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CONTENTS

LONG-TERM GAINS IN THE SONORA RAM TEST

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INTRODUCTION

A ram performance testing program has been conducted at the Texas Agricultural Experiment Station at Sonora since it was initiated in the fall of 1948, with the first test being completed in the spring of 1949. The present report deals with an analysis of time trends for the 28-year period from the spring of 1949 to the spring of 1976. During this period of time 3984 rams from 90 flocks representing seven breeds have completed the test and of this number 3622 or 90.0% were Rambouillet. In addition, Rambouillet is the only breed which has been present for each year of the test. For these reasons only this one breed has been included in the analyses.

TEST PROCEDURES

The rams to be tested are nominated by and remain in the property of contributing breeders, and thus constitute a selected population from the outset. Considerable variation has existed in the age and weight of the rams at initiation of tests. Most have been fed in sire groups of four rams consisting of paternal half sibs, but this has not been universally observed. Within a given year all rams or at least those which have been used in the present analyses, were fed the same ration on an *ad libitum* basis. The same ration, subject to year-to-year variation in ingredient contents, has been fed for a period of years, but over the 28-year period a total of six different rations have been utilized. All rations were formulated in a manner considered adequate to permit the rams to maximize their energy intake (*i.e.* roughage did not limit intake). The rams were given a brief adjustment period (variable over years, but not less than one week) prior to shearing and initial weighing. The animals were sheared again at the end of the test period. Test lengths have been variable over the years and have decreased to the present period of 140 days for animal gains. The wool growth period is usually 2 or 3 days longer since the animals are not shorn on the date they are weighed. The fleece data have been adjusted to 365-day equivalent. The data collected have included average daily gain (ADG), grease (GW) and clean wool (CW) production, staple length (SL), fiber diameter (FD) and scores for face covering (FC) and skin folds (SF). Scores were assigned on a 1 to 4 basis by a committee of three with the lower values being more desirable. The scoring standards and methods were outlined by Shelton and Campbell (1960). Ultrasonic reading of fat thickness and ribeye area have been recorded since the 1971-1972 test period, but have not been included in the present

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[1]A large number of people contribute to this program, and the author would like to acknowledge Dr. J.W. Bassett for the fiber work and Mr. D. W. Spiller for care of the experimental animals.

analysis. A selection index (I=60 X ADG in lbs. + 4 X SL in inches + 4 X CW in lbs. - 5.0 X FC - 4.0 X SF) has been calculated since 1962 (Shelton 1959) and has been retrospectively applied to the data as far back as 1950 for the purpose of this study. Other very similar indexes have been calculated and reported, but the one shown here has been used throughout this analysis. Individual producers make their own selections for stud rams, but have used extensively those with high performance in individual traits or high index values. In early years top rams were often used in several flocks, and thus to some degree this program represents pooled efforts in breeding for improvement.

ANALYTICAL PROCEDURES

Under the conditions of this test no control is possible over pretest environment and thus considerable variability exists in weight and condition of the rams as they are placed on test. Certain fleece traits (grease or clean wool production and fiber diameter), and index value are consistently and significantly related to initial weight and have been adjusted based on regression calculated for each year.

Other traits have not been consistently and significantly related to initial weight and these have not been adjusted. Estimating genetic change with time presents problems with most animal data because of the difficulty of removing environmental drift or change (Smith 1962). The maintenance of genetic controls or unselected populations is generally the procedure, but even this presents problems of random drift or inbreeding. In this program it was not possible to maintain genetic controls. An attempt was made to estimate environmental change or trends by utilizing repeat matings of the same sire in the same flock in subsequent years (Nwakalor *et. al.*, 1976). The data contained test groups from two or more sires for each of the 27 comparisons. This is not a true estimate of environmental change since genetic change in the ewe flock from one year to the next would be confounded with environmental change. This is thought to be a very minor source of error, but in any case would tend to reduce estimates of genetic change. The procedure appears to have provided good estimates of environmental change in the traits such as staple length, fiber diameter and scores for face cover and folds. These traits tend to be highly inherited and little influenced by initial weight and pretest environment. The method of estimating environmental change does not appear to have adequately partitioned changes in initial weight, since this is highly variable between flocks and only repeat matings within the same flock were considered. For this reason, those values which have been adjusted for initial weight are thought to be more accurate; overall change was measured by regression of each variable on years. Estimates of environmental change were subtracted from overall trends and the remainder expressed as genetic change. This was done for all Rambouillet and for six individual flocks which have been represented in the test for 24 or more years

RESULTS AND DISCUSSION

The number of rams by years and overall time trends are shown in Table 1 and Figure 1. It should be remembered that these are phenotypic values and that no corrections have been made for environmental trends. These data show consistent improvement in all of the variables studied. The similarity in trends in Figure 1 suggests that daily gain is a major variable influencing the trend in index value. The regression of mean values for a number of traits on years is shown in Table 2 for six individual flocks and for the total population. These may be interpreted as the average annual change. In this case it will be noted that a statistically significant change occurred in all traits measured (for the overall population) except for fiber diameter. The same may generally be said for each of the individual flocks except that flock No. 5 did not significantly improve in clean wool production and flock No. 6 did not increase grease wool production. In three of the six flocks the wool became significantly finer during this period of time.

In Table 3, these overall trends have been partitioned into the environmental and genetic components. The accuracy of the environmental adjustments may be open to question, but still the evidence is overwhelming that genetic change has been great over this period of time. For instance only one flock (No. 5) failed to make genetic progress in all the traits included in the index. Even this flock shows a positive value for fleece weight when adjusted for initial body weight. The consistency of the results suggests some bias to the data or that there is a great deal of similarity in the genetic material involved. The latter is known to be the case to a large degree, in that high performing rams have been widely used throughout several flocks. Differences in trends between individual flocks can be related to known breeding practices within the flocks, and this tends to support the methodology involved. Those flocks showing the least change tend to be these which have remained more isolated in their breeding program.

It is not possible to calculate selection differential from these data or to express progress as a function of what might have been expected. The adequacy of the method of calculating environmental adjustments may be questioned. However, there is overwhelming evidence of substantial genetic improvement of the traits measured in these tests. In evaluating this apparent response the reader should not lose sight of the fact that this program operates on a central testing concept in which each years' test animals represent a base population of several thousand breeding ewes. At the same time it is important for the breeders or participants in this test to recognize that the procedures employed provide only a mechanism for selecting for those traits which can be measured on a growing ram and also provide a measure of response only under "well fed" test conditions. The test provides no mechanism to select for or to estimate change in such traits as adaptability or fertility which are extremely important in the ewe flock. These data indicate that with adequate numbers and appropriate

methodology, significant genetic change can be realized and this emphasizes the importance of identifying the appropriate traits to be included in selection programs.

Data on efficiency of production were not included in the present analyses since feed use data are not available on individual animals. However, among those animals which were fed in sire groups, feed intake data are available by sire group. These data, up to 1972, were utilized by Shelton, *et al.* (1976) in attempting to estimate efficiency of nutrient use for wool production. These data provide no evidence of improvement in efficiency of production and suggest that the increases obtained have been through increase in feed intake. The significance of this observation should not be overlooked in planning the future of this or other selection programs.

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Table 1. Means for Rambouillet by Years

Year	No. Rams	Weight Init. lbs.	Weight Final lbs.	Adg. lbs.	Yield %	Staple in.	Face cover score	Skin fold score	Fleece Weights 12 Mo. Basis Grease Act. lbs.	Grease Adj. lbs.	Clean Act. lbs.	Clean Adj. lbs.	Fiber Diameter Act. microns	Fiber Diameter Adj. microns	Index Value Act.	Index Value Adj.
1949	88	74.9	187.6	.372	48.4	3.37	2.64		13.8	14.6	6.65	6.80				
1950	86	85.7	209.4	.447	47.6	3.53	2.77	2.65	16.5	17.3	7.84	8.16			47.82	49.07
1951	94	83.8	195.1	.497	44.9	3.34	2.70	3.15	18.0	19.1	8.08	8.56			49.35	51.28
1952	140	85.3	187.2	.455	46.2	3.47	3.30	2.00	17.7	19.1	8.17	8.67			49.35	51.34
1953	93	87.8	193.5	.472	47.3	3.56	2.99	2.77	18.4	18.9	8.65	8.92			51.11	52.21
1954	76	84.4	198.1	.506	47.9	3.80	2.89	2.41	19.5	20.4	9.26	9.53			58.56	59.63
1955	85	95.2	203.9	.485	49.4	4.29	2.77	2.55	17.8	18.1	8.73	8.87			57.12	57.66
1956	93	101.1	209.0	.482	46.2	3.87	2.71	2.23	19.8	19.8	9.14	9.10			58.47	58.32
1957	113	98.5	209.5	.496	48.5	4.02	2.79	2.12	18.8	18.9	9.07	9.14			59.66	59.93
1958	112	94.4	194.3	.595	49.7	4.21	2.62	2.27	18.2	18.3	8.97	9.06	22.84	22.89	66.20	66.58
1959	116	88.4	169.7	.483	51.1	4.17	2.97	2.06	15.6	16.3	7.94	8.38	21.18	21.40	54.45	56.09
1960	149	93.5	176.3	.493	52.9	4.36	2.83	1.81	16.7	17.0	8.80	9.06	22.51	22.54	60.81	61.84
1961	191	98.5	178.7	.477	52.1	4.26	2.60	1.76	16.8	16.9	8.74	8.79	22.06	22.10	60.60	60.79
1962	162	95.8	182.5	.516	50.4	4.29	2.54	2.22	17.9	18.2	9.05	9.22	23.32	22.46	62.75	63.43
1963	129	87.1	177.9	.541	50.7	4.11	2.49	1.69	17.4	18.0	8.88	9.38	22.44	22.80	65.24	67.27
1964	138	90.0	181.0	.546	51.4	4.54	2.55	1.90	17.9	18.6	9.17	9.56	22.11	22.36	66.94	68.51
1965	139	90.0	175.3	.509	52.3	4.10	2.59	1.92	17.5	18.5	9.13	9.65	21.66	21.89	62.80	64.87
1966	103	99.4	186.5	.517	48.1	4.35	2.30	1.94	20.4	20.4	9.78	9.80	21.84	21.85	68.32	68.38
1967	100	95.3	180.2	.506	48.5	4.39	2.20	1.97	19.2	19.4	9.28	9.51	22.94	23.08	66.20	67.10
1968	114	94.4	179.7	.508	51.1	4.33	2.14	2.08	18.3	18.8	9.31	9.57	22.78	22.89	66.04	67.05
1969	132	81.7	164.0	.539	52.1	4.52	2.23	1.74	17.0	18.6	8.82	9.82	21.91	22.39	67.59	71.58
1970	109	90.8	207.0	.659	50.0	4.41	2.03	1.71	19.6	20.5	9.84	10.38	22.33	22.54	79.55	81.71
1971	129	101.5	213.1	.664	49.3	4.69	2.06	1.88	20.4	20.3	9.96	9.90	22.73	22.71	80.57	80.34
1972	120	109.1	205.5	.689	49.6	4.82	2.12	1.64	19.9	19.3	9.82	9.57	22.28	22.15	82.73	81.74
1973	139	107.8	204.5	.692	52.1	4.92	2.16	1.88	20.9	20.2	10.87	10.57	21.86	21.70	86.36	85.16
1974	151	106.7	205.8	.708	51.3	4.78	2.00	1.76	19.8	19.4	10.15	9.90	21.85	21.81	85.13	84.17
1975	129	110.3	196.0	.645	52.9	4.62	2.02	1.67	19.8	18.6	10.45	9.87	21.29	21.02	82.19	79.88
1976	101	120.3	221.5	.723	51.8	4.81	1.88	1.57	21.0	19.8	10.90	10.03	22.75	22.26	90.52	87.06

Table 2. Average Annual Change for Indicated Traits for Six Individual Flocks and for all Rams Tested.

