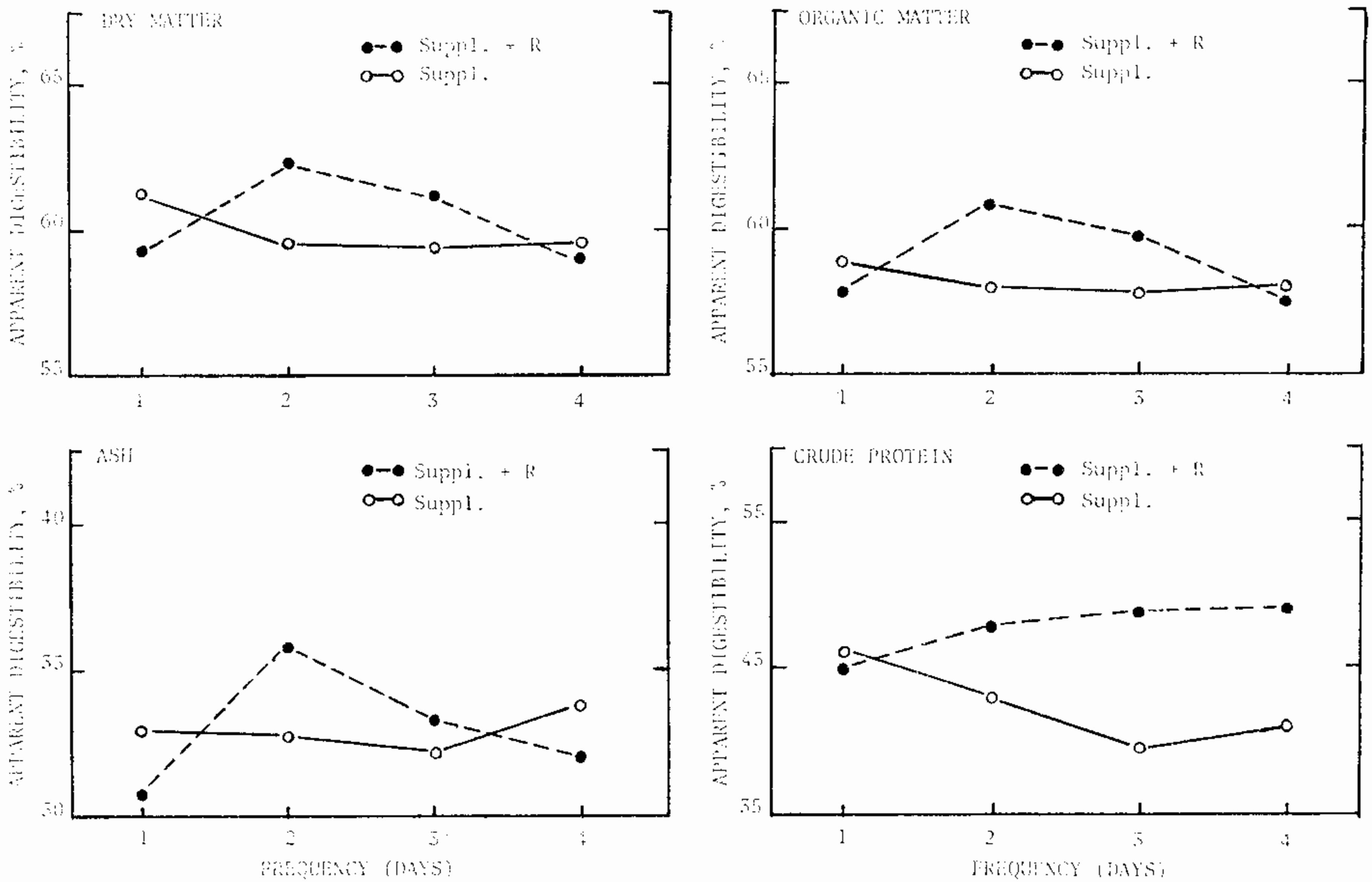
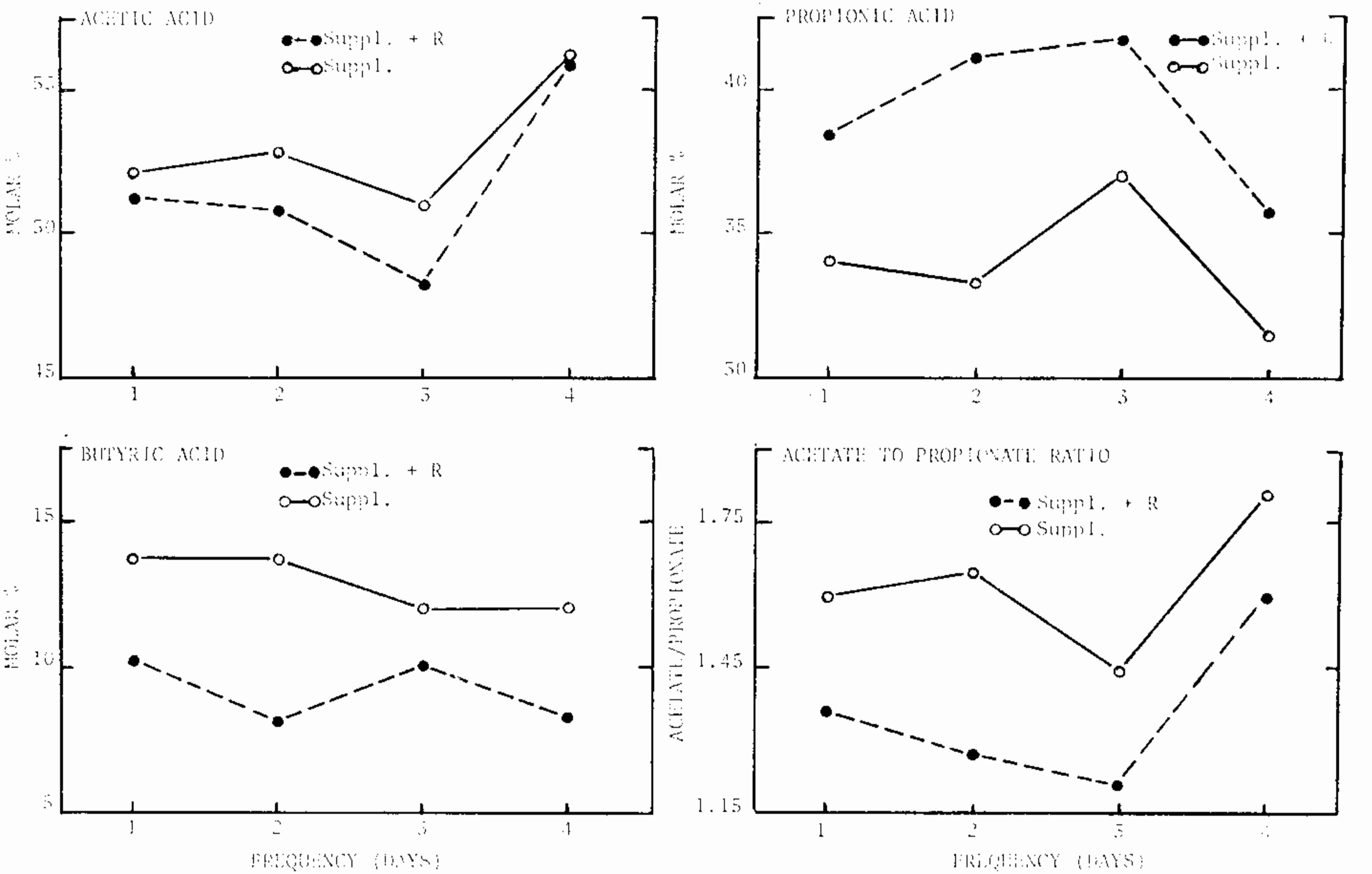


FIGURE 2. EFFECT OF RUMENSIN AND FREQUENCY OF PROTEIN SUPPLEMENTATION ON MOLAR PERCENTAGES OF ACETIC, PROPIONIC AND BUTYRIC ACIDS IN RUMEN FLUID.



COMPARISON OF DRY MATTER INTAKE AND DIGESTIBILITY AND SOME BLOOD CONSTITUENTS OF SHEEP AND GOATS

M. C. Calhoun, B. C. Baldwin, Jr. and Maurice Shelton

SUMMARY

Fifty-two yearling females representing two goat breeds (Angora and Spanish), and three sheep breeds (Barbado, Karakul and Rambouillet) were grouped in pens according to species and breeds; they were fed a uniform diet ad libitum). Blood samples were collected for determination of whole blood, serum, and plasma constituents after the animals had been on the diet for seven days. Dry matter digestibility of the diet was determined using chromic oxide as an indicator. Results of these measurements and differences between animal types are presented in this report.

INTRODUCTION

In a preliminary study designed to assess the value of a rumen-protected methionine product for mohair growth in Angora goats, low plasma methionine values were consistently observed for unsupplemented animals when plasma amino acid concentrations were determined by a gas-liquid chromatography procedure (1). In order to confirm this and provide additional information on plasma amino acid levels, values obtained for Angora were compared with those for Spanish goats and Barbado, Karakul and Rambouillet sheep using the conventional ion exchange chromatography procedure.

Voluntary feed intake, energy intake per unit of metabolic body size, dry matter digestibility and concentrations of several blood constituents were also measured for comparison purposes.

EXPERIMENTAL PROCEDURE

Fifty-two yearling females representing two goat breeds (Angora and Spanish), and three sheep breeds (Barbado, Karakul and Rambouillet) were grouped in pens according to species and breed; they were fed a complete diet (ad libitum) for a 21-day uniformity period. The diet was formulated to contain 2.82 Mcal DE/kg and 10% crude protein (Table 1). Blood samples were collected for the determination of whole blood, plasma and serum constituents after the animals had been on the diet for seven days. Voluntary feed intake was recorded for a 14-day period; days 8 thru 21. Upon completion of the uniformity period, one-half the animals were switched to a 12% crude protein diet and the other one-half to a 16% crude protein diet (Table 1). Chromic oxide was included in these diets (0.2%) and they were fed ad libitum for 12 days. Fecal samples were collected from all animals on the 12th day, dried and stored until they could be used for determinations of feed digestibility.

RESULTS AND DISCUSSION

Initial live weights, feed intakes of the animals, and dry matter digestibilities of the diet are summarized in Table 2. Feed intakes per unit metabolic body size (g/day/kg live weight$^{.75}$), and energy intakes per unit metabolic body size (Kcal DE/day/kg live weight$^{.75}$) were less for the Angora and Spanish goats and Barbado sheep than for the Karakul and Rambouillet sheep ($P<.05$). Values for Angora goats were less than for Spanish goats, but the differences were not significant.

Dry matter digestibilities of the diets were similar, regardless of the crude protein content of the diets, and there was not an interaction between crude protein levels and animal types. Therefore the dry matter digestibility data for the 12 and 16% crude protein diets have been combined and are presented as a single value for each type of animal (Table 2). There were significant differences in dry matter digestibility between animal types ($P<.05$). The Karakul breed of sheep had the lowest dry matter digestibility, followed by Barbado. Values for Angora and Spanish goats were higher and similar to Rambouillet sheep.

The low dry matter digestibility (44.0%) obtained for the Karakul sheep is difficult to explain. However, diurnal variation in excretion and incomplete recovery are recognized limitations with the use of chromic oxide as an external indicator. Because of this, determination of digestibility, using conventional feeding and collection procedures, might be used to substantiate this observation.

A summary of the results obtained for the blood parameters measured is presented in Table 3. Hematocrit values were lowest for Angora goats ($P<.05$) and highest for Spanish goats ($P<.05$). The sheep breeds were similar and all were different from the goats ($P<.05$). Whole blood glucose was higher for the Rambouillet (51.6 mg/dl) than for the Barbado (41.6 mg/dl) ($P<.05$), but the others were not significantly different.

Total serum protein levels were similar for all types and averaged 6.2 and 6.3 g/dl for the goat and sheep breeds, respectively. However, serum albumen levels were lower for goats than for sheep (2.2 vs 2.6 g/dl, $P<.05$). Although not measured directly, it would appear that serum globulin levels are higher for goats than for sheep.

Serum calcium was lower for Spanish goats (8.8 mg/dl) than for Angora goats (9.6 mg/dl) ($P<.05$). Serum calcium was lower for both breeds of goats ($P<.05$) than for the three sheep breeds, which averaged 10.9 mg/dl. Inorganic phosphorus was higher for the Karakul (8.1 mg/dl) than for the goats which averaged 6.8 mg/dl ($P<.05$). All other comaprisons were not significant.