Flock	No. Years	Adg. lbs.	Staple Length in.	Face Cover Score	Skin Fold Score	Grease Wool lbs. Act.	Grease Wool lbs. Adj.[1]	Clean Wool lbs. Act.	Clean Wool lbs. Adj.[1]	Yield %	Fiber Diameter microns Act.	Fiber Diameter microns Adj.[1]	Index Value Act.	Index Value Adj.[1]
1	28	.009**	.053**	-.042**	-.064**	.079**	.042**	.059**	.050**	.115**	-.008	.030*	1.397**	1.346**
2	28	.010**	.047**	-.059**	-.003	.234**	.154**	.145**	.103**	.103*	.006	-.014	1.574**	1.403**
3	24	.014**	.069**	-.050**	-.030**	.233**	.154**	.156**	.116**	.180**	-.065**	-.099**	2.062**	1.897**
4	28	.011**	.046**	-.034**	-.029**	.156**	.109**	.098**	.081**	.130**	-.021	-.019	1.506**	1.434**
5	28	.008**	.044**	-.045**	-.040**	-.138**	-.072**	-.016	.019	.280**	-.070**	-.067**	1.003**	1.140**
6	24	.007**	.063**	-.050**	-.048**	.028	.024	.068**	.079**	.318**	.020	.046	1.384**	1.427**
Total	28	.010**	.050**	-.042**	-.034**	.130**	.078**	.097**	.075**	.171**	-.008	-.029**	1.480**	1.382**

[1]Refers to values which were adjusted to a constant initial weight.

*$P \leq .05$

*$P \leq .01$

Table 3. Estimates of Environmental and Genetic Change for Indicated Traits for 28-Year Period.

Trait	Estimated Environmental Change		Estimated Genetic change						
				Flocks					
	Annual	Total	Overall	1	2	3	4	5	6
Initial Wt. kg.	.0213	.594	23.668	22.697	29.269	31.891	25.621	22.218	7.759
Adg. lbs.	.0024	.064	.207	.180	.213	.321	.249	.172	.132
Staple Length in.	.0057	.159	1.252	1.310	1.151	1.772	1.115	1.081	1.607
Face Cover Score	.0071	.197	-1.361	-1.361	-1.840	-1.610	-1.137	-1.467	-1.590
Skin Fold Score	-.0001	-.003	- .960	-1.778	- .092	- .829	- .812	-1.100	-1.336
GW, lbs.	.0147	.411	3.241	1.797	6.147	6.125	3.969	4.288	.376
Adj. GW, lbs.	.0090	.251	2.444	1.414	4.556	4.550	3.293	1.767	.924
CW, lbs.	.0079	.222	2.504	1.437	3.837	4.145	2.515	.660	1.681
Adj. CW, lbs.	-.0143	-.398	2.501	1.894	3.276	3.656	2.660	.915	2.609
Fleece Yield %	.0286	.801	3.987	2.419	2.078	4.231	2.850	7.025	8.100
Fiber diam. microns	.0080	.224	- .456	- .445	- .056	-2.033	- .823	-2.184	.328
Adj. Fiber diam. microns	.0080	.224	-1.039	-1.064	- .622	-2.996	- .750	-2.105	1.067
Index Value	.0555	1.565	39.869	37.542	42.518	56.162	40.589	26.524	37.184
Adj. Index Value	.2225	6.230	32.469	31.464	33.043	46.892	33.914	25.696	33.726

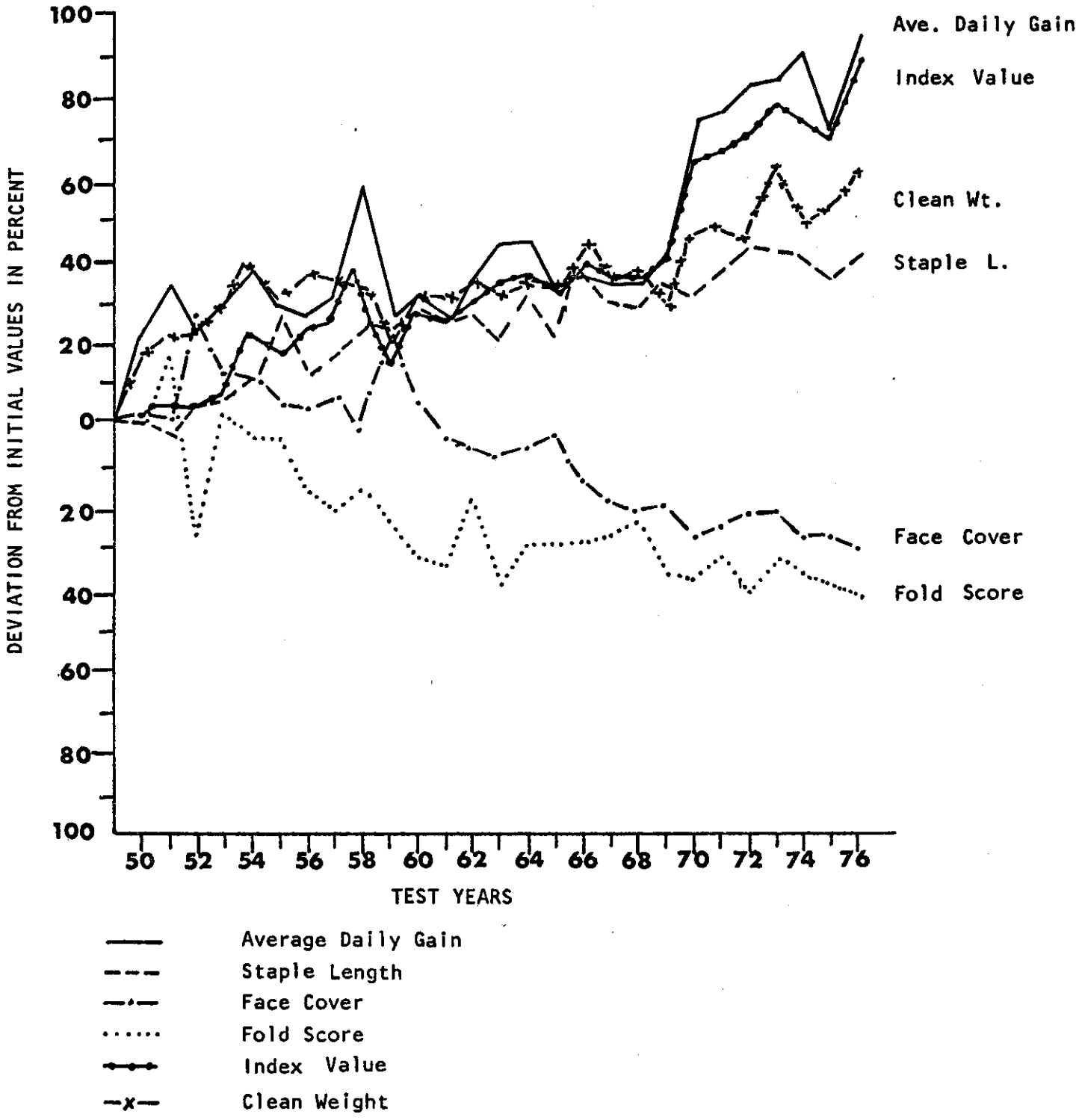

Figure I. Time trends in a performance testing program for sheep (Rambouillet rams only).

PR-3496

ANTIBIOTICS AND PROGESTERONE FOR IMPROVING EWE CONCEPTION

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In an earlier report (Shelton and Thompson, 1977) a major disparity was noted between the ovulation rate of ewes and the number of embryos present or lambs born. The same study suggested that the major loss occurred early in the gestation period. This type of loss may be explained through a lack of fertilization or loss of the embryo in early gestation. The study referred to did not provide a basis for partitioning these losses or explaining their cause. Australian workers (Restall et al. 1976) suggest that fertilization is an "all or none" proposition whereas they found embryo survival to follow a binomial distribution. This suggested that some causative force or agent might be involved in fertilization failure, whereas embryo survival is more likely an independent function. Over a period of years workers at this center have isolated a number of microorganisms from the reproductive tracts of ewes found to be open after exposure to rams. Primary among these have been corynebacterium sp. (pyogenes or psuedotuberculosis) and mycoplasmas or ureaplasmas. However, the mere presence of the organisms does not indicate a cause and effect relationship. One approach in the study of this relationship between the presence of these organisms and reproductive failure is through the administration of drugs to which the organisms may be sensitive. Thus studies have been conducted utilizing terramycin and sulfamethiazine administered at or near breeding. Progesterone injections were also included as an additional treatment.

MATERIALS AND METHODS

Aged ewes purchased at a local auction were utilized in dry lot studies conducted in the fall of the year. All ewes should have been cycling. Since the ewes were purchased during summer or early fall, several were found to be pregnant, and thus the numbers contributing data were reduced lower than was originally planned. The initial treatments employed consisted of (a) control, (b) 8 ml. terramycin (50 mg. oxytetracycline hydrochloride per ml.) injected intraperitoneally on days 2 and 4 post mating, (c) 50 mg. repositol progesterone injected intramuscularly on day 4 post mating. In one study sulfamethiazine added to the water replaced the progesterone treatment. In this case the ewes were subjected to alternate five-day treatment and control periods. The average per head per day intake was 1.25 oz. of a 12.5% solution of sodium sulfamethiazine during medication periods. Since the ewes were treated as a group, the treatment periods were imposed at random with respect to the stage of the estrus cycle and, thus, day of mating. In the first two comparisons the ewes were self fed alfalfa pellets in dry lot. In the third test they were fed a mixed ration based on cottonseed hulls as a roughage.

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Shown in Table 1 are the data for 1975 and 1976. In this comparison the ewes were slaughtered approximately 42 days after exposure to rams (17 day cycle length + 25 days for fetus to be observable). Thus if the ewe failed to conceive and recycled, the ovulation rate reported is that of a cycle subsequent to the treated cycle. These data again confirm a high ovulation rate with a significant disparity between the ovulation rate and the number of embryos present. Both treatments appear to have improved conception, but with the number involved the differences are not statistically significant. The apparent response to progesterone is largely in one year and has been tentatively attributed to a counteracting effect of the estrogen content of the alfalfa. This will be discussed in another report in this publication. The apparent response to terramycin was further tested in 1977 along with sulfamethiazine. These data are shown in Table 2. In this case a portion of the ewes were lambed. In the data shown in Table 2 there was no evidence of a beneficial effect for terramycin, but a suggestion of a response to sulfamethiazine. With the small numbers involved these studies are difficult to interpret, but taken collectively there is little evidence that the use of these antimicrobial agents played a significant part in reducing the loss of potential embryos.

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TABLE 1. EFFECT OF TERRAMYCIN AND PROGESTERONE IN CONNECTION WITH MATING ON CONCEPTION RATE OF EWES FOLLOWING EXPOSURE TO RAMS FOR ONE CYCLE.

Treatment	No. Ewes	Avg. Body Weight, lbs.	Ovulation Rate per ewe	No. Embryo per ewe	% Ewes Pregnant	% of ovulations represented by Embryos
			1975 Data			
Control	15	99.9	1.93	1.40	86.7	72.5
Terramycin	17	107.4	1.76	1.52	84.1	86.4
Progesterone	15	103.2	1.87	1.33	73.3	71.1
			1976 Data			
Control	11	112.6	1.80	1.10	70.0	61.1
Terramycin	15	114.9	1.80	1.26	73.3	70.0
Progesterone	12	113.6	1.75	1.41	83.3	80.6
			Combined Data			
Control	26	105.2	1.87	1.27	79.6	67.9
Terramycin	32	110.9	1.78	1.39	84.4	78.7
Progesterone	27	107.8	1.82	1.37	77.4	75.3

TABLE 2. INFLUENCE OF TERRAMYCIN AND SULFAMETHIAZINE ON CONCEPTION IN THE EWE FOLLOWING EXPOSURE TO RAMS FOR ONE ESTRUAL PERIOD.

1977 Data

Treatment	No. Ewes	Avg. Body Weight, lbs.	Ovulation Rate per ewe	No. Embryos per ewe	% ewes Pregnant	% Ovulations represented by Embryos
			Results at Slaughter			
Control	13	110.2	1.46	0.92	76.9	63.2
Terramycin	12	100.8	1.67	0.83	58.3	50.0
Sulfamethiazine	12	98.4	1.42	1.17	83.3	82.4
			Lambing Results			
		Avg. Body Weight	% Lambing	Lambs Per Ewe		
Control	12	128.1	83.3	1.33		
Terramycin	12	130.1	91.7	1.17		
Sulfamethiazine	13	123.1	84.6	1.31		
			Combined Data			
		Avg. Body Weight, lb.	% Preg or Lambing		Lambs or Embryos per ewe	
Control	25	118.8	79.9		1.12	
Terramycin	24	115.5	75.0		1.00	
Sulfamethiazine	25	111.2	84.0		1.24	

PR-3497

AN APPARENT ADVERSE EFFECT OF ALFALFA ON REPRODUCTION RATE OF SHEEP

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There appears to be an increasing use of alfalfa in rations for sheep, especially with the increased level of feeding or increased number of confinement programs associated with current favorable prices. In the last three years alfalfa pellets have often been purchased by the Research Center at San Angelo and used for maintaining ewes on experimental programs. Since the pellets (suncured hay pellets) were purchased via competitive bids on the open market, the source or site of production is not always known, but would be presumed to be the Southwest. During this period of time some observations have been made which suggest caution in using high levels of alfalfa for breeding sheep, and it is the purpose of this report to call this to the attention of producers.

MATERIALS AND METHODS

In the fall of 1976 a group of ewes was bred in dry lot while being fed graded levels of alfalfa (Sefidbakht *et al.* 1977). In the studies in question, protein level and alfalfa levels were confounded as protein level increased as level of alfalfa increased. In the studies in question there was no positive effect of protein or alfalfa on reproduction, but there was a strong suggestion of a negative effect at levels of alfalfa above 50%. The only statistically significant value was a negative relationship between serum protein (from alfalfa) and number of embryos. However, not included in the previous analyses were additional groups of ewes of the same source which were fed simultaneously a ration consisting of 100% alfalfa from the same supply. The level or success of reproduction of the ewes on 100% alfalfa were well below that of even the lower levels involved in the previous report, and when these data are integrated with the previous study it tends to lend support to the interpretation of an adverse effect of alfalfa. These data are plotted in Figure 1. In addition to the results shown in Figure 1, the injection of progesterone shortly after mating in the ewes fed on 100% alfalfa appeared to partially alleviate the adverse effects of high alfalfa. These data strongly suggest that estrogenic activity present in the alfalfa had an adverse effect on reproduction. Unfortunately, the lot of alfalfa involved had been fed before the suggestion of an adverse effect was noted, and thus no laboratory analyses of estrogenic activity was made. Also routine laboratory determination of estrogenic activity of feedstuffs is very difficult.

In addition to the suggestion of an adverse effect on fertility, other suggestions of an estrogenic effect have been noted. During the

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past winter a number of pregnant ewes have been fed rations of 100% alfalfa pellets. Two particular problems were observed which may possibly be explained by high estrogenic activity. Several cases of vaginal or uterine prolapse were observed which are relatively rare on other rations. Also udder inflamation and several cases of mastitis, which could not be associated with infection, were encountered and contributed to lamb losses. Both these observations could possibly be explained by a high level of estrogenic-like activity in the ration.

Alfalfa, along with a number of other legumes, have long been known as having estrogenic activity (phyto-estrogens such as coumestrol). However, producers have generally routinely fed alfalfa hay or pellets without concern for this problem. It is known that variety as well as growth conditions affects the estrogenic level. Drought, poor growing conditions or attacks of plant diseases tend to increase estrogenic activity (Newsome and Kitts, 1977). Also the level of intake, which is high with self-fed pellets, could increase the level of estrogens ingested over lower levels of feed intake from hay or limited feeding of pellets. These data suggest that rations composed of not more than 50% or lower levels of intake of alfalfa would not have caused trouble. Also there should be little cause for concern if the animals were not in critical stages of reproduction.

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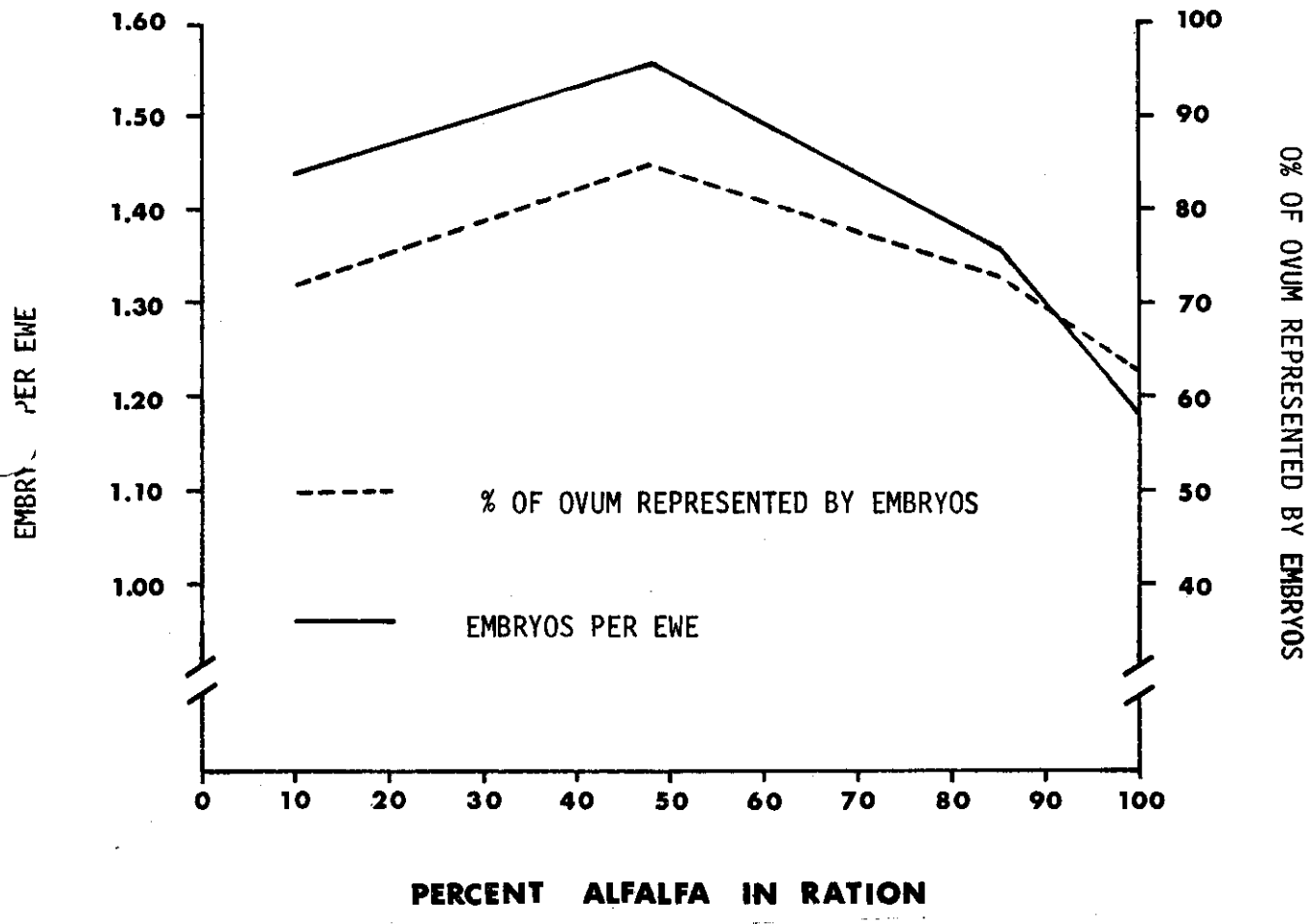

Figure 1. The relation of levels of alfalfa in ration to reproductive success of ewes self fed in dry lot during breeding.

PR-3498

A PREGNANCY-DETECTION DEVICE

Phil Thompson, Maurice Shelton and George Ahlschwede*

An accurate means of early pregnancy detection in sheep and goats would be of great economic potential to the producer. The primary advantage would be through culling or removing to a different level of management for the open ewes while concentrating efforts on the pregnant ewes or does. Several methods for pregnancy diagnosis have been reported and illustrated in recent years with accuracy in determination as early as 30 days into a pregnancy. Among these methods are the use of the "doppler shift" principle, rectal abdominal palpation and the use of rams with markers (1, 3 and 4). Each of these is a dependable means of testing, but each may have some limitations to a given producer's circumstances because of equipment costs, handling and time requirements or some measure of expertise in a particular procedure. In recent months a newer commercial device has been made available which uses ultrasonic sound waves to detect the presence of fluids within a pregnant uterus (during 60-120 days gestation) as means of pregnancy determination. This machine uses no internal probes or special handling equipment and requires only a short handling time.

EXPERIMENTAL PROCEDURE

From January through March 1978, 370 observations were made at the Texas A&M University Research and Extension Center at San Angelo in a preliminary evaluation of the "Scanopreg" (model 738)[1]. Two hundred and four ewes representing various breeding schedules and breeds (Rambouillet, Finn, Finn X Rambouillet and Karakul X Rambouillet) were checked at various stages of pregnancy. Repeat observations on the same animal account for the larger number of observations cited above. Diagnoses were made on 146 ewes after the rams had been removed for at least 60 days. The remaining observations were made with ewes which had been in the presence of a ram within 1 to 2 weeks prior to the first pregnancy test. Ewes were tested before removal (or slaughter) from the pasture to smaller lambing lots or shed lambing. With the exception of one particular breeding group, all obviously pregnant ewes were removed before actual testing and data collection began.

Ewes were held in a natural standing position with as little movement by the animal as possible. The transducer was placed 2 to 3 inches in front of the ewe's right side teat on a non-wooled area. The transducer was positioned to direct the ultrasonic beam at an area 45° up and 30° forward on the left side, taking special attention to avoid the bladder.

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[1]The instrument used was manufactured by Ithaco Inc., Ithaco, New York.

Any excess oil and soil were removed from the skin area to allow for a sufficient contact area for the transducer. The basis of the test is dependent on fluids having different sound reflecting qualities to other tissues, and that the gravid uterus contains considerable fluids. The procedure is thought to be more accurate between 60 and 120 days of gestation. Before this date the size of the uterus and the fluid present may be small. After 120 days the growing fetus tends to displace the fluids in the uterus. The latter may be especially true for ewes with twin lambs. However, ewes past 120 days and carrying twin lambs should be observably pregnant.