Serum urea nitrogen was less ($P<.05$) for the Barbado (8.6 mg/dl) than for the Karakul (11.6 mg/dl) or Rambouillet (12.4 mg/dl). The goat breeds were not different from the sheep in serum urea nitrogen and averaged 10.4 mg/dl. Barbado sheep also had the lowest serum creatinine levels of any of the sheep breeds ($P<.05$).

The goats were neither different from each other nor different from the sheep. Total bilirubin in the serum of Angora goats was higher (P<.05) than for Spanish goats (.20 vs .09 mg/dl). Spanish goats were similar to the sheep in bilirubin, which averaged .08 mg/dl.

Serum alkaline phosphatase activity tended to be lower for goats than for sheep; however, the goat values were not significantly less than for the Rambouillet. Creatine phosphokinase levels were less (P<.05) for the Angora goats and Rambouillet sheep than for the Barbado and Karakul sheep. Lactic dehydrogenase levels were less (P<.05) for goats than for sheep and less for Spanish goats than Angora goats (P<.05). Rambouillet sheep were lower in lactic dehydrogenase than either Barbado or Karakul sheep (P<.05). Angora goats had the lowest serum glutamic-pyruvic transaminase activity (21.1 IU/l); Spanish goats had the highest value (31.5 IU/l). The sheep breeds averaged 25.1 IU/l and were not different. Serum glutamic-oxalacetic transaminase values tended to be lower for the goat breeds.

Concentrations of free amino acids in jugular vein plasma are summarized in Table 4. Relative concentrations of these amino acids appear to be separable into three categories. In the first category are the amino acids which are present in the plasma of goats and sheep at about the same concentrations. These are alanine, glutamic acid, isoleucine, leucine, tyrosine and valine. In the second category, plasma levels are distinctly different for goats, compared to sheep. These amino acids are aspartic acid, histidine, lysine, ornithine and threonine. The third category is comprised of those amino acids which appear uniquely different for the Angora goat, compared to all others. These are arginine, cystine, glycine, methionine and serine.

The total of nonessential amino acids (NEAA) is much higher and the total of essential amino acids (EAA) is much lower for Angora goats than for the other animals studied. This is due to higher levels of glycine and serine in Angora goat plasma and lower levels of the essential amino acids arginine, cystine, lysine and methionine.

The very low levels of plasma-free methionine observed for Angora goats confirm previous results (1). Angora goats are very efficient fiber producers, and the fiber (mohair) they produce is high in sulfur-containing amino acids. This may explain the low levels of both methionine and cystine observed in Angora goats relative to the other animals used in this study.

LITERATURE CITED

Bassett, J.W., B.C. Baldwin, Jr., M.C. Calhoun and R. Stobart. 1981. Plasma methionine and mohair response to dietary rumen-protected methionine in Angora goats. Tex. Agr. Exp. Sta. Prog. Rpt. 3904

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TABLE 1. INGREDIENT COMPOSITION AND CALCULATED NUTRIENT CONTENT OF EXPERIMENTAL DIETS

Ingredient	Diets		
	Uniformity	12%CP[2/]	16%CP[2/]
	%		
Grain sorghum	54.7	34.5	20.9
Cottonseed hulls	29.9	40.0	40.0
Cottonseed meal	7.9	16.65	29.75
Molasses	4.0	6.0	6.0
Salt	0.5	0.5	0.5
Calcium carbonate	1.5	1.35	1.85
Vitamin and mineral premix[1/]	1.0	1.0	1.0
Ammonium chloride	0.5	-	-
Nutrient			
Total digestible nutrients, %	64.7	58.1	54.8
Digestible energy, Mcal/lb	1.28	1.15	1.09
Crude protein, %	10.0	12.0	16.0
Digestible protein, %	7.0	8.4	11.7
Calcium, %	.71	.68	.90
Phosphorus, %	.28	.34	.45
Potassium, %	.62	.80	.93

1/ The vitamin and mineral premix contributed 0.1% sulfur, 0.1% potassium, 22.0 ppm zinc and 0.65% salt (NaCl) to the complete diet. It also added 1000 IU of vitamin A, 125 IU of vitamin D_2 and 15 mg of chlortetracycline to each pound of diet.

2/ The 12 and 16% crude protein diet contained 0.2% chromic oxide.

TABLE 2. COMPARISON OF THE RELATIVE INTAKE AND DIGESTIBILITY OF A DIET FED TO ANGORA AND SPANISH GOATS AND BARBADO, KARAKUL AND RAMBOUILLET SHEEP

Criterion	Goat Breeds		Sheep Breeds			S.D.
	Angora	Spanish	Barbado	Karakul	Rambouillet	
Number of animals	11	11	10	10	10	
Live weight, kg	22.4^{a} [1/]	28.9^{b}	32.5^{b}	57.0^{c}	59.2^{c}	1.42
Live weight, $kg^{.75}$ [2/]	10.3	12.4	13.6	20.7	21.3	.44
Feed intake, kg/day [3/]	$.94^{a}$	1.34^{b}	1.48^{b}	3.44^{c}	3.18^{c}	.13
Feed intake, g/day/$W^{.75}$	91.9^{a}	107.1^{a}	109.1^{a}	166.0^{b}	149.5^{b}	10.3
Energy intake, KcalDE/day/$W^{.75}$	260.0^{a}	302.8^{a}	308.0^{a}	468.5^{b}	422.1^{b}	28.7
Dry matter digestibility, %	56.4^{c}	55.1^{bc}	50.8^{b}	44.0^{a}	58.1^{c}	3.04

1/ Means in the same row with different letters are significantly different ($P<.05$).

2/ Live weight, $kg^{.75}$ approximates the animals metabolic body size.

3/ As fed basis.

TABLE 5. COMPARISON OF SOME BLOOD PARAMETERS OF ANGORA AND SPANISH GOATS AND BARBADO, KARAKUL AND RAMBOUILLET SHEEP

Criterion	Goat Breeds		Sheep Breeds			S.D.
	Angora	Spanish	Barbado	Karakul	Rambouillet	
Hematocrit, %	26.8^{a} [1/]	42.1^{c}	36.1^{b}	35.5^{b}	34.5^{b}	5.27
Whole blood glucose, mg/dl	45.6^{ab}	43.9^{ab}	41.6^{a}	43.2^{ab}	51.6^{b}	8.77
Serum Analyses:						
Total protein, g/dl	6.2^{a}	6.2^{a}	6.5^{a}	6.1^{a}	6.4^{a}	.44
Albumen, g/dl	2.3^{a}	2.2^{a}	2.6^{b}	2.7^{b}	2.6^{b}	.24
Calcium, mg/dl	9.6^{b}	8.8^{a}	10.7^{c}	11.1^{c}	10.9^{c}	.70
Inorganic phosphorus, mg/dl	6.7^{a}	6.8^{a}	7.7^{ab}	8.1^{b}	7.0^{ab}	1.28
Urea nitrogen, mg/dl	11.3^{ab}	9.6^{ab}	8.6^{a}	11.6^{b}	12.4^{b}	2.84
Creatinine, mg/dl	$.88^{ab}$	$.90^{b}$	$.73^{a}$	$.89^{b}$	$.98^{b}$	.17
Total bilirubin, mg/dl	$.20^{b}$	$.09^{a}$	$.04^{a}$	$.10^{a}$	$.09^{a}$	.10
Alkaline phosphatase, IU/l	187^{a}	222^{a}	447^{c}	376^{bc}	272^{ab}	140
Creatine phosphokinase, IU/l	152^{a}	171^{ab}	218^{b}	210^{b}	148^{a}	55.6
Lactic dehydrogenase, IU/l	430^{b}	333^{a}	632^{d}	638^{d}	536^{c}	69.2
Glutamic-pyruvic transaminase, IU/l	21.1^{a}	31.5^{c}	25.3^{b}	26.5^{b}	23.4^{ab}	4.31
Glutamic-oxalacetic transaminase, IU/l	134^{ab}	119^{a}	142^{bc}	170^{d}	156^{cd}	22.0

[1/] Means in the same row with different letters are significantly different (P<.05).

TABLE 4. CONCENTRATION OF AMINO ACIDS IN JUGULAR VEIN PLASMA OF ANGORA AND SPANISH GOATS AND BARBADO, KARAKUL AND RAMBOUILLET SHEEP

Amino Acid	Goat Breeds		Sheep Breeds		
	Angora	Spanish	Barbado	Karakul	Rambouillet
	(μmol/100 ml plasma)				
Alanine[1/]	23.7[a][3/]	26.0[a]	22.6[a]	27.3[a]	24.7[a]
Arginine[2/]	8.16[a]	14.7[b]	16.8[b]	16.5[b]	14.5[b]
Aspartic acid[1/]	5.82[a]	6.57[a]	9.12[b]	9.36[b]	8.94[b]
Cystine[2/]	1.58[a]	3.87[b]	3.83[b]	3.26[b]	3.28[b]
Glutamic acid[1/]	12.0[a]	11.5[a]	11.6[a]	11.6[a]	11.8[a]
Glycine[1/]	102.3[c]	70.3[b]	46.8[a]	59.5[ab]	73.5[b]
Histidine[2/]	7.95[a]	9.77[a]	14.3[b]	12.7[ab]	13.7[ab]
Isoleucine[2/]	6.73[ab]	7.67[b]	5.76[a]	7.58[ab]	7.16[ab]
Leucine[2/]	16.2[a]	15.3[a]	12.1[a]	14.7[a]	14.3[a]
Lysine[2/]	10.4[a]	16.1[b]	25.3[d]	25.9[d]	21.3[c]
Methionine[2/]	.678[a]	1.97[b]	2.03[bc]	2.84[c]	2.86[c]
Ornithine	5.18[a]	10.1[b]	19.1[c]	28.6[d]	18.2[c]
Phenylalanine[2/]	5.32[ab]	3.91[a]	4.76[ab]	6.10[b]	5.66[ab]
Serine[1/]	36.6[b]	8.92[a]	9.26[a]	13.1[a]	14.0[a]
Threonine[2/]	9.10[a]	7.24[a]	12.8[b]	12.7[b]	12.5[b]
Tyrosine[2/]	7.37[ab]	6.10[a]	7.23[ab]	7.40[ab]	8.16[b]
Valine[2/]	23.7[ab]	26.5[b]	20.3[a]	26.1[b]	24.1[ab]
Total NEAA[1/]	180.42	123.3	99.38	120.86	132.94
Total EAA[2/]	97.19	113.13	125.21	135.78	127.59

1/ Nonessential amino acids were added to give total NEAA
2/ Essential amino acids were added to give total EAA
3/ Means in the same row with different letters are significantly different ($P < .05$)

VENEREAL TRANSMISSION OF OVINE UREAPLASMAS

C. W. Livingston, Jr. and Betty B. Gauer

SUMMARY

Rams experimentally infected with ovine ureaplasma transmitted the ureaplasma to uninfected ewes at the time of coitus. There was no evidence of transmission of ureplasma by other routes. Venereal transmission apparently is the primary route of infection under natural conditions.

INTRODUCTION

Ureaplasmas were isolated from sheep first in 1975 (4). Although ureaplasmas are recognized as a cause of venereal infections in man, the route of natural ureaplasmal infection in sheep has not been confirmed. Ureaplasmas are associated with vaginitis, uterine infections, and infertility in sheep (1, 2). The purpose of this study is to determine the importance of venereal transmission in ureaplasmal infections of sheep.

EXPERIMENTAL PROCEDURE

Yearling Rambouillet rams found to be negative culturally for ureaplasmas were experimentally infected with a specific serotype of ovine ureaplasma. The ram selected for use in this experiment remained infected for over 700 days with the same ureaplasmal serotype. Ten yearling Rambouillet ewes were selected from a flock that appeared to be culturally free of ureaplasma. A paint marker was placed on the brisket of the infected ram to mark the ewe when the ram mounted during coitus. Vaginal swabs were obtained before and after coitus from all ewes. The ram was electroejaculated periodically and the semen cultured for the presence and enumeration of ureaplasma.

RESULTS

All ewes remained culturally negative for ureaplasma prior to coitus. Immediately after coitus ureaplasmas were cultured from the vaginal swabs from every ewe. Most ewes remained infected throughout the gestational period.

DISCUSSION

Venereal transmission appears to be the primary route of ureaplasmal infection in sheep. Rams once infected with ureaplasma remain infected for periods up to two years. Ewes were successfully infected with ureaplasma upon coitus with infected rams and nearly all remained infected a minimum of five months. There was no evidence that ovine ureaplasmas were transmitted to the ewes prior to coitus. Ureaplasmas have been isolated from lambs in an infected flock under range consitions (3) but these lambs were older lambs in contact with sexually active rams. The observations strongly suggest that ovine ureaplasmosis is a newly recognized venereal disease.