The specific instrument being tested uses a series of 2 lights and a beeping sound in denoting a response to pregnancy. A stable red light was recorded as indicating an open ewe. Any green lights accompanied by a beeping sound indicated pregnancy. The transducer probe was manipulated in such a manner to insure that if a gravid uterus was present it should have been recorded. The final determination of pregnancy was made by lambing records or post-slaughter analyses of the reproductive tracts. The age of the fetus was determined by the use of crown-rump length and reported literature values (2).

RESULTS AND DISCUSSION

A summary of the "Scanopreg" performance at various stages of fetal development is shown in Table 1. These data suggest that positive readings are highly accurate with only one erroneous reading, and this may be explained by the loss of a lamb. However, a negative or open diagnosis is less accurate. For instance, in the period of 0-30 days, 64% of the observations were erroneously reported as open when the animals were actually pregnant. This may actually be more a function of the number pregnant than the accuracy of diagnosis. Although smaller numbers were involved, the period of 31-60 days resulted 18 similar erroneous open readings. In the period of 61-120 days, a total of 240 animals were tested. During this period, 173 were correctly classified pregnant, but 6 animals (2.5% of the total) were classified as open which were actually pregnant. In the period of 120 days or over, only 20 animals were tested. Although these were accurately classified pregnant, the number is too small to serve as a basis for drawing conclusions during this period.

The limitations of this procedure consist of it being effective for only the period of 60-120 days. The animal must be held completely still and calm, thus letting the weighted uterus assume a natural position which should be readily detected. At various times during these examinations it was noted that it was difficult to maintain sufficient contact with the skin due to excessive nervous movement and deposits of skin oils. This poor contact caused a flickering of the pregnant signal light which was or was not accompanied by a constant horn sound. This signal was considered to be and was verified as being

a positive pregnancy response and not a malfunction of this particular unit. Only in these few cases were any ewes held for more than a minute while a more complete search for the uterus was made before classification of the individual.

Under good range and flock management conditions in which as much as 95% of the ewes are pregnant, it is unlikely that the procedure will find great use. However, under conditions such as attempted spring or out-of-season mating in which up to 50% of the ewes may be open, it should be of great value. Another use might be aged ewes in market channels. Pregnancy testing and removal of pregnant animals from slaughter should be of value to the sheep industry as well as the packing industry.

Among the large number of procedures which have been tested for pregnancy diagnosis, this one appears most practical. A preliminary evaluation has also been made concerning its use with Angora goats, but results to date have not been as good as those with sheep.

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Table 1. Classification of Ewes Tested at Various Stages of Pregnancy.

Fetal age in days	No. tested	No. diagnosed pregnant	No. diagnosed correctly	% Correct	No. diagnosed open 2/	No. diagnosed correctly 2/	% Correct	Overall % accuracy
0-30	52	2	2	100.0	50	18	36.0	38.5
31-60	58	29	28 1/	96.6	29	11	37.9	67.2
61-90	151	90	90	100.0	61	58	95.1	98.0
91-120	89	83	83	100.0	6	3	50.0	96.6
121 +	20	20	20	100.0	0	-	-	100.0

1/ The one incorrect ewe had not lambed by this writing and is believed to have lambed in the pasture.

2/ Open ewes were placed in groups based on the last exposure to rams.

Figure 1. Pregnancy Testing Device Showing Placement of Probe.

PR-3499

KIDDING SYSTEMS FOR ANGORA DOES

Carl Menzies[1], Maurice Shelton[1], George Ahlschwede[2] and Don Spiller[3]

Texas Angora goat numbers have declined to a drastically low level. Poor kid crops, relative to the high reproductive potential, have prevented a buildup in numbers. and economical techniques that will improve kid crops are needed. Nutritional deficiencies, predators, inclement weather and diseases are major causes of low kid crops. High mohair prices 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 producers when hair prices dropped to low levels and labor became scarce. Since no comparative data are available on the cost/benefit ratio of such systems, this study was initiated to develop economically feasible management systems to prevent a significant portion of the high death losses of newborn kids.

EXPERIMENTAL PROCEDURES

One hundred and twenty-five supposedly pregnant yearling and aged does were shorn and divided into three treatment groups (Confinement, Trap and Pasture) on February 27, 1978. These were maintained as separate groups during a 44-day kidding season until April 12. 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 42 does kidded in confinement at the Sonora Station were kept in a drylot, with access to shelter. They were fed approximately 2.4 pounds of suncured alfalfa pellets and .25 pound of rolled sorghum grain daily. At least twice daily, does were checked, and those which had kidded were placed with their kid in a mothering stall where they remained for from one to several days, depending upon the well-being of does and kids and demand for stalls. Upon removal from stalls, does and kids were combined into 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. Kids were provided supplemental heat from heat lamps during cold weather.

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The Trap group of 42 does was kidded in three small, approximately 5 to 15-acre traps, on the Sonora Station. This prevented does from getting very far from their kids. The Pasture group of 41 does was kidded out in an approximately 400-acre pasture on the Hill Ranch. Both these groups had no access to shelter and were self-fed a 15% crude protein salt-limited feed.

RESULTS AND DISCUSSION

Reproductive performance and feed and labor requirements are reported in Table 1. The 35 does which kidded in confinement had 37 kids and raised 35 up to April 12, when they were placed back on pasture. Only two sets of twins were produced. Starvation was the assumed cause of death of the two kids dying. The number of kids born in the Trap and Pasture groups is not known. It appeared that 37 does in each group kidded and 28 and 24 kids, respectively, were reared to April 12. Thus, in this test, does kidded in confinement reared 24.3% and 35.1% more kids than those kidded in traps or in a large pasture.

It required more feed and labor for maintaining does in confinement than for does given no special care at kidding and self-fed supplemental feed in traps or pasture. Approximately 30 minutes daily was required to care for does in confinement, compared to only about 30 minutes twice weekly to check feeders in traps and pastures. Another labor consideration is that does in the Trap and Pasture group had to be gathered so that capes could be removed.

(The portable kidding stalls can be inspected at the Sonora Station, and details on construction will be provided upon request.)

This one year's data is a limited evaluation of these systems. Assuming the availability of ranch facilities and current favorable prices, these results support the desirability of more intense management at kidding. Except where new construction is required, this practice can be instituted without a long-term commitment and could be discontinued when prices become less favorable. Many environmental factors can conceivably affect results. Such things as predators, weather, quantity and quality of range forages, health, udder soundness and age of does could affect performance obtained from such systems. This test will be repeated, and when sufficient data are collected, it will be treated to a cost/benefit analysis.

TABLE 1. REPRODUCTIVE PERFORMANCE AND FEED AND LABOR REQUIREMENTS (44-DAY PERIOD).

	Confinement	Trap	Pasture
Number of does	42	42	41
Number of does kidding	35	37	37
Number of kids born	37	Unknown	Unknown
Number of kids raised	35	28	24
Kidding % of does kidding	100	75.7	64.9
Feed per doe, lbs.[1/]	116.7	35.7	25
Estimated labor, hrs.	22	5	5

[1/] Does in confinement were fed approximately 2.4 pounds of suncured alfalfa pellets, plus .25 pound of grain sorghum per day. Does in traps and on pasture in addition to range forage, had free access to a salt-limited 15% crude protein supplement, consisting of 24% cottonseed meal, 54% grain sorghum, 15% salt, 1% dicalcium phosphate, 2% ammonium sulfate and 4% fat.

PR-3500

INTERSEXES IN GOATS

Maurice Shelton and C. W. Livingston, Jr.*

The presence of horns appears to be the natural state in most wild ruminants. An adaptive advantage for the presence of horns can be easily visualized among animals subject to predation or competition for limited resources. Also natural selection for horns, at least in competing males, may be envisioned even in the absence of an adaptive advantage. This is supported by the fact that horn development is a sex-limited or sex-influenced trait, with horn development primarily limited to the male. In the more primitive types the males tend to be horned, with the females hornless (Basrur, 1969). Although the horned condition appears to be the norm, mutations to polled or hornless conditions have occurred with most species, and these are often favored or at least permitted to exist under condition of domestication. The actual or presumed advantage for hornless animals may be safety, reduced space requirements, reduced injuries or damages to the carcass and, in the case of goats, freedom from becoming entrapped by the horns in net wire fences.

The interrelationship of horns with the productive traits have not been completely characterized even though it is known to cause trouble with certain species. One of the most noted instance of problems arising from the absence of horns is that of intersexes in goats. The purpose of this report is to describe this condition and review the existing state of knowledge concerning its occurrence.

In 1976, the Texas Agricultural Experiment Station leased the H. D. Winters-Wall Ranch at Brady, along with the livestock thereon. One group of livestock acquired with the property was a flock of Spanish or Meat Type goats which had been bred polled for a number of years. When these animals were first worked, approximately 30 intersex or improperly sexed individuals were identified in the offspring of approximately 600 breeding aged does. Assuming a 100% kid crop the previous season, this could represent up to 5% of the total kid crop or 10% of the female kids. These numbers are approximate since the animals were not individually identified and the ages of the animals or previous removal was not known. Without close inspection many of these intersexes would be classified as females and left in the flock, and thus up to 10% of the flock could have been non-breeders. Most flocks of polled goats contain some non-breeders attributable to this condition. Other financial losses may occur from a reduced sale value of the improperly sexed individuals. There is also a suggestion from previous research that some mortality may be associated with this condition. For these reasons, breeders should be aware of this trait and how it can be avoided or its effect minimized. All strains of polled goats which have been studied have exhibited this problem. It has apparently not been reported in Angora goats, but there are relatively

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few polled Angora, and the explanation may well be that the condition has not been studied with this breed.

ANATOMICAL FEATURES

The improperly sexed individuals are masculinized females in which the vulva or clitoris appear as a penile-like structure which may be in a normal location for females or be displaced ventrally. Since urination is usually somewhat abnormal, urine stains with an occasional odor may be evident. Occasional animals have been observed to urinate from a penis in a normal position for this structure. At autopsy and dissection of the reproductive tract of affected animals, vestigial or infantile type of uterus will be found. The ovaries are non-functional and may be displaced, and will occasionally be observed as testicular-like lumps of material in the area of the udder. A scrotum is not normally present, but does sometimes occur with non-functional testes present. The animals involved are not functional as either sex, but may show male-like libido. Since they grow up without the burden of reproduction, often at maturity they will be some of the largest animals in the flock. Thus, any large, growthy animals in the doe flocks which are not obviously producing kids should be inspected. However, this applies only to polled animals as this condition almost never occurs in horned animals.

MODE OF INHERITANCE

As previously mentioned, the improperly sexed individuals are genetic females which have been masculinized by a apparent hormonal abnormality while the kid was carried in the uterus. This condition is almost totally restricted to polled goats (Asdell 1944, and Hancock and Louca 1975). The polled condition is dominant in goats. The intersex condition is described as a recessive plietropic effect of the polled gene with incomplete pentrance.

Stated differently this means that the intersex is an additional effect of the polled gene, but since it is recessive in nature it occurs only in the pure polled (homozygous) animals. Even with the homozygous polled animals the condition is not completely expressed. Since the homozygous animal cannot be readily distinguished from the heterozygous animal, it is difficult to calculate the expressivity of the condition. It is generally thought that 40 to 50% of the homozygous females are intersexes. Even when all the intersexes are classified as females, there is a proportional deficiency of females among offspring of polled goats. This suggests either that there has been some fetal or perinatal loss among the intersexes or that some were classified as males which were actually intersexes. Supporting the latter thesis, a number of infertile phenotypic males have been observed in polled flocks (Soller *et al.*, 1963).