LITERATURE CITED

1. Doig, P. A. and Ruhnke, H. L. Isolation of ureaplasma from sheep with granular vulvitis. Vet.Rec.100:179-180, 1977.

2. Livingston, C. W., Jr. and Gauer, B. B. A specific ureaplasmal serotype associated with ovine uterine infections. Am.J.Vet.Res.39: 1699-1701, 1978.

3. Livingston, C. W., Jr. and Gauer, B. B. Incidence of ureaplasmas and mycoplasmas in Texas sheep flocks. Texas Agric. Exp.Sta. PR-3710.

4. Livingston, C. W., Jr. and Fauer, B. B. Isolation of T-strain mycoplasma from sheep and goats in Texas. Am J. Vet. Res. 36:313-314, 1975.

INTERNAL PARASITE CONTROL WITH FENTHION

S. Tembely and T. M. Craig

SUMMARY

Topically applied Fenthion at 8.5 or 12.5 mg/kg had no effect in controlling either the nasal bot or barberpole worm in naturally infected lambs from the Edwards Plateau of Texas.

INTRODUCTION

Fenthion* a systemic antiparasitic drug has effects against both arthropods and nematodes. It is approved as a cattle insecticide for use against cattle grubs and lice. Fenthion has been used successfully against a number of parasites including dog and cat fleas, mange, ticks, large round worms and larval stages of dog heartworms. With the removal of haloxon from the list of approved drugs for use in sheep and the poor efficacy of thiabendazole in the Edwards Plateau alternative anthelmintics are absolutely essential. It was decided to initiate a trial using fenthion as a possible alternative drug against sheep parasites.

EXPERIMENTAL PROCEDURE

Twenty-one 5 month old mixed breed lambs were purchased from a single source in the Edwards Plateau. The lambs were identified, weighed and assigned to 7 replicates based on body weight, i.e. the 3 heaviest, next 3 etc. Feces and blood were collected from each lamb. The lambs within each replicate were randomly assigned to one of the following treatments (1) Topically applied 20% fenthion solution at 8.5 mg/kg (2) Topically applied 20% fenthion solution at 12.5 mg/kg or (3) Untreated controls. The fenthion was applied to the skin on the dorsal midline after parting the wool. The lambs were observed for one week, then slaughtered and evaluated parasitologically.

RESULTS AND DISCUSSION

The results of the experiment are given in tables 1 and 2. Unfortunately several fecal samples collected at time of slaughter were inadvertently discarded so that changes occuring between treatment and slaughter could not be analyzed. The amount of Fenthion used was calculated as being equivalent to the cattle dosage 8.5 mg/kg or higher than the cattle dose yet less than the toxic level 12.5 mg/kg. The fenthion appeared to be well absorbed although some undoubtly was adsorbed by the wool. If the drug had been given orally it may have shown some effect, however, several lambs at both treatment levels bloated several hours after treatment, which is an indication of absorption and is approaching a toxic level.

*Spotton Cutter Animal Health, Shawnee, Kansas

Many of the lambs in the experiment were anemic due to the effect of the barberpole worm and it was chance that assigned the lambs with the fewest worms to the control group. The egg counts which were done indicated a fall in egg counts in all groups during the week between treatment and slaughter. This may have been due to the effects of movement and change in diets as the lambs were maintained on alfalfa cubes during the trial.

TABLE 1 Lamb weights, parasite egg counts and packed erythrocytes counts at beginning of trial

GROUP	NUMBER	WEIGHT kg	EPG+	PCV*
CONTROLS	7	21.5# (13.6-29.5)	17,711# (7,600-47,150)	24.7# (18-34)
8.5 mg/kg FENTHION	7	22.7 (15.9-31.8)	27,642 (13,950-41,400)	21.7 (14-27)
12.5 mg/kg FENTHION	7	22.7 (15.9-29.5)	18,283 (2,350-47,600)	27 (17-32)

- mean/range

+EPG - helminth egg/gram feces.

*PCV - (packed cell volume) percent of red blood cells in blood.

TABLE 2 Mean numbers of parasites collected from lambs after slaughter.

GROUP	nasal bot Oestrus	barberpole worm Haemonchus	hair worm Trichostrongylus	thread-necked strongyle Nematodirus
CONTROLS	5	714	128	971
8.5 mg/kg FENTHION	9	4742	199	142
12.5 mg/kg FENTHION	7	1257	0	1386

LITERATURE CITED

1. Craig, T. M., Shepherd E.: Efficacy of Albendazole and Levamisole in sheep against Thysanosoma actinoides and Haemonchus contortus from the Edwards Plateau, Texas. AM J VET RES 41: 425-426, 1980.

ACKNOWLEDGEMENTS

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THE EFFECTS OF TIME OF SHEARING ON WOOL AND LAMB PRODUCTION

Maurice Shelton, Phil Thompson and Don Spiller

SUMMARY

Data has been collected on four experimental shearing groups of finewool ewes to study the effects of season or time of shearing on wool and lamb production in the Edwards Plateau region of Texas. The experimental groups were shorn one time per year either in February, May, August or November. The data do not provide a basis for clear cut conclusions or recommendations. Fleece weights distinctly favored those groups shorn late in the year (August or November). However, the fleeces resulting from shearing on these dates often carried a heavy defect primarily from needle grass and would have distinctly been of lowered value. Some death losses of ewes were encountered when ewes were carried in full fleece through needle grass season. Body weights do not show a strong effect of shearing date which cannot be readily explained by the amount of wool or state of pregnancy or lactation. Ewes shorn late in the year (November) showed a distinct advantage in lamb production. However, this advantage is difficult to explain and may represent chance variation or experimental error. For this reason a shift to a single fall shearing would not be recommended unless or until this experience is corroborated. In these studies no known losses occurred from freezing following shearing on the dates shown. If a producer has a problem with needle grass it seems desirable that spring shearing, close to the date of needle release, should remain a recommendation. If needle grass is not a problem, these data suggest that shearing might be practiced over a much longer season with some possible advantage for shearing later than usual. However, more work would be needed before a firm recommendation concerning this matter can be made.

INTRODUCTION

In the major sheep producing areas of Texas, shearing is generally a seasonal operation contributing to inefficient use of farm labor and shearing crews. In 1975, an experiment was started to look at the advantages or disadvantages of spreading out the traditional spring shearing to other seasons of the year and the possible effect this might have on wool and lamb production in the Edwards Plateau area of Texas.

EXPERIMENTAL PROCEDURE

In 1975, data collection was begun at the leased Hill Ranch in Edwards County with 132 yearling Rambouillet ewes. The ewes were randomly assigned into one of four shearing groups to test the effects of season of shearing on lamb and wool production. The study was continued through the 1980 lambing season. The experimental groups were shorn on or near the first of 1) February, 2) May, 3) August and 4) November. Each ewe was shorn only one time per year on the dates dictated by the group to which she was assigned. Animals were managed as a single flock under range conditions for that particular area of the Edwards Plateau. These ewes were shorn in 1975 on the dates indicated and this required that some were carried past the normal shearing date. Some death loss was incurred due to a serious problem of needle grass as this test started. Ewes were mated in October and lambed in March of the following year. The February shearing group were the only animals which were tagged prior to lambing, unless conditions were deemed necessary. Ewes were lambed out by shearing groups in open pastures, but they were run together at other times. No attempt was made to pair up individual ewes and lambs, and thus lamb production data are group values.

Individual ewe records were kept for grease fleece weight, shorn body and weight at the time of breeding. Some of these items of data were not collected in every year. Any wool tags collected were weighed in bulk and an average weight was added on to each individual fleece. Lambs were weaned and individually weighed in early to middle summer depending on the available forage conditions.

RESULTS AND DISCUSSION

The average 12 month wool production data for each treatment group is shown in Table 1. Ewes shorn later in the year (August and Novemer) produced significantly heavier grease fleeces (P>.05) than did those shorn in February or May. The mean fleece weights were 8.77, 8.39, 7.68 and 7.29 pounds, respectively, for the four experimental shearings. August and November shorn ewes had fleeces containing greater accumulations of vegetable matter which varied from year to year due to rainfall. This was mainly threeawn and Texas wintergrass seed carried on bellies, legs and faces. The original experimental plan did not call for yield or vegetable matter determinations. However, it became obvious that summer and fall shorn ewes had lower yielding fleeces with a higher vegetable matter content. This was confirmed by values determined for 1980. In some seasons following good spring moisture the fleeces of the August and November shorn ewes were in very poor condition and nearly matted with needle grass. Rainfall data collected at the Sonora Experiment Station (adjacent to the Hill Ranch) showed that all heavy shearings by any experimental group was preceded by a period of increased moisture. These heavier rains generally fell in the late spring and summer and would more directly effect the August and November shearings. This rainfall showed that during the test period 1979 was the driest year and the smallest difference between average fleece weights. Although the late shearing showed a distinct advantage in fleece weights it appears undesirable at the present to suggest this as a reason for delayed shearing. Shorn body weights over the four year test period showed a slight increase in actual body size within groups (Table 2). This data does indicate that there was a significant difference in weights between groups (P>.01). Since the shorn body weights were collected at different seasons the differences largely reflect seasonal as contrasted to treatment differences. The fact that all animals were supplemented a salt controlled high protein feed prior to and during lambing should be taken into consideration when noting the weights of the February group and the fluctuations in the November group. The average shorn body weight of the May and August groups remained mostly stable during the experimental period. Weight of the ewes at breeding has remained fairly stable for all experimental groups, with the exception of the May shorn animals (Table 3). The ewes in this group were lighter at the beginning of the test period and have since reached approximately the same mature weight. It should be noted that breeding weight is greatly influenced by the amount of wool on each group and the nutritional stress of each year.

Lamb production was greatly influenced by year (Table 4). The precent lamb crop marked and average weaning weights of the lambs were both higher for all treatment groups in 1977 and 1979. In both of these years range conditions were better and the lambs were not weaned until late July. In 1976 and 1978, lambs were weaned in early June. The November group which was shorn two months prior to lambing produced the highest overall percent lamb crop. This was followed by the February, May and August groups. The August group produced the lowest overall lamb crop, but annually surpassed all groups in average weaning weight. However, this difference is small and may reflect only a smaller number of multiple births. The lambs produced in 1976 are not included in the marking percentage, because not all the treatments had been in effect at mating time. The average percentage of lambs marked per ewe over the term of the experiment for each shearing treatment were February, 91.4; May, 95.8; August, 91.2 and November, 111.4. These values are based on a total of four lambings over the time of this experiment, and are statistically significant.

Data collected from five weaned lamb crops is shown in Table 4. The average weight per lamb weaned was greatest for the August shearing treatment (70.3 lbs.). It should be remembered that ewes within this group also produced the fewest number of lambs per ewe each year and the least total pounds of lamb over the course of the test. The November sheared ewes weaned the most total number of lambs which average 68.8 pounds over the course of the experiment which produced the greatest number of total pounds of lamb. The February and May shearing treatments produced weaned lambs weighing an average of 65.6 and 66.6 pounds respectively.

TABLE 1. YEARLY AVERAGE GREASE WOOL PRODUCTION (LBS.) PER EWE

Shearing date:	(N) 1976	(N) 1977	(N) 1978	(N) 1979	AVE.
February	(31) 7.48	(31) 7.89	(27) 7.43	(25) 8.04	7.68
May	(33) 7.05	(27) 6.52	(25) 6.97	(22) 7.90	7.24
August	(26) 8.88	(25) 9.30	(24) 9.26	(20) 7.40	8.77
November	(26) 11.86	(27) 8.86	(26) 8.95	(23) 7.91	8.39

TABLE 2. MEAN SHORN BODY WEIGHTS (Lbs.)

YEAR	1976	1977	1978	1979	AVE.
February	109.7	104.9	109.0	115.6	109.8
May	94.4	91.6	94.5	99.4	95.0
August	109.2	101.2	103.3	107.1	105.2
November	98.1	90.0	113.2	103.8	101.3

TABLE 3. AVERAGE EWE WEIGHT (Lbs.) AT BREEDING

YEAR	1976	1978	1979	1980	AVE.
February	109.7	113.2	117.0	112.9	113.2
May	94.7	111.8	119.5	111.7	109.4
August	109.2	109.4	121.5	105.2	111.3
November	112.1	110.5	115.7	108.0	111.6

TABLE 4. EFFECT OF SHEARING ON LAMB PRODUCTION

YEAR	1976	1977	1978	1979	1980	AVE.
% Lambs Marked:						
February		100.0	100.0	84.0	81.5	91.4
May		82.1	82.0	110.0	109.1	95.8
August		84.6	84.6	86.0	109.5	91.2
November		114.8	115.0	116.0	100.0	111.4
Average Weaning Weight (lbs.):						
February	64.0	75.1	51.2	74.0	63.1	65.6
May	67.0	75.3	47.7	75.2	69.0	66.6
August	73.0	81.1	56.8	78.6	70.8	70.5
November	79.0	77.7	52.0	78.4	72.3	68.8

PLASMA METHIONINE AND MOHAIR RESPONSE TO DIETARY RUMEN-PROTECTED METHIONINE IN ANGORA GOATS

J.W. Bassett, B.C. Baldwin, Jr., M.C. Calhoun and R.H. Stobart

SUMMARY

Use of rumen-protected methionine produced a linear increase in plasma methionine levels, while d,ℓ-methionine produced an increase over the control group. A quadratic response to the rumen-protected methionine was shown for feed intake, grease and clean fleece weights while d,ℓ-methionine gave a response not different than the controls.

INTRODUCTION

Availability of the animo acid methionine has been shown to be a factor which limits wool production (1, 3) since Angora goats normally produce a greater amount of clean fiber per unit of body weight than do Rambouillet sheep and produce it more efficiently (2), the availability of methionine may also be limiting mohair production. The objective of this research was to provide preliminary information on the supplementary methionine requirements of Angora goats and the mohair response to increasing the post-ruminal supply of methionine.

EXPERIMENTAL PROCEDURE

Sixty, mature, castrated male Angora goats were used in this study. On arrival at the TAES Research Center in San Angelo they were weighed, drenched and vaccinated. A 28-day uniformity period immediately preceded the 112-day experimental period. Experimental treatments were: (1) control (2) 0.1% rumen-protected methionine (PRMet) (3) 0.2% RPMet (4) 0.3% RPMet and (5) 0.16% d,ℓ-methionine. A 40% sorghum hay diet was used throughout this study (Table 1). The RPMet and d,ℓ-methionine were mixed with this diet to give the treatments used. Animals were weighed bi-weekly and blood samples for plasma amino acid analyses were obtained initially and at 56 and 112 days. The goats were sheared prior to the uniformity period and again upon completion of the 112-day methionine feeding period. Dye banding and measurement of hair length were used to proportion mohair production between the uniformity and experimental periods.

RESULTS AND DISCUSSION

Visual examination as well as periodic measurement of fecal coccidial oocyst counts on a representative number of animals indicated there were no problems with coccidioses. The only problem encountered was related to the pugnacious nature of these animals. There was considerable fighting among goats within pens until a pecking order was established and then the dominant goat(s) kept others away from the feeder. This problem was solved to some degree by limiting the number of goats per pen to four and spending the time necessary to insure those goats were reasonably compatible.

Results of the chemical analyses of the experimental diet are given in Table 1.

Live weights, feed intakes, mohair measurements and plasma free methionine levels are summarized in Table 2. The average initial live weight was 89.5 ± 3.5 lb. Live weight gains during the 112-day experimental period averaged 14.0 ± 2.3 lb and there were no treatment effects on gains. Feed intake of goats receiving d,ℓ-methionine was not different from the control group. Feeding RPMet increased feed intake at the 0.1 and 0.2% levels but not at the 0.3% level. The overall effect of RPMet on feed intake was quadratic ($P<.10$) and described by the equation $Y = 2.58 + 3.28X - 10.97X^2$ where X is percentage of RPMet in the diet and Y is feed intake in lb/day.

Mohair production was stimulated by feeding the RPMet product but not by d,ℓ-methionine. The response was quadratic for both grease and clean fleece weight. The equation for grease mohair was $Y = 4.22 + 16.06X - 51.56X^2$; $r = 0.61$, $P<.05$ and for clean mohair $Y = 3.30 + 10.38X - 33.64X^2$; $r = 0.58$, $P<.10$; where X is the percentage of RPMet in the diet and Y is weight of mohair produced during the 112-day experimental period.

There was a linear increase in plasma free methionine levels as the percentage of RPMet increased in the diet. The equation describing this relationship was $Y = 0.45 + 6.22X$, $r = 0.74$, $P<.05$; where X is the percentage of RPMet in the diet and Y is the µg/ml of free methionine in the plasma. d,ℓ-methionine also increased the plasma methionine levels; however, the response was less than when an equivalent amount of methionine was provided by the RPMet product.

LITERATURE CITED

1. Ferguson, K. A. 1975. The protection of dietary proteins and amino acids againt microbial fermentation in the rumen. *In* Digestion and Metabolism in the Ruminant. Univ. of New England. Publ. Unit, Armidale, N.S.W.

2. Gallagher, J. R. 1971. Relative efficiencies of conversion of feed to fiber of the Angora goat and Rambouillet sheep. Texas Agr. Exp. Sta. PR-2932.

3. Reis, P. J. and D. A. Turks. 1974. The influence of abomasal supplements of methionine on wool growth of wheat-fed sheep. Australian J. Agr. Res. 25 1919.

ACKNOWLEDGEMENT

This research was supported in part by the Natural Fibers and Food Protein Commission of Texas. The assistance of Dr. R. J. Komarek (Tenn. Eastman Research Laboratories, Rochester, New York) in providing the rumen-protected methionine product and determining plasma amino acid levels is appreciated.

TABLE 1. PERCENTAGE INGREDIENT COMPOSITION AND CHEMICAL ANALYSES OF THE EXPERIMENTAL DIET

Ingredient	%
Sorghum grain, milo	36.6
Sorghum hay, ground	40.0
Cottonseed meal, 41% crude protein	14.0
Molasses, sugarcane	6.0
Calcium carbonate	1.4
Vitamin & Mineral premix	1.0
Salt, plain	0.5
Ammonium chloride	0.5
	100.0
Chemical analyses[1/]	
Dry matter, %	89.2
Crude protein, %	15.7
Acid detergent fiber, %	20.9
Total digestible nutrients, %	72.6

[1/] Dry matter basis.

TABLE 1. PERCENTAGE INGREDIENT COMPOSITION AND CHEMICAL ANALYSES OF THE EXPERIMENTAL DIET

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Vitamin & Mineral premix	1.0
Salt, plain	0.5
Ammonium chloride	0.5
	100.0
Chemical analyses[1/]	
Dry matter, %	89.2
Crude protein, %	15.7
Acid detergent fiber, %	20.9
Total digestible nutrients, %	72.6
Calcium, %	0.92
Phosphorus, %	0.28
Magnesium, %	0.21
Potassium, %	0.32
Sulfur, %	0.32
Iron, ppm	176
Copper, ppm	3.6
Manganese, ppm	42.5
Zinc, ppm	36.6

1/ Dry matter basis.

TABLE 2. LIVE WEIGHT, FEED INTAKE, MOHAIR MEASUREMENTS AND PLASMA FREE METHIONINE LEVELS IN ANGORA GOATS FED RUMEN-PROTECTED METHIONINE

	Rumen Protected Methionine, %				d,ℓ-methionine	
	0.0	0.1	0.2	0.3	0.16	s.d.
Goat number	12	12	12	12	12	
Initial live weight, lb	94.7	93.0	92.9	86.5	80.2	6.1
Final live weight, lb	106.0	107.7	108.3	100.4	94.9	3.8
Live weight change, lb	11.2	15.0	15.4	13.9	14.7	4.0
Feed intake, lb/day	2.59	2.79	2.81	2.58	2.60	0.18
Grease fleece weight, lb	4.21	5.38	5.31	4.43	4.30	0.74
Clean fleece weight, lb	3.30	4.01	3.73	3.39	3.27	0.28
Plasma methionine, μg/ml	0.57	0.81	1.83	2.30	1.07	0.79

FIGURE 1

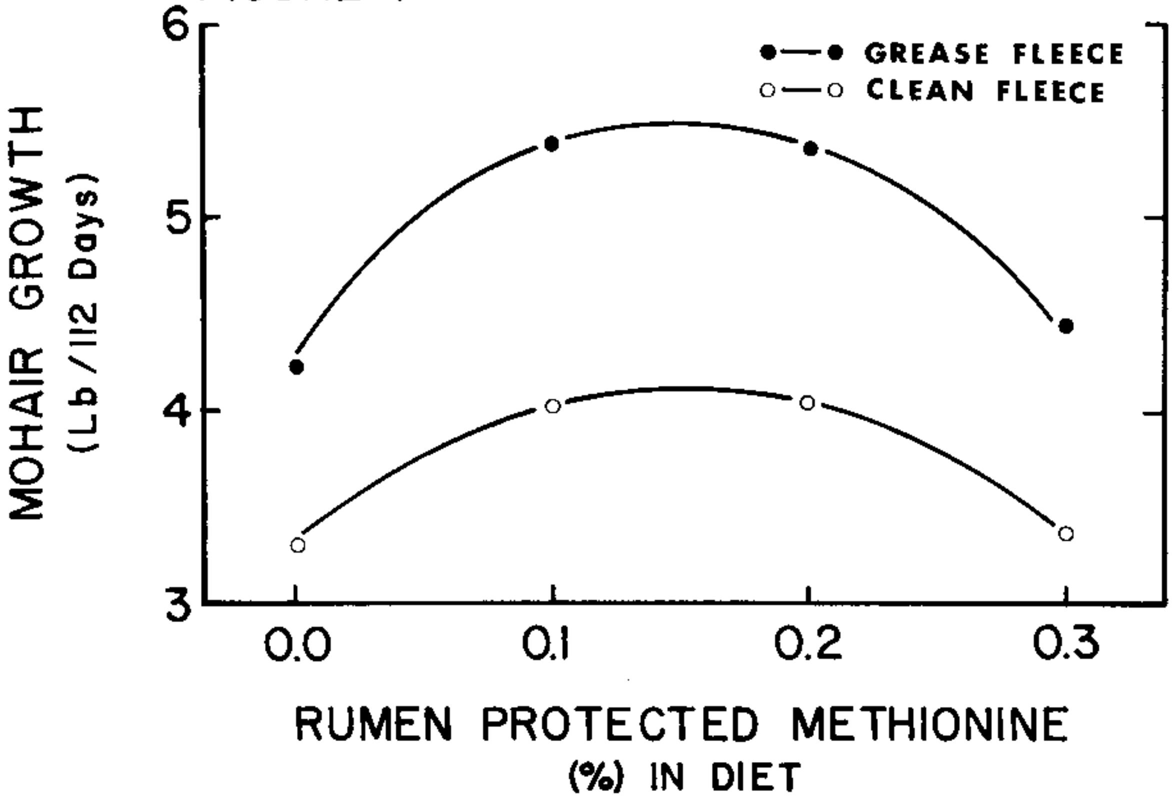
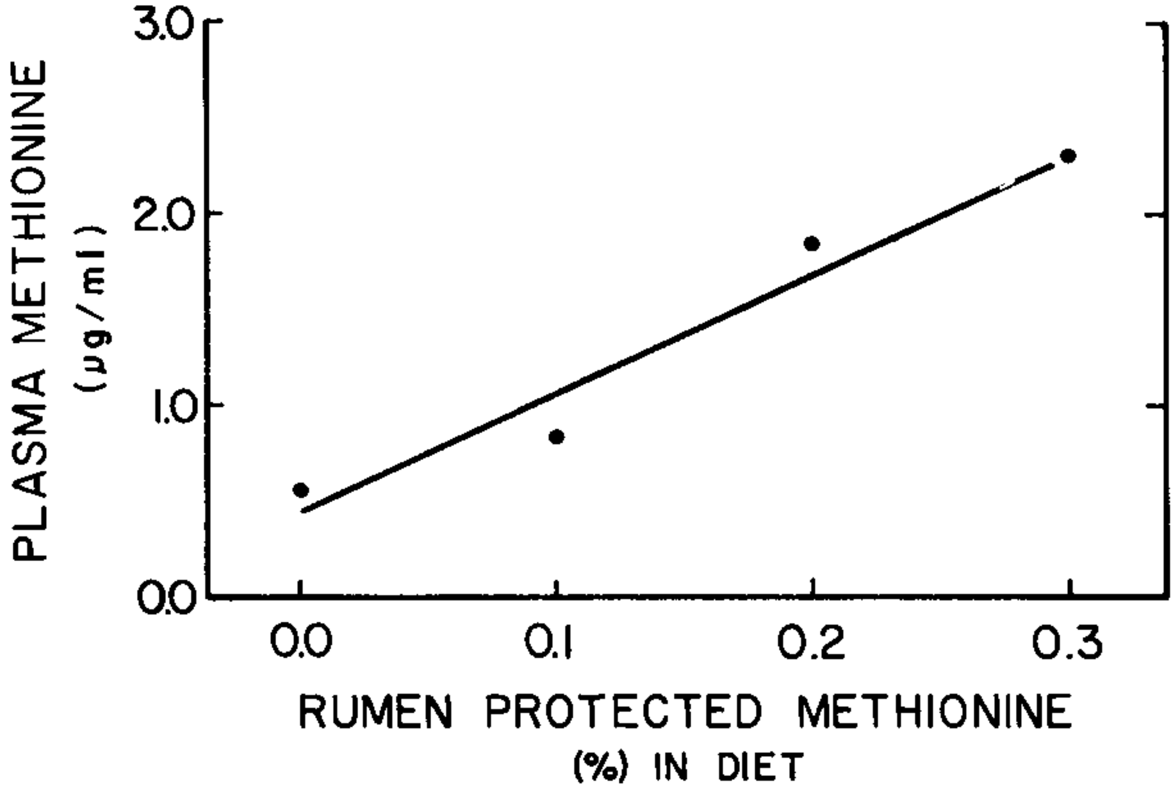