RECOMMENDATION

It seems clear that producers should not attempt to concentrate the polled gene in Meat Type goats. The burden of the intersexes would seriously complicate replacement of the doe flocks, reduce genetic progress, and reduce flock fertility to the extent that unidentified intersexes are present in the breeding flock. If polled animals are considered to be desirable for management purposes, a high percent of polled animals can be maintained in the flock without incurring an intersex problem if the flock can be maintained largely heterozygous. Theoretically no intersexes would be encountered if all offspring were heterozygous. This could be accomplished by mating only horned males to polled does or the reverse of this. Although no intersexes would be encountered, only approximately one half of the animals would be polled. Another procedure would be to alternate the use of polled and horned males. If all animals in the breeding flock (both males and females) were heterozygotes and a pentrance value of 50% is assumed, a maximum of 6.25 of the total kid crop or 12.50 of the females could be intersexes. If horned and polled males are used alternately, the intersexes would be on the order of 1/2 or less of the above figures. It would knowingly be less than 1/2 above because of a deficiency of homozygous polled females which are reproducing. Actually if these males are used in alternate years, the frequency of the intersexes in the kid crop would be zero in the year that horned males were used and could amount to more than 6.25% in the year that polled males were used.

Many producers who prefer polled males have adopted the practice of dehorning which can be done reasonably effectively early in life with a hot iron. This not only removes the horns, but more radical burning allegedly reduces the odor from rutting males.

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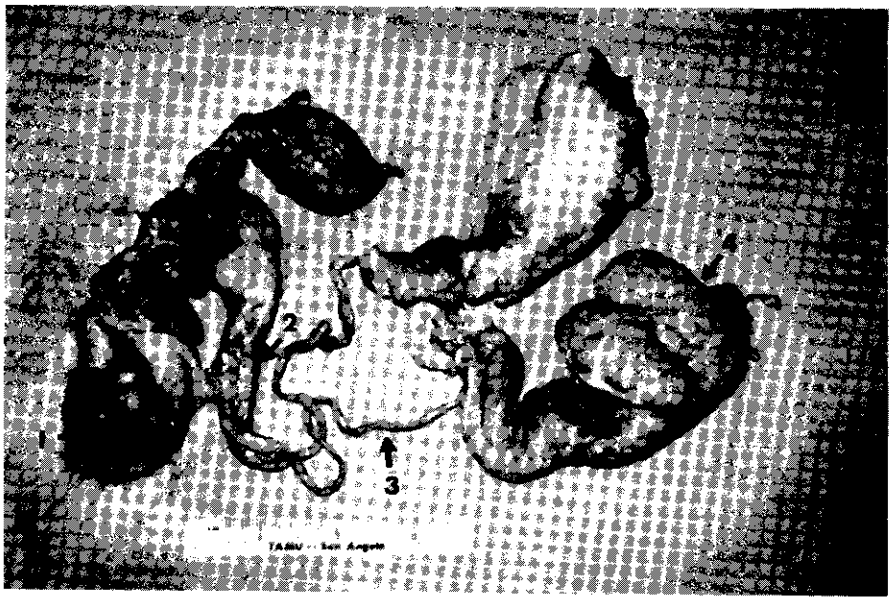
Figure 1. The reproductive tract of an intersex.



1 - enlarged clitoris
2 - infantile uterus
3 - fallopian tube
4 - testis-like structure replacing ovary

PR-3501

EFFECT OF SUPPLEMENTAL FEED ON VOLUNTARY FORAGE CONSUMPTION BY PREGNANT AND LACTATING EWES

J.E. Huston and B.S. Rector*

Productivity of range livestock is affected primarily by the amount and quality of feed consumed. Highly productive sheep are well fed during critical periods of the productive cycle (breeding, gestation and lactation). Supplemental feeding can improve the level of nutrition during these critical periods when the pasture or range fails to provide adequate quality and/or quantity of forage. This experiment was conducted to determine the effects of different types and amounts of supplemental feeds on consumption of forage and total nutrients during the dormant season (January 1977).

EXPERIMENTAL PROCEDURE

Feed intake was determined in 81 ewes (62 pregnant and 19 lactating) during January 1977 by an indigestible marker technique. The ewes were individually fed one of two supplements (Table 1) daily in the amounts shown in Table 2. The feeding levels were estimated to provide the following: low level, 1/3 and 1/10 of protein and energy requirements, respectively; medium level, 2/3 and 2/10 of protein and energy requirements, respectively; and high level, 2/3 and 3/10 of protein and energy requirements, respectively. Chromic oxide, an indigestible marker, was included in the supplemental feed at known concentrations. The experimental animals were commercial Rambouillet ewes that averaged 60 kg (133 pounds) pregnant and 54 kg (120 pounds) lactating. Diet samples were obtained from three esophageally fistulated ewes that grazed with the flock. The marker was fed for 3 weeks prior to and during a 5-day collection period. During the sampling period, fecal samples were collected daily, directly from the rectum. Chromic oxide concentration in fecal samples was determined by a standard colorimetric procedure, and total feces was calculated. Forage intake was computed using total feces and diet digestibility, determined by *in vitro* digestibility estimates on the diet samples.

RESULTS AND DISCUSSION

Forage quality was low during the 1977 dormant season. Digestible organic matter in the sampled diets was determined to be 45.8%, compared to the recommended levels of 55% and 65% for pregnant and lactating ewes, respectively. Increasing levels of supplementation resulted in associated decreases in forage consumption, but net increases in total feed consumption in the pregnant ewes (Table 2). Increases in supplementation to the lactating ewes resulted in an increase in forage consumption by the group receiving the medium level of supplementation, but a substantial decrease in the high fed group. The small number of ewes (2) in the medium group

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limits the confidence in the observed values. Due to the design of the experiment, it was not possible to determine forage consumption in unsupplemented ewes. It is possible that low level supplementation would result in a stimulation in forage intake, followed by partial substitution of concentrate for forage as supplement increased to the high level.

Figures 1 and 2 graphically illustrate the effects of concentrate feeding on digestible organic matter consumption (forage and supplement). As the supplement portion of the total diet of pregnant ewes increased, the forage portion decreased. However, total digestible organic matter consumption increased. In the lactating ewes, the medium level of supplementation resulted in a large increase in total consumption, compared with a small increase in the high group compared to the low level group. The data in Figures 1 and 2 are expressed as digestible organic matter, rather than as total dry matter as in Table 2. The higher digestibility of the concentrates contributed to a greater overall intake in the high fed lactating ewes, compared with the low fed lactating ewes.

Lactating ewes consumed 25.9% more digestible organic matter than pregnant ewes ($P<.05$). Calculations on nutrient requirements indicate that lactating ewes should consume about 50% more than pregnant ewes. It has been observed that dry and pregnant ewes perform well on the forage resource in this study, but nursing lambs do not gain satisfactorily. These data suggest that lactating ewes may not eat enough, probably due to the physical limitation of the gastrointestinal tract. Moreover, supplemental feeding of lactating ewes during periods when forage quality is low may be only partially effective because of the displacement effect. In this study, each unit of supplemental feed consumed increased total consumption of lactating ewes by only 0.12 unit; thus, feeding a lactating ewe 100 g of digestible organic matter as a supplement increased her total consumption by only 12 g, compared to a 54 g increase for each 100 g fed to pregnant ewes.

The results of this study illustrate the need to explore the opportunities for (1) improving the nutritional characteristics of the basic resource (forage) and (2) supporting lamb performance by means other than high level supplemental feeding of ewes (creep feeding).

TABLE 1. COMPOSITION OF FEED CONCENTRATES

	Supplement	
	1	2
	%	%
Ingredients		
Cottonseed meal	80	50
Sorghum grain	18	48
Molasses	2	2
	100	100
Digestibility[1]	75	75

[1] Computed.

TABLE 2. EFFECT OF FEED CONCENTRATES ON FORAGE AND TOTAL INTAKE BY EWES ON RANGELAND.

	Level of Supplementation		
	Low	Medium	High
Pregnant ewes			
Number of ewes	31	16	15
Supplement fed (Table 1)	1	1	2
Supplement (g/day)	113.5	227.0	340.5
Forage (g/day)	2,026.3	1,954.5	1,878.2
Total (g/day)	2,139.8	2,181.5	2,218.7
Lactating ewes			
Number of ewes	6	2	11
Supplement fed (Table 1)	1	1	2
Supplement (g/day)	151.3	302.6	454.0
Forage (g/day)	2,536.8	2,702.7	2,120.0
Total (g/day)	2,688.1	3,005.3	2,574.0

FIGURE 1. DIGESTIBLE ORGANIC MATTER INTAKE BY PREGNANT EWES ON RANGELAND.

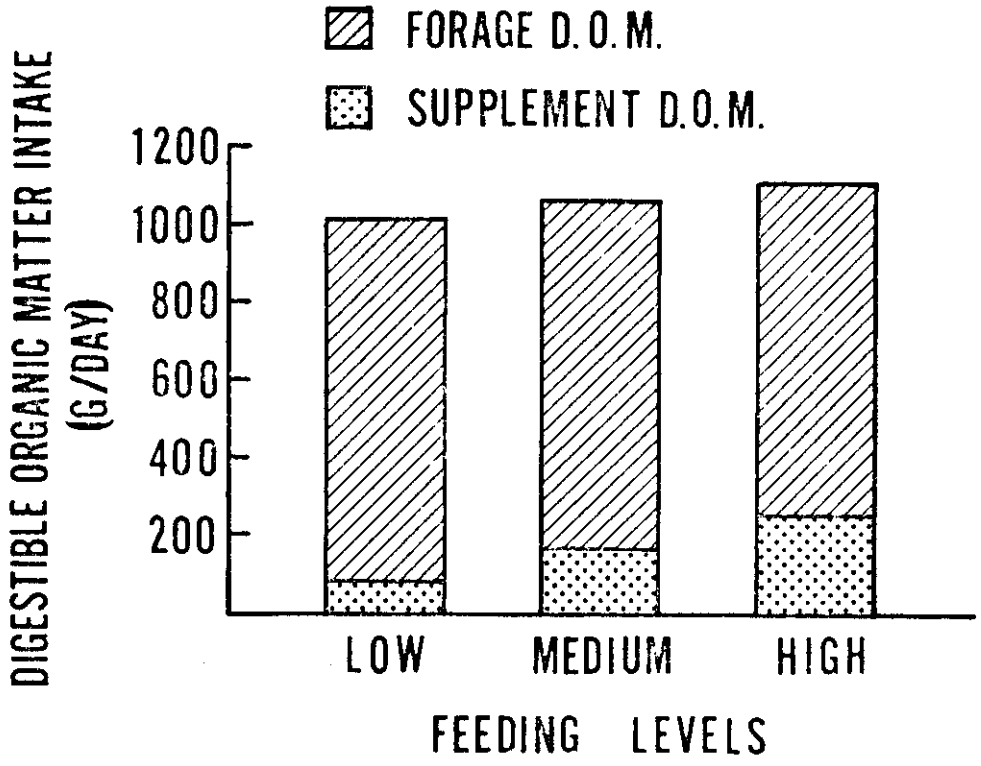
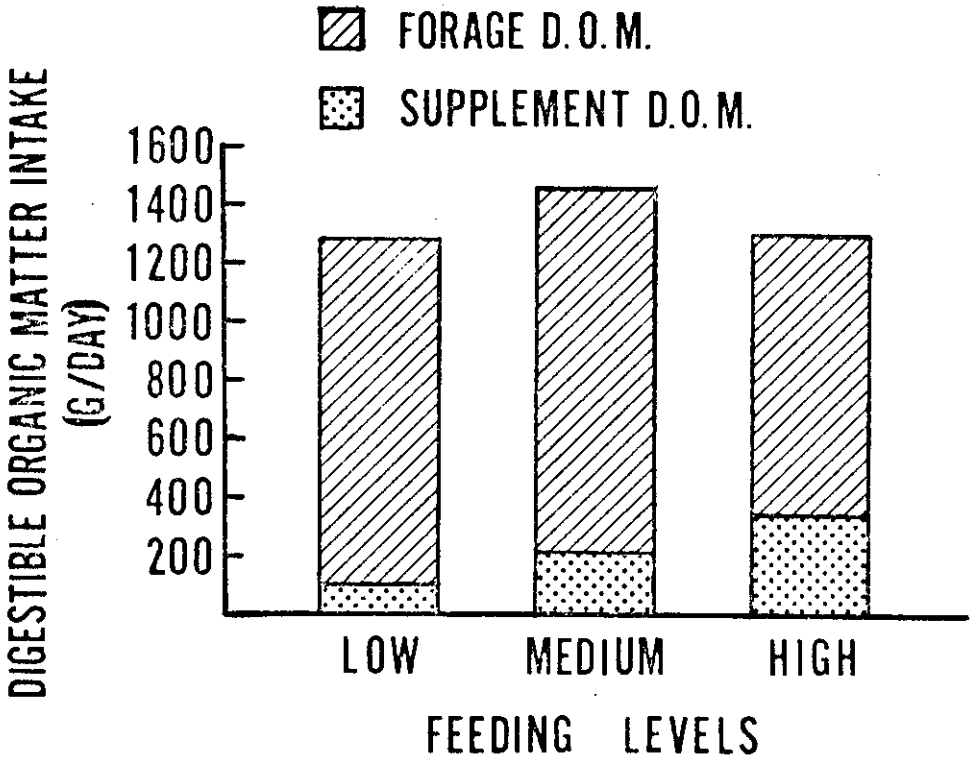


FIGURE 2. DIGESTIBLE ORGANIC MATTER INTAKE BY LACTATING EWES ON RANGELAND.



THE INFLUENCE OF FEED LIMITERS (SALT AND GYPSUM) ON THE PERFORMANCE OF LACTATING EWES

Maurice Shelton and Gary Snowder[1,2]

INTRODUCTION

Livestock producers of this state have had a long history of using salt (sodium chloride) to limit intake of supplemental feed for the grazing animal. The alternatives of daily or intermittently hand feeding of a controlled amount or of self feeding are both undesirable alternatives. Salt is known to have some undesirable effects, and for this reason, alternative materials have been tried on an applied as well as on experimental basis. One alternative which has been used to a limited extent is gypsum (calcium sulfate). Both these materials are known to have the potential for some positive as well as negative influences. Both materials, especially sodium chloride, would be expected to markedly increase water intake. This can present problems in cold weather due to water freezing over or the amount of feed energy required to warm up the cold water which the animal drinks. Both materials have the potential of altering nutrient utilization in ways which are too complex to review at this point. Little data are available in this state on the influence of feed limiters on animal performance when used with sheep.

MATERIALS AND METHODS

In this study ewes with baby lambs at side were used in an experiment to study the influence of feed limiters on various aspects of performance. They were self fed ground sorghum hay. In addition, they were hand fed a grain supplement formulated as follows:

Ingredient	% of Ration
Ground sorghum grain	60.00
Cottonseed meal	30.00
Molasses	5.00
Dehydrated alfalfa	4.00
Trace mineral salt	1.00

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[2]The authors wish to express appreciation to Mr. Foster S. Price, Sterling City, for providing the gypsum used in these studies.

The experimental treatments consisted of hand feeding the above ration as follows:

1. 2 lbs. of above concentrate mixture per ewe per day.
2. 2 lbs. concentrate plus the equivalent of 20% salt.
3. 2 lbs. concentrate plus the equivalent of 10% salt and 10% gypsum.

The 2 lb. level of intake was the targeted intake, but in some cases, total intake was limited by a lower intake of the ewes receiving one of the limiters. The experimental plan called for hand feeding all three groups the same amount of the basic ration, but it was not possible to do this perfectly, and some deviation from this plan occurred. The data collected included feed intake (concentrate and hay), body weight changes of ewes and lambs and milk production of the ewes. The estimates of milk production were obtained by weighing the lambs before and after nursing following removal for two 12-hour periods during the week. As will be seen, this may not have been an accurate measure of total milk production of the ewes with single lambs. The ewes were fed in seven replicates of three ewes and their lambs per treatment group. Two of the seven replicates were made up of ewes with twin lambs whereas the other five replicates were with ewes having single lambs. The ewes were assigned to the experiment as they lambed; thus, all replicates were not conducted concurrently. The ewes were placed on experiment when the lambs were approximately one week of age. The experiment continued for 42 days, and by this time, the lambs were consuming a significant portion of the feed.

Feed limiters of the type used here are normally used to limit intake of a supplement when used on a range having adequate roughage. These were the conditions simulated in this study. It is important to remember that if these conditions were markedly altered, the results may have been different. Salt is known to increase water intake and to cause the feed to move through the tract at a more rapid rate. This can have the effect of reducing digestibility, but it has also been shown to, at times, stimulate wool production by causing more protein to get through the rumen in an undegraded state.

The material referred to as gypsum was a product which was mined in Sterling County and has in the past received limited use as a feed limiter.

As seen in Table 1, the ewes were consuming approximately six ounces of the feed limiters daily, and this is a higher intake of these chemicals than would be expected in the manner in which this material is normally used. However, as a percent of the total intake, this is relatively low since the ewes were consuming over six pounds of feed daily.

RESULTS AND DISCUSSION

The replicates were combined for reporting except that the twin and single lambs were treated separately. The results are reported in Table 1. Milk production by weeks for ewes nursing single and twin lambs is shown in Figure 1. No attempt has been made at statistical analyses of these data. Taken collectively, there is little evidence of a significant adverse effect of the feed limiters used on animal performance under the conditions of this trial. In other studies, it has been shown that the sulfate molecule (as in calcium sulfate) has a tendency to reduce overall feed intake. Although on the surface this may appear to be desirable in a feed limiter, this is not actually the case. It is only desirable that the feed limiter control intake of the concentrate or supplement to which it is added. It may be significant that both groups receiving gypsum shown in Table 1 consumed less hay, but these differences are not considered to be statistically significant.

As would be expected, the data on milk production shown in Figure 1 indicate much higher milk production for the ewes nursing twin lambs. Also, ewes with single lambs do not reach peak milk production until the 3rd and 4th week. This is no doubt due to the lambs' inability to take all the milk. However, it is possible that a part of this may be experimental error in that the lamb nursing only twice per day is unable to take all the milk which the ewe produced in two meals.

TABLE 1. EFFECT OF FEED LIMITERS (SALT AND GYPSUM) ON PERFORMANCE OF EWES AND LAMBS

Treatment	No. Ewes	No. Lambs	Ave. Daily Milk lbs.	Lamb Ave. Daily Gain lbs.	Ewe Body Wt. Change (Total) lbs.	Ave. Daily Feed Intake, lbs.		
						Conc. Rate	Hay	Limiter
			Ewes With Twin Lambs					
Control	15	15	2.96	.399	- 3.9	1.510	4.28	0
Salt	15	15	2.69	.343	- 4.1	1.420	3.94	.356
Salt & Gypsum	16	16	2.90	.351	- 8.4	1.504	3.85	.376
			Ewes With Single Lambs					
Control	6	12	4.11	.195	-13.3	1.640	4.25	0
Salt	6	12	4.21	.192	- 7.5	1.656	4.21	.414
Salt & Gypsum	5	10	3.74	.202	- 5.9	1.552	4.01	.388

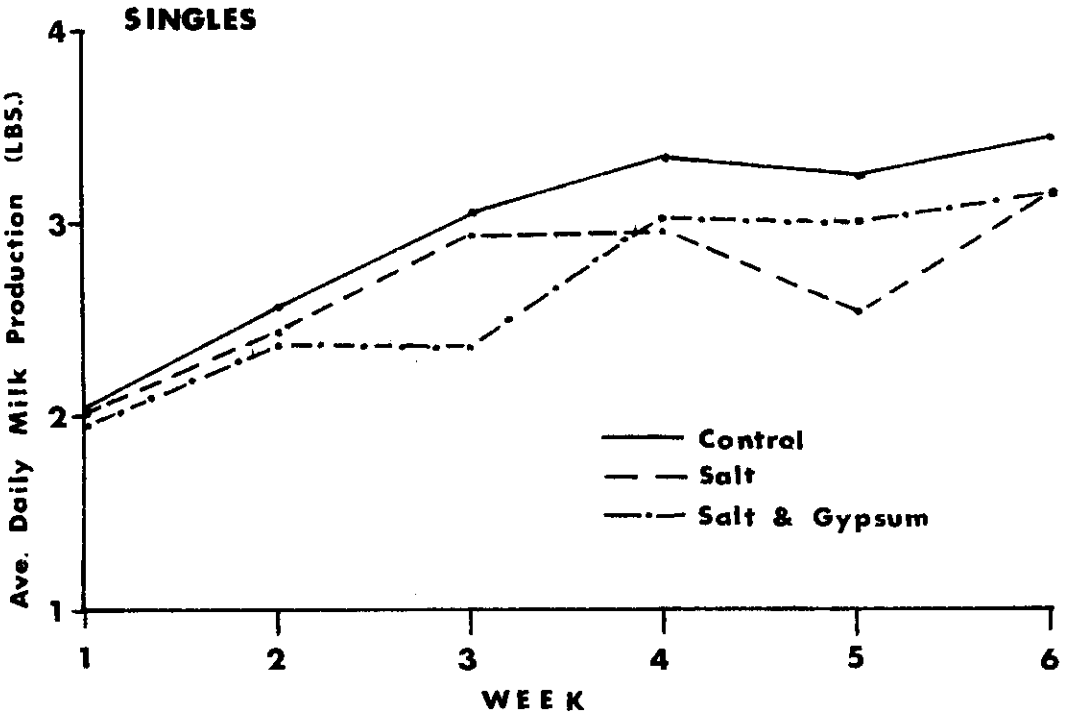
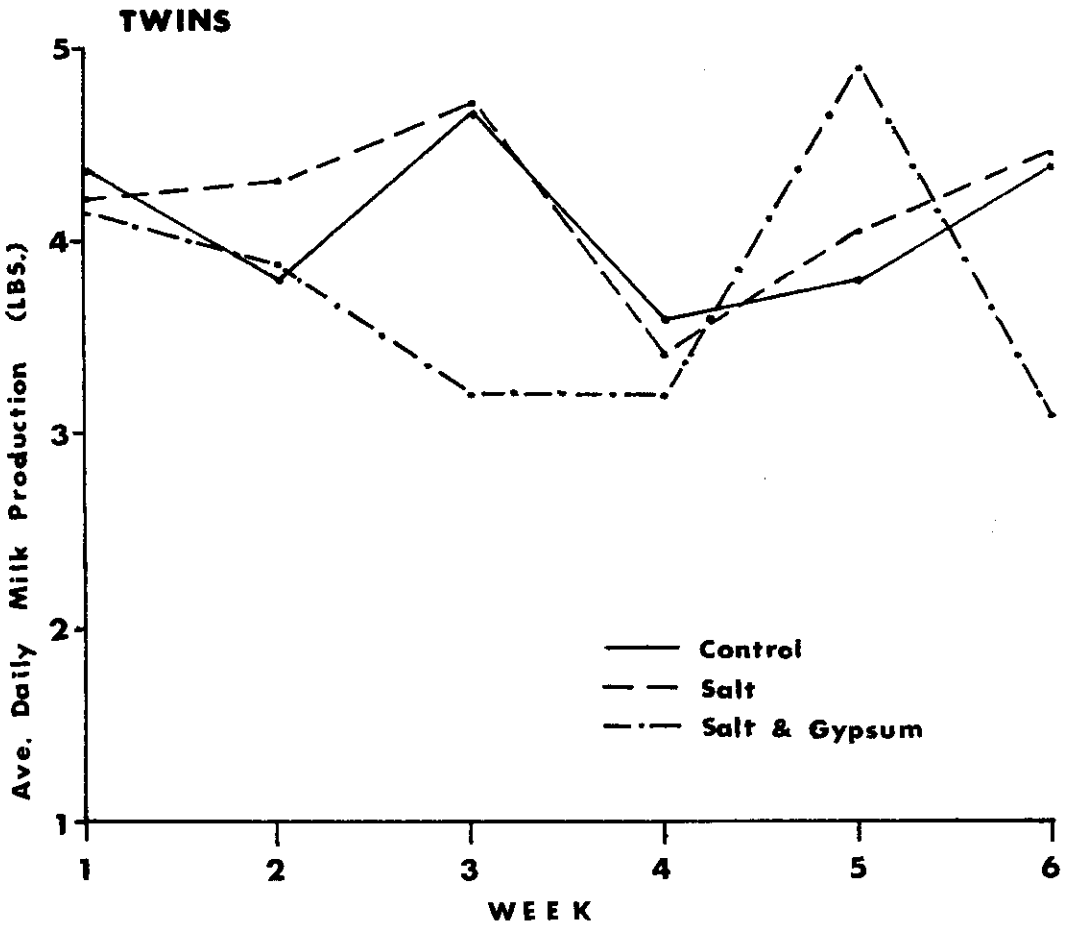