FIGURE 2



OBJECTIVE MEASUREMENTS OF TEXAS MOHAIR

R. H. Stobart and J. W. Bassett

SUMMARY

Objective measurements of kid, yearling, and adult mohair were made of samples obtained from seven warehouses over four shearing seasons. Differences were observed among the age groups as expected. Measurements of samples from different warehouses tended to be similar within age groups, but there were exceptions which were sufficiently large to be of economic importance. Differences between the spring and fall clips were observed, but the greatest variation was found when comparing the 1980 spring clip to the previous 1979 fall clip. The 1980 spring clip was lower in clean yield, finer in fiber diameter and shorter in lock length than either the 1979 spring or fall clips. This indicated the influence of nutritional-environmental factors during the growing period preceding that shearing. Objective measurements provide a basis for determining both the presense and degree of variability of traits determining mohair market value.

INTRODUCTION

There have been no recent measurement figures available that describe the Texas mohair clip or that can be used to compare the Texas clip with mohair from other countries.

Mohair samples were obtained from seven warehouses located within the major Angora goat production areas to provide objective measurements of mohair fiber traits that are of economic importance to the mohair fiber processor.

EXPERIMENTAL PROCEDURE

The project was initiated with the fall 1978 clip and continued through the spring 1980 clip, four consecutive shearing seasons. Core samples were taken from mohair which was available within each warehouse at the time of sampling. Core samples were taken with a ½" pressure coring device, with a minimum of 20 cores per sample. The core samples were used to measure clean yield, fiber diameter, and kemp and med fiber counts. Lock lengths were measured from either hook or hand samples obtained during the last three sampling periods.

RESULTS AND DISCUSSION

The clean yields for each warehouse by age category are shown in Table 1. Seasonal and yearly variations are apparent, with the fall clips of each age group tending to be higher in yield than the following spring clips. The 1980 spring clip tended to have the lowest clean yield of the four sampled. Yearling and kid mohair tended to be slightly lower in clean yield than the adult mohair. While differences between warehouses in clean yield were generally small, there were some differences which were sufficiently large to be of economic consideration in determining market value.

Fiber diameter measurements are reported in Table 2. The fiber diameter of the adult mohair did not change greatly during the first three clips which were sampled, although the 1979 spring clip tended to be slightly coarser than the fall clips on either side. The major diameter difference is in the spring 1980 clip in which the adult hair was considerably finer in diameter at all locations. The yearling mohair sheared in spring, 1979 was coarser than that sampled the previous fall, which is expected in comparing the 3rd and 4th shearing seasons for most young Angora goats. However, the 1980 spring yearling (or "young goat" as it is referred to in some areas) was as fine as or finer than the 1979 fall yearling. The kid mohair followed a similar pattern in that the 1979 spring kid was coarser than the 1978 fall kid mohair, but the 1980 spring kid was not greatly different from the 1979 fall shearing. These data indicate the very strong influence of range forage and environmental factors on mohair fiber diameter between seasons and years.

Kemp fibers are hollow ("medullated") fibers in which over 65% of the fiber volume is air space. This contributes to a chalky white appearance, and a lack of strength and elasticity. It prevents the fiber from being dyed to the same shade as the rest of the fibers and is considered as very undesirable by the fiber processor. "Med" fibers are also hollow but are less than 65% air space and do not present the same problems in processing. However, med fibers are considered to be an indication of potential kemp problems. The major area of concern with the data of Table 3 is that there appeared to be an increase in incidence of kemp across the four shearing seasons, which should be monitored.

Lock length data are not as complete as the other factors. If Angora goats are sheared at six month intervals, locks are long enough that length is not usually considered a problem. In the past there has not generally been a premium given for above average length. The lock length data shown in table 4 indicate that the fall shearing is generally longer than the spring, with the 1980 spring being the shortest of the four. Variations exist that are probably sufficient to warrant price differentials.

These data indicate that while objective measurements tend to show a degree of similarity between warehouses within a particular shearing season, differences can exist which are of real economic importance. A variation between fall and spring seasons is normal, but this can be greatly influenced and changed by environmental factors. This was particularly true in this study where the environment-nutrition prior to the spring 1980 shearing caused a decrease in clean yield, a greater than normal decrease in lock length, and either little or no increase in fiber diameter.

ACKNOWLEDGEMENTS

Appreciation is expressed to managers of the following warehouses which provided mohair for sampling:

Del Rio Wool & Mohair Company, Del Rio
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Ranchman's Wool & Mohair, Inc., Ingram
Rocksprings Wool & Mohair In., Rocksprings
Sanderson Wool Commission Company, Sanderson
Sonora Wool & Mohair Company, Sonora
Uvalde Producers Wool & Mohair Inc., Uvalde

This research was funded in part by The Natural Fibers and Food Protein Commission of Texas, Dallas.

The assistance of Mr. Harry Reals, U.S.D.A. Livestock Marketing Grades and Standards Division, Wool & Mohair Laboratory in obtaining and measuring the spring, 1979 clip is greatly appreciated.

TABLE 1. MOHAIR CLEAN YIELDS, PERCENT

	Shearing season			
	1978	1979		1980
Warehouse*	Fall	Spring	Fall	Spring
		ADULT		
A	79.9	76.8	86.8	75.6
B	79.9	77.0	84.0	75.6
C	78.9	78.4	*	73.9
D	81.0	79.3	80.2	78.2
E	77.1	76.4	79.1	77.0
F	**	**	74.9	**
		YEARLING		
A	78.7	79.9	82.7	72.7
B	78.2	75.9	79.6	**
C	78.1	76.4	77.7	76.7
D	**	75.3	**	70.8
E	73.9	75.6	77.1	71.8
F	73.0	75.6	77.1	71.8
		KID		
A	79.3	74.9	78.6	73.0
B	78.0	74.0	79.2	72.1
C	80.9	75.4	88.0	71.1
D	**	73.9	79.6	69.6
E	78.4	73.0	78.6	73.8
F	78.1	73.0	76.3	66.3

* Warehouses are listed in random order, but are the same for each age category

** Data not available

TABLE 2. FIBER DIAMETER, MICRONS AND SPINNING COUNTS

Warehouse	1978 Fall		1979 Spring		1979 Fall		1980 Spring	
	Micron	Sp.Ct.	Micron	Sp.Ct.	Micron	Sp.Ct.	Micron	Sp.Ct.
			ADULT					
A	36.1	24s	35.3	24s	36.5	24s	34.3	26s
B	35.7	24s	37.0	24s	35.9	24s	33.4	26s
C	35.1	24s	36.3	24s	36.5	24s	31.0	28s
D	32.4	28s	34.9	26s	34.4	26s	33.2	26s
E	35.6	24s	36.6	24s	35.4	24s	33.1	26s
F	36.2	24s	36.4	24s	36.0	24s	33.3	26s
G	**		**		36.3	24s	**	
			YEARLING					
A	31.5	28s	36.8	24s	31.3	28s	31.6	28s
B	31.4	28s	35.0	24s	31.2	28s	**	
C	31.2	28s	33.8	26s	32.4	28s	30.5	30s
D	**		32.8	28s	32.7	28s	30.4	30s
E	32.2	28s	32.0	28s	31.4	28s	31.5	28s
F	32.0	28s	33.5	26s	31.4	28s	32.5	28s
			KID					
A	27.0	36s	29.1	30s	25.2	36s	265.	36s
B	25.2	36s	30.2	30s	26.3	36s	26.0	36s
C	26.0	36s	28.2	32s	25.5	36s	23.9	40s
D	**		27.4	32s	24.6	40s	26.2	36s
E	26.2	36s	28.2	32s	24.1	40s	25.4	36s
F	26.6	36s	30.2	30s	24.7	40s	27.9	32s

Shearing season

** Data not available

TABLE 3. KEMP AND MED FIBERS, PERCENT

Warehouse	1978 Fall		1979 Spring		1979 Fall		1980 Spring	
	Kemp	Med	Kemp	Med	Kemp	Med	Kemp	Med
				ADULT				
A	0.7	0.6	1.0	1.9	0.3	0.3	1.5	0.6
B	0.4	0.5	0.6	1.1	0.6	0.2	1.6	1.1
C	0.4	0.3	0.6	1.5	0.4	0.7	1.4	0.8
D	0.7	0.4	0.5	1.0	0.3	0.2	1.0	0.6
E	0.3	0.4	0.4	1.8	0.3	0.2	1.2	0.6
F	0.4	0.5	0.4	1.2	0.4	0.3	1.5	1.0
G	**	**	**	**	0.5	0.3	**	**
				YEARLING				
A	0.5	1.2	0.5	2.0	0.3	0.2	1.3	1.3
B	0.1	0.6	0.1	1.3	0.3	0.5	**	**
C	0.5	1.8	0.2	1.2	0.4	0.2	1.0	0.1
D	**	**	0.4	0.7	0.6	0.2	0.7	0.6
E	0.1	0.5	0.7	*	0.4	0.1	0.6	0.5
F	0.2	0.5	0.1	1.2	0.3	0.3	1.1	1.5
				KID				
A	0.4	0.4	0.6	1.6	0.3	0.5	1.0	0.8
B	0.4	0.4	0.5	0.4	0.5	0.3	1.3	0.7
C	0.6	0.4	0.2	1.1	0.3	0.3	0.6	0.2
D	**	**	0.3	1.0	0.8	0.5	0.8	0.5
E	0.9	1.1	0.8	*	0.2	0.3	1.1	0.4
F	0.6	0.5	0.1	1.7	0.4	0.1	0.8	0.1

** Data not available

TABLE 4. LOCK LENGTH, INCHES

	Shearing season			
	1978	1979		1980
Warehouse	Fall	Spring	Fall	Spring
		ADULT		
A	**	3.7	5.6	4.5
B	**	5.1	**	4.8
C	**	4.6	**	**
D	**	4.2	4.9	**
E	**	4.5	4.4	4.0
F	**	4.3	4.5	4.5
		YEARLING		
A	**	3.9	4.4	4.0
B	**	**	**	**
C	**	4.6	**	3.7
D	**	3.3	4.5	**
E	**	4.4	4.6	4.0
F	**	4.6	4.4	**
		KID		
A	**	4.3	4.2	4.2
B	**	**	**	4.5
C	**	4.3	**	4.6
D	**	3.3	4.3	**
E	**	5.1	4.5	4.6
F	**	5.6	4.6	4.8

** Data not avaiable

DIET SELECTION AND DIGESTIBILITY IN CATTLE, SHEEP, AND GOATS

Barron Rector, Ed Huston, Ken Bales, and Sue Engdahl

SUMMARY

Diets were sampled in cattle, sheep, and goats grazing rangelands near Brady, Texas during 1979-80 using animals with esophageal fistula. All three species consumed a large number of plants, but goats selected the most diverse diet. Variations in digestibility between animal species and among seasons were smaller than expected, perhaps as a result of dry conditions. Several interesting aspects of grazing preference were noted and discussed.

INTRODUCTION

The Edwards Plateau is well known for having a highly diverse vegetation suitable for grazing a combination of cattle, sheep and goats. Competition among animals within a single species and between different animal species forms the basis for estimating animal equivalence. A study began in 1979 at the Winters-Wall Ranch to determine the important relationships between animal species in different combinations and the immediate and long-term effects of such combinations on range vegetation. Data collected include diet selection, forage intake, available vegetation, and animal productivity.