FIGURE 1. INFLUENCE OF NUMBER OF LAMBS NURSING AND FEED LIMITERS ON EWE MILK PRODUCTION.



PR-3503

FEEDING SODIUM BENTONITE IN LAMB RATIONS

Phil Thompson, and Maurice Shelton and Millard Calhoun*

Sodium bentonite (bentonite) has often been used in livestock feeds for its anticaking and hardening abilities in pelleting and pressed blocks. These practices were initiated to improve the appearance, handling and consumption of the feed without any knowledge of its effects on animal performance. Bentonite is a naturally occurring montmorillonite clay which can be found in certain areas of Texas and produced relatively inexpensively. It has the physical capability to take up or release water and certain cations without any major changes in the basic compound itself. Research work with bentonite added to a basal ration has suggested that there may be a beneficial effect to animal performance. Few explanations have been offered because the bentonite itself has no nutritive value.

EXPERIMENTAL PROCEDURE

Three feedlot performance trials were conducted at the Texas A&M University Research and Extension Center at San Angelo to study the effects of bentonite in a lamb diet. Each trial initially consisted of 30 lambs (3 pens with 10 animals each) fed a loose mixed ration consisting mainly of cottonseed hulls and dry rolled grain sorghum (Table 1). Three treatment levels of bentonite were 0, 2, 4% of the complete formulation. Blackface crossbred wether and ewe lambs were fed for 60 days in trials I and II, respectively. In trial III whiteface wether lambs of the same origin were fed for 68 days. Lambs were randomly alloted to treatment pens after shearing, drenching, vaccination for enterotoxemia and weighing.

In each trial animals were placed on a starter ration for 14 days and a intermediate ration for 7 days before being given the high concentrate finisher ration. Animals were fed *ad libitum*. All treatment groups were weighed individually at 7-day intervals. Upon completion of each feeding trial, all animals were taken to Armour and Company in San Angelo for collection of carcass data.

RESULTS AND DISCUSSION

The treatment means for animal performance and carcass evaluation for each trial are listed in Table 2. The addition of bentonite to the experimental rations resulted in a highly significant improvement in daily gain. The overall treatment means for ADG were; .510, .583 and .556 pounds for the treatments 0, 2 and 4% bentonite, respectively. This same trend in weight gain was repeated in all experimental trials (see Figure 1). Lambs consuming 2% bentonite made greater gains than the control treatment groups with the lambs consuming the 4% bentonite

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diet being intermediate in performance. Weekly weight gain records (Table 3) showed that lambs fed bentonite made better gains and maintained feed consumption during all feeding regime changes. During the first 21 days of feeding, the overall accumulated ADG for the 2 and 4% treatment levels were 29 and 17%, respectively, greater than the groups receiving no bentonite. It should be noted that lambs consuming 4% bentonite did not gain as efficiently as the other treatment groups, yet they did not suffer as severe a reduction in weight gains during these changes. After the adaptation period of 28 days, the control groups made greater gains than the two groups receiving bentonite. This appears to suggest the possibility of a buffering effect. If this is the case bentonite might more properly be utilized in the adaptation phase and dropped in the latter part of the breeding period. These results are in reasonable agreement with research done in South Dakota (Huntington *et al.* 1977 a & b) where lambs being fed bentonite vs. controls made greater gains during the first 21-28 days of feeding, although over a 110-day feeding period there were no significant differences in animal performance.

Overall, there was an improvement of more than 8% in the feed-to-gain ratio for the animals receiving 2% bentonite as opposed to the controls. Feed efficiency response between trials is not as consistent as is the ADG. During trial III, one animal was removed from each of the 0 and 4% bentonite treatment lots because of poor performance. The only death occurring from enterotoxemia was in trial III at the 4% level. Even though calculator adjustments were made in the total feed consumption, these animal losses do not aid in accounting for all the decreases in feed efficiency values of these particular groups in trial III as compared to those of the two previous trials.

Some problems were also encountered with the feeding of the 4% bentonite ration. Feedbunks had to be cleaned more often because of the smaller particles being sorted out. Not all of this weighback could be considered strictly bentonite due to the dustiness of the particular cottonseed hulls purchased for use in these trials. If a slightly larger amount of a binding agent (molasses) had been used or if the feed had been pelleted, this dust problem might have been decreased significantly.

There were no significant treatment effects upon dressing percent, final grade, fat thickness (*l. dorsi*), percent kidney fat, yield grade, fat color or firmness in connection with feeding of bentonite at a 2 or 4% level. Carcasses within trials tended to be uniform for all of these traits. The large differences between experimental trial III and trials I and II in percent kidney fat and yield grade should be attributed to breed differences of whiteface and blackface crossbred lambs and a slightly longer feeding period.

SUMMARY

Feeding bentonite in these experimental lamb rations at a 2% level

significantly increased ADG and improved the efficiency of feed utilization. Feeding bentonite had its greatest effects on accumulated gains in the initial adaptation phases. The addition of 2 or 4% bentonite had no significant effects on any of the chilled carcass measurements recorded. It would appear that adding bentonite to a lamb feeding regime would improve animal performance and make adaptation to high concentrate diet more economical by maintaining growth and feed consumption. These data also suggest that if lambs were fed for a longer period (>70 days) that the initial effects of bentonite might become less significant.

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TABLE 1. PERCENT COMPOSITION OF THE BASAL RATIONS[a,b]

Ingredient	Starter	Finisher
Cottonseed hulls	40.00	10.00
Dehydrated alfalfa	5.00	5.00
Dry rolled sorghum grain	37.65	73.40
Cottonseed meal	9.50	4.00
Urea	.75	1.10
Molasses	5.00	4.00
Calcium carbonate	1.10	1.50
Salt, vitamin, trace mineral mix	1.00	1.00

[a]Bentonite was added into these rations by weight and not at the expense of any ingredient.

[b]The intermediate ration used in all trials was an 50/50 mix of the above rations.

TABLE 2. MEAN ANIMAL PERFORMANCE AND CARCASS DATA

Trial No.	I			II			III		
% Bentonite	0	2	4	0	2	4	0	2	4
No. animals	10	10	10	10	10	10	9	10	8
Initial wt, lbs.	74.7	76.5	74.5	72.1	72.4	72.0	76.2	73.3	72.5
Gain, lbs.	30.5	36.7	34.9	28.3	31.7	31.6	35.2	41.4	38.1
ADG, lbs.	.525	.612	.582	.488	.528	.527	.518	.609	.561
Feed/gain	6.94	7.10	7.55	7.53	7.17	7.36	8.51	6.93	9.85
Carcass wt, lbs.[a]	57.0	60.3	59.1	54.3	56.1	55.2	57.0	58.4	55.9
Dressing %	54.2	52.3	54.0	54.0	53.9	53.3	51.1	50.9	50.6
Final grade[b]	11.2	11.4	11.6	11.1	11.3	11.6	12.0	12.3	11.6
Fat thickness[c]	.20	.21	.23	.21	.24	.20	.27	.31	.26
Kidney fat %	2.7	2.3	2.4	2.7	2.2	2.8	4.2	4.9	4.8
USDA Yield grade	3.1	3.0	3.2	3.1	3.2	3.1	3.9	4.3	4.0
Fat color score[d]	3.1	3.1	3.0	3.1	3.3	3.1	3.1	3.1	4.0
Fat firmness score[e]	4.0	3.8	3.4	3.9	4.3	4.1	3.3	3.4	3.4

[a]12 Hour chilled cooler weight
[b]12=low prime, 11=high choice, 10=average choice
[c]Measurements taken between 12th and 13th ribs
[d]4=white, 3=creamy white, 2=slightly yellow, 1=yellow
[e]6=firm and dry, 5=moderately firm and moderately dry, 4=slightly firm and slightly dry, 3=slightly soft and slightly dry, 2=moderately soft and moderately oily, 1=soft and oily.

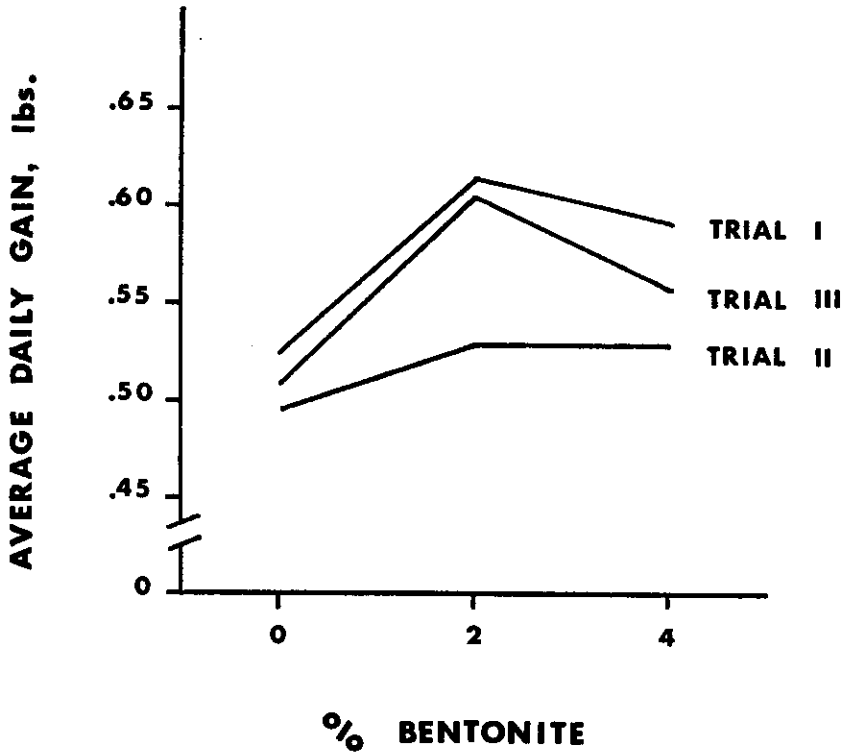

FIGURE 1. EFFECT OF BENTONITE ON AVERAGE DAILY GAIN.