EXPERIMENTAL PROCEDURE

At least four cattle, sheep and goats with esophageal fistula were grazed for four days during each season. Esophageal samples were collected, frozen, freeze-dried and separated for botanical analysis and digestibility determination. The botanical composition was summarized according to plant species into four groups: grass, forbs, browse, and sedge. Digestible organic matter (DOM) was estimated by a two-stage *in vitro* digestion procedure, which consisted of a 48-hour incubation followed by a neutral detergent extraction.

RESULTS AND DISCUSSION

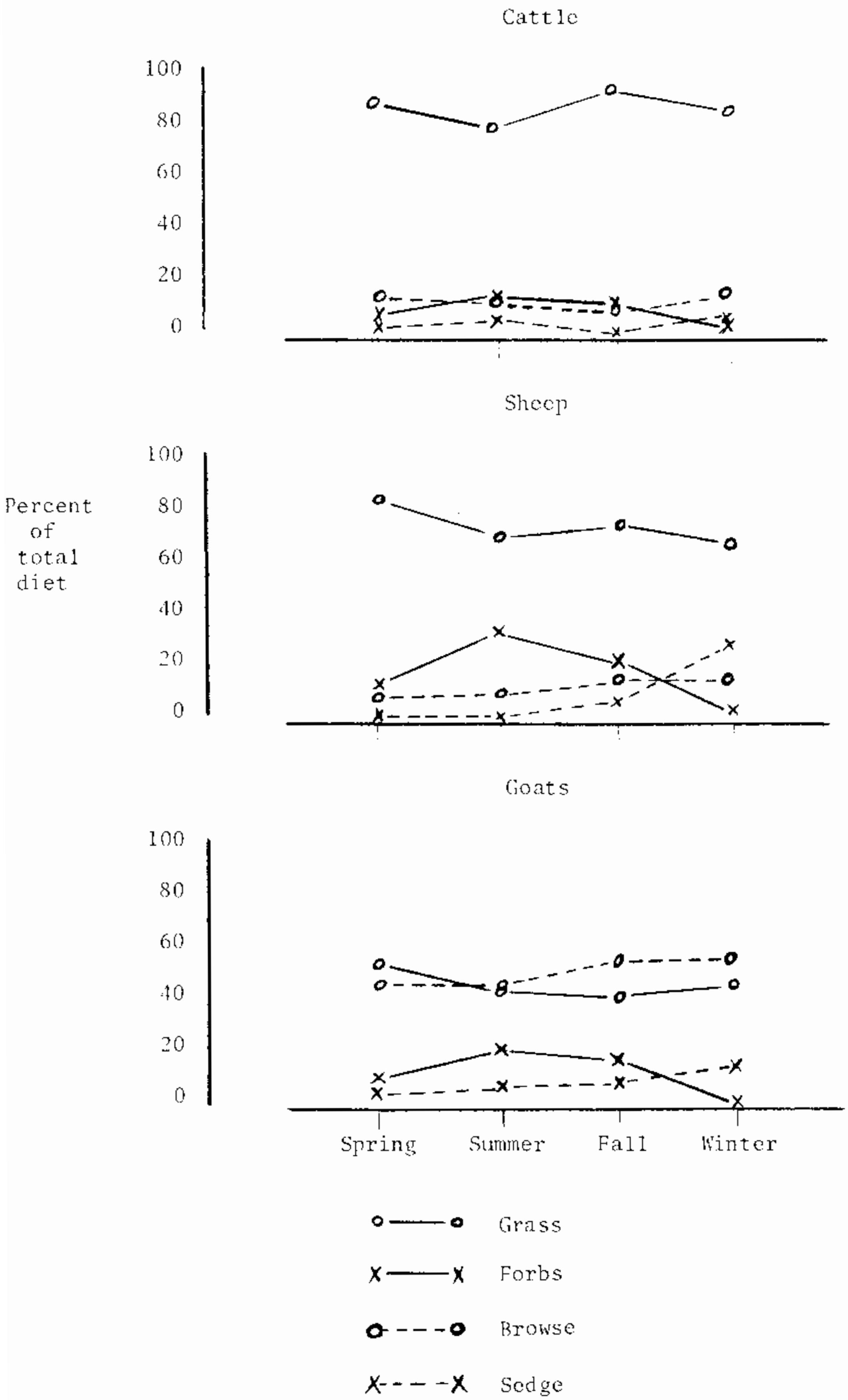
Preliminary data on diet selection and digestibility indicate animal species differences and the importance of variety in plant species. As has been reported previously, diets of goats contained a large amount of browse compared with sheep and cattle, and a proportionately lower amount of grass (Figure 1). Sheep selected more of the low-growing forbs, especially in summer, and cattle depended heavily on grasses throughout the year. Moreover, the data shows that even within forage class, different individual plants were selected by the different animal species. For example, cattle consumed mainly live oak as their browse component, whereas goats selected from a larger number of browse plants. Sheep preferred the low growing annual forbs, goats the taller perennials. Goats selected several species of grasses which were not present in diets of cattle and sheep. The variety of plant species allowed the different animals to select diets of relatively uniform digestibility across summer, fall and winter (Table 1). It is expected that when the analyses are completed, the spring diet will be significantly higher in digestibility.

The data have not been summarized according to animal combinations, but early trends indicate that animal diets differed greatly with different combinations of companion species. Results of the study will aid in estimating the replacement equivalence of different animal species on ranges having various plant proportions.

TABLE 1. DRY MATTER DIGESTIBILITIES OF DIETS SELECTED BY CATTLE, SHEEP AND GOATS DURING THREE SEASONS

Animal Species	Dry Matter Digestibility by Season (%)		
	Summer	Fall	Winter
Cattle	54	53	53
Sheep	57	58	54
Goats	57	56	52
Average	56	56	53

Figure 1. Diet selection of cattle, sheep and goats during four seasons.



DIETARY CHOICES OF SELECTED BREEDS OF SHEEP AND GOATS GRAZING IN WEST TEXAS

Lee Warren, Darrell Ueckert and Maurice Shelton

SUMMARY

Rambouillet, Karakul and Barbado sheep consume primarily grasses while Spanish goats rely more heavily on browse. All breeds of sheep consume more forbs than goats. Barbado sheep fill the grazing niche between the goats and other two breeds of sheep studied, by consuming more grass than goats but less than sheep, and by consuming more browse than sheep but less than goats. The dietary niche of Angora goats is between that of Spanish goats and Barbado sheep. Diets of all breeds of sheep and goats vary when grazing in different plant communities as well as at different sampling periods within each plant community due to differences in forage species composition, availability and relative palatability.

INTRODUCTION

Many ranchers graze with a combination of livestock species on a given area for more efficient utilization of available forage from grasses, forbs and brush. This type of grazing is beneficial in two ways: a greater variety of vegetation is grazed; and each livestock species benefits from grazing by the other species, provided grazing rates are not too high.

Microhistological analysis of fecal material has provided a fairly accurate and widely acceptable tool for determining diets of livestock and many wildlife species grazing under natural conditions. Microhistological analysis of fecal material to determine diet composition aids in understanding the dietary relationships among rangeland herbivores, animal performance, and the long- and short-term responses of forage and browse plants to grazing management. The objective of this study was to compare the grazing habits of various genotypes of sheep and goats to determine the extent to which they compete or compliment in forage utilization.

EXPERIMENTAL PROCEDURE

The sample herd utilized in this study consisted of six to ten yearling females of Rambouillet, Karakul, and Barbado sheep, and Spanish and Angora goats. Sheep and goats were grazed together in three selected range types, including a common curlymesquite grass-threeawn-liveoak (*Hilaria berlangeri-Aristida sp.-Quercus virginiana*) community, 47 km. southeast of Sonora; a mixed grass-mesquite (*Prosopis glandulosa*) community, 3.7 km. north of San Angelo; and a creosotebush-tarbush (*Larrea tridentata-Flourensia cernua*) community 25 km. southeast of Fort Stockton.

Fecal samples were collected daily during two 5-day sampling periods from five individual animals within each breed during selected seasons at each location. Fecal samples were oven-dried and ground over a 1-mm screen; then one microscope slide was prepared from each sample. Approximate dry weight composition of plants in the animal diets was determined by microscopic examination of plant epidermal tissues in the fecal samples. Plant tissue on slides was identified from reference tissue of identified plants. Twenty microscope fields per slide were observed, and frequency of occurrence of discernable plant fragments was recorded. Frequency percentages (F) were converted to density (D) by the equation $F=100\ (1-e^{-D})$ (1). Relative density (R) was calculated for all food items in the diet(s) of each individual animal by the formula:

$$R = \frac{D_i\ (100)}{\sum_{i=1}^{s} D_i}$$

Sparks and Malechek (3) have shown that relative density (R) has a 1:1 ratio to the relative amount (dry-weight basis) of each food item in the diet. Diets were averaged for all individuals within a breed for each sampling period. Similarity of diets among the various breeds was calculated using Kulcyzniski's similarity index (2).

RESULTS AND DISCUSSION

Diets varied considerably within each breed of sheep and goats at different sampling periods within each plant community due to changes in availability of forages (data not shown). Also, major changes in diets were observed within the various breeds grazing in different plant communities (Fig. 1, 2 and 3).

Grasses constituted the staple food of all breeds except Spanish goats in the common curlymesquite grass-threeawn-liveoak community during fall and winter (Fig. 1). Browse, mainly oak, was the major food of Spanish goats. Forbs were minor diet components in all breeds during fall 1979 and winter 1980 due to absence of forbs in the vegetation complex caused by extremely poor growing conditions. Rambouillet, Karakul, and Barbado sheep diets consisted of over 25% browse during this dry period.

Grasses were the major diet constituents of Rambouillet, Karakul, and Barbado sheep while browse was more important in Spanish and Angora goat diets in the mixed grass-mesquite community in spring and summer (Fig. 2). All three breeds of sheep consumed over 20% forbs and over 20% browse during this period. Forbs comprised less than 10% of the diets of Spanish and Angora goats.

Grasses were the staple food of all five breeds during fall in the creosotebush-tarbush community (Fig. 3). Forbs comprised about 40% of the diets of Rambouillet and Karakul sheep and about 30% of the diets of Barbado sheep, Spanish goats and Angora goats. Browse contributed about 30% to Spanish goat diets, 20% to Angora goat diets, and 10% to Barbado sheep diets.

Average diets of Rambouillet and Karakul sheep were very similar (Table 1), comprised primarily of grasses, with forbs second in importance, and browse third in importance (Fig. 4). Diets of Barbado sheep were more similar to diets of Rambouillet and Karakul sheep than to goat diets, but tended to be intermediate between the diets of Rambouillet and Karakul sheep and that of Angora goats (Table 1; Fig. 4). Barbado sheep consumed less grass and more browse than the other breeds of sheep, but similar amounts of forbs (Fig. 4). Diets of Angora goats and Spanish goats were distinctly different (Table 1; Fig. 4). Grasses were the staple foods of Angora goats, and browse was of secondary importance. Browse was the staple food for Spanish goats, while grasses were secondary in importance. Forbs were minor diet constituents of both Spanish and Angora goats.

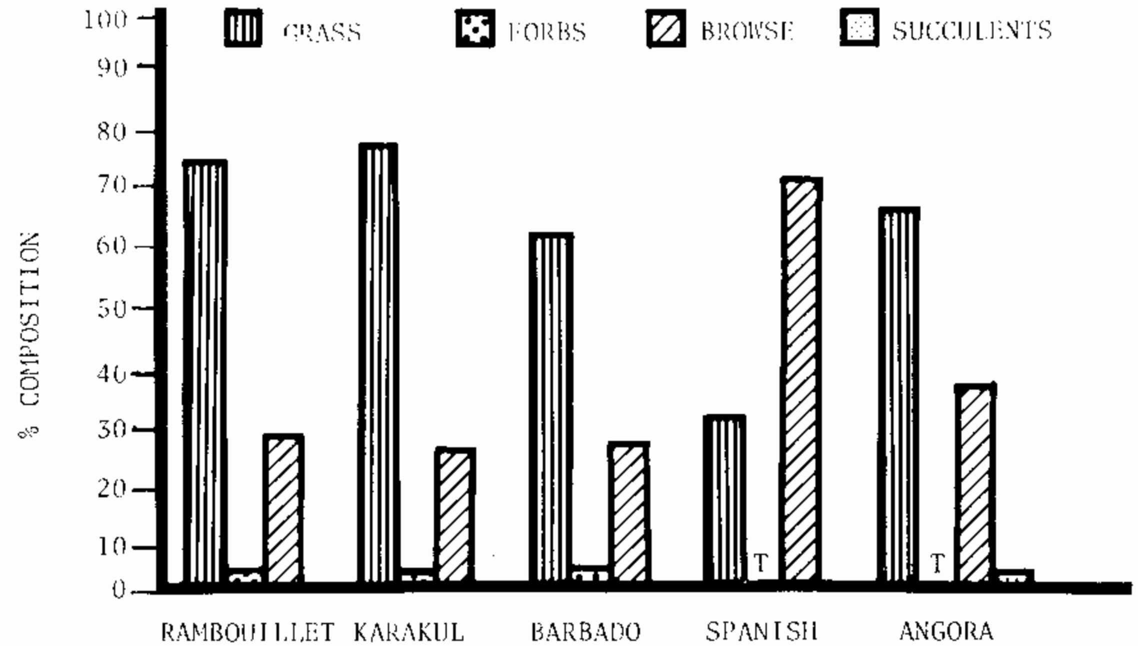
LITERATURE CITED

1. Fracker, S. B. and J. A. Brischle. 1944. Measuring the local distribution of ribes. Ecology 25:283-303.

2. Oosting, H. J. 1956. The study of plant communities. W. H. Freeman and Co., San Francisco.

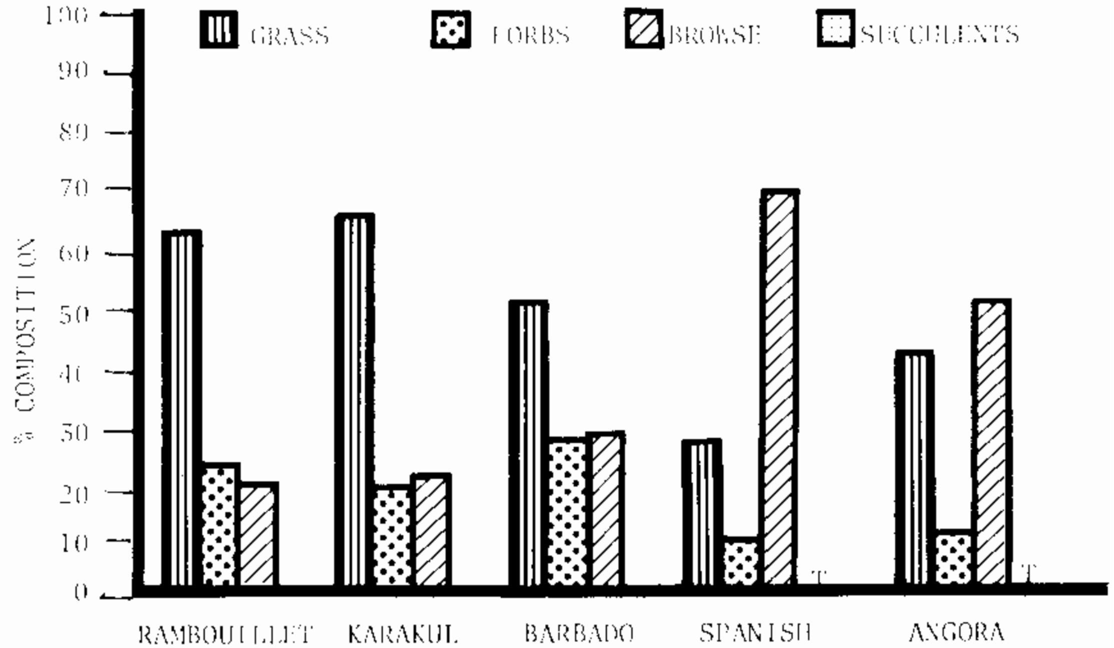
3. Sparks, D. R. and J. C. Malechek. 1968. Estimating percentage dry weight in diets using a microscopic technique. J. Range Manage. 21:264-265.

FIGURE 1.



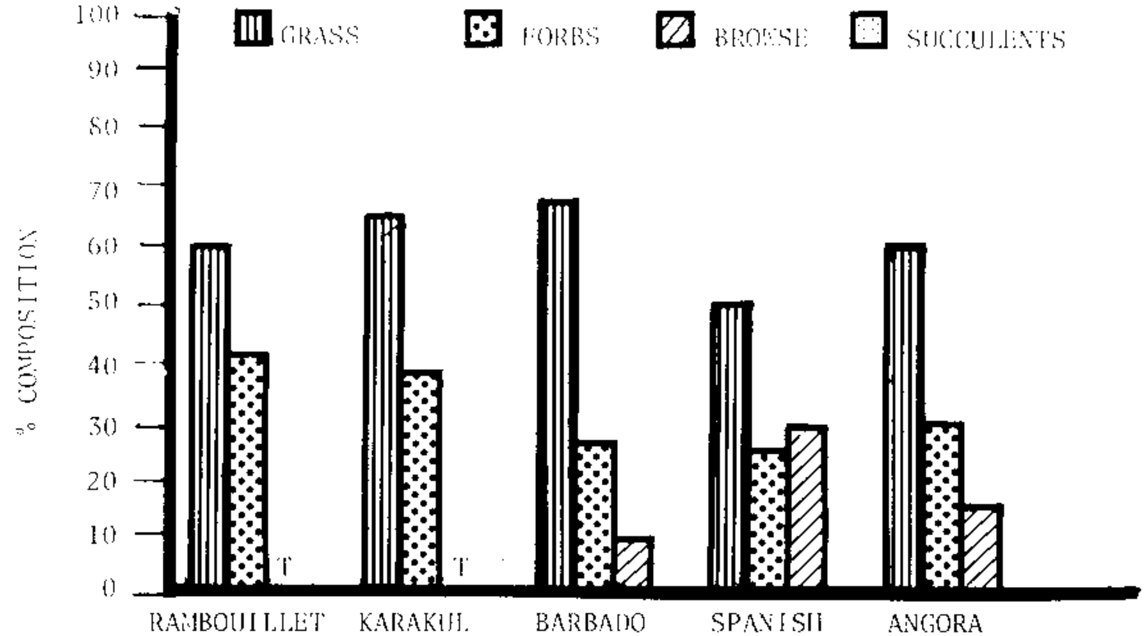
AVERAGE PERCENTAGES OF GRASS, FORBS, BROWSE, AND SUCCULENTS IN DIETS OF VARIOUS BREEDS OF SHEEP AND GOATS GRAZING IN A CURLYMESQUITE GRASS - THREEAWN - LIVEOAK COMMUNITY IN EWARDS COUNTY, TEXAS DURING NOVEMBER 26-30, 1979 AND FEBRUARY 11-15, 1980.

FIGURE 2.



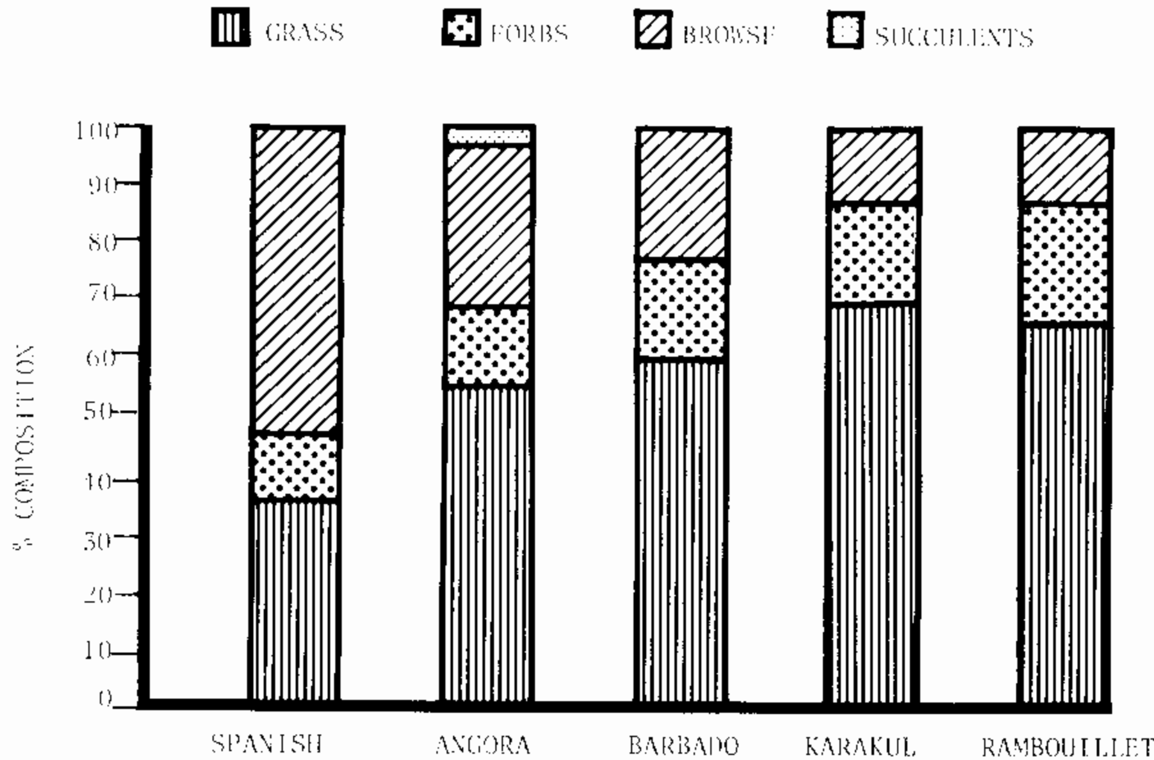
AVERAGE PERCENTAGES OF GRASSES, FORBS, BROWSE, AND SUCCULENTS IN DIETS OF VARIOUS BREEDS OF SHEEP AND GOATS GRAZING IN A MIXED GRASS-MESQUITE COMMUNITY IN TOM GREEN COUNTY, TEXAS DURING APRIL 28-MAY 2 AND AUGUST 4-8, 1980.

FIGURE 3.



AVERAGE PERCENTAGES OF GRASS, FORBS, BROWSE, AND SUCCULENTS IN DIETS OF VARIOUS BREEDS OF SHEEP AND GOATS GRAZING IN A CREOSOTEBUSH - TARBUSH COMMUNITY IN PECOS COUNTY, TEXAS DURING SEPTEMBER 29-OCTOBER 2, 1980 AND NOVEMBER 3-6, 1980.

FIGURE 4.



MEAN PERCENTAGES OF GRASS, FORBS, BROWSE, AND SUCCULENTS IN DIETS OF VARIOUS BREEDS OF SHEEP AND GOATS.

TABLE 1.

UPPER DIAGONAL MATRIX OF SIMILARITY INDICES OF DIETS OF VARIOUS BREEDS OF SHEEP AND GOATS GRAZING IN THREE DIFFERENT PLANT COMMUNITIES IN TEXAS DURING 1979-1980

	SPANISH	ANGORA	BARBADO	KARAKUL	RAMBOUILLET
SPANISH	100	69	53	49	44
ANGORA		100	66	62	57
BARBADO			100	77	74
KARAKUL				100	84
RAMBOUILLET					100

FORAGE SELECTIVITY OF GOATS IN SOUTH TEXAS PLAINS

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SUMMARY

A 13-month study was conducted to determine the botanical diet composition of goats in the South Texas Plains. A limited number of observations were also made on deer and cattle. Grasses, mainly gramas and common curlymesquite grass, constituted 36% of goat diets and 87% of cattle diets. Browse species (primarily *Condalia spp.* and *Acacia spp.*) were major components of goat and deer diets. Browse made up 54% of goat diets. Some of the more important browse species utilized by goats were condalia (brasil, knifeleaf, and lotebush), acacia (blackbrush, twisted acacia, catclaw), purple sage, guayacan, guajillo, and wolfberry.

INTRODUCTION

The South Texas Plains comprises an area of approximately 20 million acres. Gould (1975) described the area as follows: "This area originally supported a grassland or savannah-type climax vegetation. Long-continued grazing and other factors have altered the plant communities to such a degree that ranchmen of the region now face a severe brush problem. Many species of trees and shrubs have increased in the area, including mesquite, post and live oak, cacti and several acacias." There appears to be both a need and a potential to diversify the forage use and income sources through the addition of goats to the grazing system. Ideally the use of goats would control or suppress the bush and turn a present nuisance into future income. Fecal samples were collected for diet analysis to confirm that goats do in fact consume a number of the browse species found in the area, and to determine the degree to which they may compete with cattle and deer, which are normal ruminant species throughout the South Texas Plains.

EXPERIMENTAL PROCEDURE

Fecal samples from deer, cattle, and goats were collected in a 200-acre pasture on the Walker Ranch in southern McMullen County from October 1979 through November 1980. Goat samples were collected at monthly intervals whereas cattle samples were collected during December, January, June and September; deer samples were collected December, January, October and November. The initial test herd consisted of 50 Spanish goats, but only 20 survived to the end of the test because of predation. Deer samples were collected by picking up fresh droppings near a water site in an adjacent pasture. Cattle samples were collected in a similar manner from the same or adjacent pastures. The presence of goats in the experimental pasture may have altered the species composition of forages available for grazing.

Vegetation surveys were not conducted. However, the vegetation was classified as a South Texas mixed brush community consisting primarily of *Acacia spp.* and *Condalia spp.* Neither liveoak nor shinoak were present on the experimental site.

The experimental pasture was predominately a shallow sandy range site with soils being Randado and Hidalgo sandy clay loam. Precipitation averages less than 20 inches per year on the site, but the precipitation during the study period was considerably below normal, amounting to only approximately 10 inches. Essentially all this fell during one storm in September 1980 near the end of the study period. This no doubt was a factor reducing the availability and consumption of some plants such as grasses and forbs.

Fecal samples were collected at monthly intervals, and approximate dry weight composition of plants in the diets was determined by microscopic examination of plant epidermal tissues in the samples.

RESULTS AND DISCUSSIONS

Twenty-nine different plants were identified in goat diets, 18 in cattle diets and 15 in deer diets (see Tables 1, 2 and 3). Grasses were important in goat diets during the spring and in cattle diets throughout the study. Grasses contributed 36% to the average yearlong diet of goats and 87% of the average yearlong diet of cattle. The major grasses were gramas (*Bouteloua spp.*) and common curlymesquite grass (*Hilaria berlangeri*). The grama grasses constituted over half the grass consumption by goats and were the most important forage for cattle.

Forbs were a minor constituent in the diets of goats, deer and cattle, but were essentially non-existant on the study area due to poor growing conditions. Forbs contributed only 5% to the average diet of goats and less than 2% for cattle and deer. Indianmallow (*Abutilon incanum*) was the most important forb in goat diets.

Browse, mainly *Condalia spp.* and *Acacia spp.*, was the most important forage in goat and deer diets. On a yearlong basis goat diets consisted of more than 54% browse, while the deer existed almost exclusively on browse. *Condalia sp.* accounted for over half the total deer diet. Guajillo (*Acacia berlangeri*), which is sometimes considered to be a toxic plant, was consumed by goats, deer and cattle. Guajillo contributed over 13% to the average yearlong deer diet, about 5% of goat diets and about 2.5% of the cattle diets. Animal losses from plant poisoning were not evident. Pricklypear (*Opuntia sp.*) contributed 5.4% to the average yearlong goat diets, 3.7% of the deer diet and less than 1% of cattle diets.

This study confirms that goats utilize several South Texas browse species. The browse species utilized by goats and deer were similar, but, at least in this study, the goats consumed more grass than deer. This would indicate that they would be slightly more competitive with cattle than deer. Cattle utilized very few browse species. From these data it would appear that cattle and deer compliment each other best in their utilization of available forage. However, one problem is evident in relying on this combination to utilize the resources. Deer were not present in sufficient numbers to effectively utilize or suppress the browse plants. Several aerial counts indicated a deer density of about eight per section. By contrast, and if we use a mean value between the initial and final count, the goats were stocked in the experimental pasture at approximately 100 per section. This would indicate that the potential exists for a significant goat industry in the 20 million acres of the South Texas Plains. This would be even more evident in those areas where oak species are present. In this study the electric fencing employed did an effective job of confining the livestock, but did not prevent coyote predation. Perhaps some modifications of the design might serve this purpose more successfully.

LITERATURE CITED

1. Gould, F. W. 1975. Texas plants - a checklist and ecological summary. Texas Agricultural Extension Service MP585 (Revised).

ACKNOWLEDGEMENTS

The authors acknowledge the contribution of the Walker Brothers (Steve, Tom and Mike) on whose ranch this study was conducted. Mr. P. H. Coates III provided the goats used in the study.

TABLE 1. GOAT DIET DATA - WALKER RANCH
MEAN COMPOSITION

COMMON NAME	SCIENTIFIC NAME	10/79	11/79	12/79	1/80	2/80	3/80	4/80	5/80	6/80	7/80	8/80	9/80	10/80	AVE.
GRASSES															
Grama	*Bouteloua spp.*	22	9	13	21	26	29	17	41	15	24	12	3	7	18.5
Curlymesquite grass	*Hilaria berlangeri*	5	3	9	5	8	6	4	11	16	8	7	2	2	6.5
Dropseed	*Sporobolus sp.*	t	1	t	4	-	-	1	3	-	-	-	-	-	0.8
Panicum	*Panicum sp.*	t	-	2	t	3	2	3	4	-	-	-	-	1	1.2
Threeawn	*Aristida sp.*	3	2	1	4	18	18	16	1	1	7	5	1	-	6.0
Pink pappusgrass	*Pappophorum bicolor*	-	1	1	-	-	-	-	-	-	1	-	1	1	0.4
Bluestem	*Bothriochloa sp.*	-	-	-	1	1	-	-	1	1	-	-	-	t	0.3
Texas wintergrass	*Stipa leucotricha*	-	-	-	-	t	-	-	-	-	-	-	-	-	t
Misc. grass		t	t	-	1	-	1	-	3	7	2	2	5	2	1.9
TOTAL GRASSES		30	16	26	36	56	56	41	64	40	42	26	12	13	35.6
FORBS															
Indianmallow	*Abutilon incanum*	1	2	1	-	-	3	2	-	4	1	2	3	2	1.6
Verbena	*Verbena sp.*	-	t	-	-	-	-	-	-	-	-	-	-	-	t
Lepidium	*Lepidium sp.*	-	t	-	-	-	-	-	-	3	2	1	-	t	0.5
Croton	*Croton sp.*	-	-	-	-	t	-	-	-	-	-	-	-	-	t
Lesquerella	*Lesquerella sp.*	-	-	-	-	-	-	-	-	-	-	-	-	1	0.1
Unknown forb		-	-	-	-	-	-	-	-	-	-	-	-	11	0.8
Misc. forbs		-	3	t	-	t	-	t	2	6	4	3	2	4	1.9
TOTAL FORBS		1	5	1	0	t	3	2	2	13	7	6	5	18	4.9

t - trace

TABLE 1. (contd.) GOAT DIET DATA - WALKER RANCH
MEAN COMPOSITION

COMMON NAME	SCIENTIFIC NAME	10/79	11/79	12/79	1/80	2/80	3/80	4/80	5/80	6/80	7/80	8/80	9/80	10/80	AVE.
BROWSE															
Acacia(Blackbrush,Twisted Acacia,Catclaw)	*Acacia spp.*	19	40	28	5	t	-	t	-	17	6	6	28	11	12.3
Guayacan	*Porlieria angustifolia*	11	-	6	15	t	t	12	-	6	11	2	5	23	7.1
Purple sage(Cenizo)	*Leucophyllum frutescens*	11	13	13	19	12	-	2	-	-	-	11	5	13	7.5
Condalia(Brasil,Knifeleaf, Lotebush)	*Condalia spp.*	15	7	18	11	8	17	13	8	13	14	36	32	8	15.5
Guajillo	*Acacia berlandieri*	7	8	5	4	4	10	10	-	1	4	3	2	4	4.8
Kidneywood	*Eysenhardtia texana*	1	1	t	-	3	4	2	-	2	1	-	-	-	1.0
Whitebrush	*Aloysia lycioides*	1	8	t	-	-	-	-	-	-	-	2	-	3	1.2
Chittamwood	*Cotinas obovatus*	1	-	-	-	6	4	-	-	-	-	-	1	-	0.9
Narrow leaf	*Forestiera angustifolia*	-	-	t	-	-	-	-	-	-	-	-	-	-	t
Desert Yaupon	*Schaefferia cuneifolia*	-	-	-	-	-	t	-	-	-	-	-	-	-	t
Persimmon	*Diospyros texana*	-	-	-	-	-	t	-	-	-	-	-	-	-	t
Littleleaf sumac	*Rhus microphylla*	-	-	-	-	-	t	4	-	-	-	-	-	-	0.3
Allthorn	*Koeberlinia spinosa*	-	-	-	-	-	t	-	-	-	-	-	-	-	t

t - trace

TABLE 1. (contd.) GOAT DIET DATA - WALKER RANCH
MEAN COMPOSITION

COMMON NAME	SCIENTIFIC NAME	10/79	11/79	12/79	1/80	2/80	3/80	4/80	5/80	6/80	7/80	8/80	9/80	10/80	AVE.
BROWSE (contd.)															
Wolfberry	*Lycium carolinianum*	-	-	-	-	-	-	-	26	8	10	1	-	-	3.4
Yucca	*Yucca sp.*	t	-	-	-	-	-	t	-	-	-	-	-	-	t
TOTAL BROWSE		66	77	70	54	33	35	43	34	47	46	61	73	62	54.0
SUCCULENTS															
Pricklypear	*Opuntia sp.*	2	2	2	11	9	4	12	-	-	6	6	10	7	5.4

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TABLE 2. CATTLE DIET DATA - WALKER RANCH
MEAN COMPOSITION

COMMON NAME	SCIENTIFIC NAME	12/79	1/80	6/80	9/80	AVE.
GRASSES						
Grama	*Bouteloua spp.*	18	28	20	33	24.7
Curlymesquite	*Hilaria berlangeri*	13	22	8	13	14.1
Dropseed	*Sporobolus sp.*	3	6	2	4	3.8
Panicum	*Panicum sp.*	21	11	18	5	13.8
Threeawn	*Aristida sp.*	3	3	17	21	11.3
Buffalo grass	*Buchloe dactyloides*	10	4	8	5	6.8
Muhly	*Muhlenburgia sp.*	-	15	15	7	9.2
Texas wintergrass	*Stipa leucotricha*	2	1	t	-	0.8
Tobosa	*Hilaria mutica*	-	t	2	-	0.6
Bluestem	*Bothriochloa sp.*	-	-	1	-	0.2
Misc. grass		3	4	1	-	2.0
TOTAL GRASSES		73	94	92	88	87.3
FORBS						
Lepidium	*Lepidium sp.*	-	1	-	-	0.3
Indianmallow	*Abutilon incanum*	-	-	3	1	0.8
TOTAL FORBS		0	1	3	1	1.1
BROWSE						
Guayacan	*Porlieria angustifolia*	-	t	1	4	1.4
Purple sage (Cenizo)	*Leucophyllum frutescens*	10	-	-	-	2.6
Condalia(Brasil,Knifeleaf, Lotebush)	*Condalia spp.*	13	-	2	-	3.8
Acacia(Blackbrush,Twisted Acacia,Catclaw)	*Acacia spp.*	-	-	-	1	0.3
Guajillo	*Acacia berlandieri*	4	-	1	6	2.7
TOTAL BROWSE		27	t	4	11	10.8
SUCCULENTS						
Pricklypear	*Opuntia sp.*	-	3	-	-	0.8

t - trace

TABLE 3. DEER DIET DATA - WALKER RANCH MEAN COMPOSITION

COMMON NAME	SCIENTIFIC NAME	12/79	1/80	10/80	11/80	AVE.
GRASSES						
Curlymesquite	*Hilaria berlangeri*	-	-	-	t	0.1
Threeawn	*Aristida sp.*	-	t	-	-	0.1
Bluestem	*Bothriochloa sp.*	-	-	-	t	0.1
Sedge	*Carex sp.*	-	-	-	4	1.0
Unknown grass		-	-	-	t	0.1
TOTAL GRASSES		0	t	0	4	1.4
FORBS						
Misc. forbs		0	1	2	1	1.3
BROWSE						
Guayacan	*Porlieria angustifolia*	1	3	5	2	2.7
Purple sage(Cenizo)	*Leucophyllum frutescens*	1	30	4	-	8.7
Condalia(Brasil,Knifeleaf, Lotebush)	*Condalia spp.*	74	41	41	46	50.6
Acacia(Blackbrush,Twisted Acacia,Catclaw)	*Acacia spp.*	3	2	24	24	13.3
Wolfberry	*Lycium carolinianum*	1	1	-	t	0.5
Desert yaupon	*Schaefferia cuneifolia*	2	2	2	1	1.7
Chittamwood	*Cotinas obovatus*	-	-	3	1	1.1
Granjeno(Spiny hackberry)	*Celtis pallida*	-	-	-	3	0.6
Guajillo	*Acacia berlandieri*	15	13	15	13	13.7
Misc. browse		-	4	-	t	1.0
TOTAL BROWSE		97	96	94	90	93.9
SUCCULENTS						
Pricklypear	*Opuntia sp.*	3	3	5	4	3.7

t - trace

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