TABLE 3. EFFECTS OF BENTONITE ON WEEKLY ADG (LBS.) FOR ALL TRIALS

Feeding Regime	Days	% Bentonite 0	2	4
Starter	1-7	.038	.038	.327
Starter	8-14	1.066	1.362	.797
Intermediate	15-21	.199	.281	.403
Finisher	22-28	1.091	1.224	1.064
Finisher	29 - Completion	.583	.551	.521

PR-3504

EFFECT OF DIETARY MONENSIN ON COCCIDIAL OOCYST NUMBERS, FEEDLOT PERFORMANCE AND CARCASS CHARACTERISTICS OF LAMBS

M.C. Calhoun[1], L.H. Carroll[2], C.W. Livingston, Jr[1]. and Maurice Shelton[1]

Monensin[3] has been reported to be effective in treating both naturally occurring (1) and experimentally produced (2) coccidial infections in lambs. Optimum response was obtained at a supplementation level of 4.5 mg of monensin per pound of feed.

Monensin has also been demonstrated to be of significant value in improving performance of cattle under both feedlot (3,6,7) and grazing conditions (4,5). Also, in preliminary studies with lambs, monensin improved feed efficiency.

This experiment was carried out to obtain more information on the value of monensin in reducing feed requirements of lambs. Coccidial oocyst numbers were also measured to check the effectiveness of monensin against coccidiosis in lambs.

EXPERIMENTAL PROCEDURES

Two hundred forty nine (249) crossbred, feeder lambs were used for this study. A pre-experimental, uniformity period of 21 days was used to adapt the lambs to the rations and pens. During the first 14 days, lambs were shorn, weighed, drenched with tramisol and vaccinated for enterotoxemia. A 50% roughage ration was used to start lambs on feed (Table 1). Then they were stepwise adapted to a 20% roughage feed by decreasing the roughage level by 10% at 4 day intervals.

At the beginning of the experimental monensin feeding period, lambs were again weighed and then switched to either a 10 or 30% roughage (peanut hulls) feed. Five levels of monensin (0, 5, 10, 20 and 30 grams per ton) were fed in combination with each peanut hull level. The duration of the feeding period was 70 days.

Lambs were weighed at 14-day intervals during the experiment. Initial and final weights used were the average of double weighings.

Nine lambs were slaughtered at the beginning of the experiment to obtain information on the dressing percent and carcass yield and grade when the experiment started. All remaining lambs were slaughtered upon completion of the study. In addition to carcass weights, the following carcass data were collected with the assistance of a USDA grader: USDA Quality Grade, fat thickness measured over the 1 dorsi, estimated percent kidney and pelvic fat, USDA Yield Grade and fat color and firmness scores.

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[1] Texas Agricultural Experiment Station, Texas A&M University System, San Angelo, Texas.

[2] Lilly Research Laboratories, Eli Lilly and Company, Dallas, Texas.

[3] Monensin is an experimental drug obtained from Eli Lilly and Company and is not cleared for use in lambs.

Fecal samples for monitoring coccidiosis were obtained from three lambs per pen initially and again at 28 and 56 days.

Rumen fluid samples were obtained by stomach tube from three lambs per pen and analyzed for volatile fatty acid concentrations. These rumen samples were collected during the week following the 56-day weigh period.

RESULTS AND DISCUSSION

The calculated nutrient composition of the experimental diets are shown in Table 2.

Three lambs were lost during the experiment, one from polyarthritis and two due to water belly (urinary calculi) problems. A serious problem was encountered with polyarthritis (stiff lamb disease), and a total of 49 lambs was treated for this condition. Treatment consisted of 4 cc of injectable Terramycin (each cc contained 50 mg of Oxytetracycline hydrochloride) given by intraperitoneal injection when stiffness was first observed.

A preliminary analysis of the data suggested the incidence of polyarthritis was unrelated to the treatments imposed. Furthermore, lambs treated for polyarthritis gained, on the average, only 0.03 lb/day less than healthy lambs in the same pens. Because of this, the polyarthritis problem was not further considered in the interpretation of the information from this experiment.

The performance of a pen of lambs on the 30% peanut hull diets and 10 grams per ton of monensin was considerably less than the other two pens on this treatment. Because of this, the information from this pen was not included in the summary of results.

Initially, 95.6% of the lambs sampled were shedding coccidial oocysts. The numbers ranged up to 188 thousand oocysts per gram of feces. However, there were no signs of clinical coccidiosis at any time during this experiment. The changes in coccidial oocyst numbers, as the experiment progressed, and the effect of monensin are shown in Table 4. This Table gives the number of lambs with oocysts in their feces, as well as the average number measured and the range of values observed at 0, 28 and 56 days. In the control group, the total number of lambs with oocysts present remained about the same throughout the study. But the numbers of oocysts dropped from an average of 2,742 initially to 491 at 56 days. Monensin decreased coccidial oocyst numbers at all levels fed. This effect was apparent at 28 days. There was a further reduction from 28 to 56 days. At levels above 5 g/ton, there were no oocysts detected at 56 days. Based on the reduction in coccidial oocyst numbers, 10 grams of monensin per ton of feed appears to be an effective level for treatment of coccidiosis in feedlot lambs.

The effect of monensin on the observed feedlot performance of lambs is presented in Table 5. There was not a significant interaction between

monensin and the energy level in the ration. Therefore, the results for the 10 and 30% peanut hull rations were combined in this Table. The results presented are cumulative for the times shown. No attempt was made to separate out performance by 14-day weigh periods because it was felt that this was too short an interval to give meaningful results. In this Table, live weight gains are figured from actual feedlot weights, with no correction for rumen fill.

A monensin response was evident at 14 days for live-weight gain. The response was quadratic ($P<.05$) and is described by the equation: $Y = .419 + .020x - .00083x^2$; where X = monensin level in g/ton and Y = live weight gain in lb/day. At 14 days, an effect of monensin was also apparent for feed intake and feed efficiency; however, because of the variation in pen performance over a short time period, these differences were not significant.

By 28 days, there were significant monensin effects for observed live weight gain (quadratic, $P<.01$), feed intake (linear, $P<.05$) and feed/gain (quadratic, $P<.01$). This pattern of response was maintained at each subsequent weighing throughout the 70-day experiment. The equations describing these monensin responses are given in Table 6. These equations were used to estimate the optimum level of monensin. Predicted from the live weight gain data, the optimum level ranged from 11.4 to 13 g/ton. Similar estimates from feed/gain data tended to be slightly higher, ranging from 13.1 to 15.7 g/ton. Monensin response was greatest early in the feeding period and then decreased for both observed feedlot live weight gain and feed efficiency, as evidenced by the change in the coefficients for the quadratic equations and the predicted improvement (Table 5). On the other hand, the effect on feed intake increased as the trial went on. At 28 days, feed intake was decreased .084 lb. for each 10 g/ton increase in monensin in the feed, whereas, at 70 days, the rate of decrease was .118 lb. of feed per day for each 10 g/ton increase in monensin.

Adjusted feedlot performance is summarized in Table 7.

The average dressing percent of the nine lambs in the initial slaughter group was used to adjust initial live weights of all remaining lambs to 51%. Carcass weights at slaughter were used to adjust final live weights to a dressing percent of 51. Adjusting initial and final live weights in this manner removes variation in rumen fill. Gains calculated from adjusted initial and final live weights reflect carcass rates of gain.

There was an effect of monensin on adjusted live weight gains for the 70-day feeding period, with no interaction between energy level and monensin. The equation for this relationship is $Y = .584 + .00467x = .00020x^2$ ($P<.05$), where Y = adjusted live weight gain in pounds per day and X = monensin level in the feed in grams per ton. This equation predicts a maximum adjusted gain of .611 lb/day at 11.7 g of monensin per ton of feed, an improvement of .027 lb. per day or 4.6% over the lambs receiving no monensin in their feed.

In the case of feed efficiency (feed/adjusted gain), there was a significant interaction between energy level and monensin. Therefore, these performance data have been separated to show the effects of monensin on the 10 and 30% peanut hull diets (Table 7 and Figure 1).

If there is a beneficial effect of monensin on feed efficiency in the 10% peanut hull diets, it is at the 5 g/ton level, where feed requirements per pound of adjusted live weight gain were 6.3% less than for the controls. In contrast, feed efficiency was improved at all levels of monensin in the 30% peanut hull diet. Maximum response was at 17.8 g of monensin per ton of feed. At this level, feed requirements for gain were 23.2% less than for lambs without monensin.

The relationship between monensin in g/ton (X) and feed/gain (Y) was $Y = 7.22 - .153x + .0043x^2$ ($P<.01$) for the 30% peanut hull diets (1.16 Mcal DE/lb of feed).

The effect of monensin on the carcass characteristics of lambs is summarized in Table 8. The two energy levels are combined in the Table because there was not a significant interaction with monensin for any of the carcass measurements. Monensin was without effect on carcass weights, USDA final grade, and fat color or firmness scores. However, there was a significant effect on dressing percent, fat thickness over the *l dorsi*, estimated percent kidney and pelvic fat, USDA yield grade and percent consumer cuts.

Monensin decreased the molar percent of rumen fluid acetate (Figure 3), butyrate (Figure 5) and increased propionate (Figure 4). The acetate to propionate ratio was also decreased (Figure 2). The effects on rumen volatile fatty acid proportions and the acetate to propionate ratio were linearly related to the level of monensin in the feed. The equations for these relationships are given with their respective figures. Both energy levels were combined in the equations, since similar trends were evident for both the 10 and 30% peanut hull diets and there were no significant interactions between energy level and monensin for the volatile fatty acid parameters.

The positive response to monensin obtained in this study with feedlot lambs is similar to that previously reported for feedlot cattle (3,6,7).

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TABLE 1. PERCENT INGREDIENT COMPOSITION OF UNIFORMITY AND EXPERIMENTAL DIETS

Ingredient, %	Uniformity (Pre-Experimental) Diets [4] Peanut Hulls, %				Experimental Diets [5] Peanut Hulls, %	
	50	40	30	20	10	30
Sorghum grain [1]	39.13	47.46	55.64	63.92	72.06	55.70
Peanut hulls	50.00	40.00	30.00	20.00	10.00	30.00
Cottonseed meal [2]	4.55	5.95	7.50	8.96	10.55	7.45
Molasses	4.00	4.00	4.00	4.00	4.00	4.00
Calcium carbonate	0.82	1.09	1.36	1.62	1.89	1.35
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin and mineral premix [3]	1.00	1.00	1.00	1.00	1.00	1.00

[1] Dry rolled.

[2] 41% crude protein.

[3] Composition of premix is given in Table 3.

[4] Chlortetracycline was included in the pre-experimental diets at a level of 25 mg/lb.

[5] Monensin was included at levels of 0, 5, 10, 20 and 30 grams per ton of complete mixed diet (air dry basis).

TABLE 2. CALCULATED NUTRIENT COMPOSITION OF UNIFORMITY AND EXPERIMENTAL DIETS

Ingredient, %	Uniformity (Pre-Experimental) Diets [4] Peanut Hulls, %				Experimental Diets [5] Peanut Hulls, %	
	50	40	30	20	10	30
Nutrient (As Fed Basis)						
Total digestible nutrients, %	54.35	58.92	63.45	68.00	72.53	63.47
Digestible energy, Mcal/lb.	0.91	1.03	1.16	1.28	1.41	1.16
Crude protein, %	9.31	10.03	10.81	11.55	12.34	10.79
Digestible protein, %	6.10	6.91	7.77	8.60	9.46	7.75
Crude fiber, %	31.33	25.66	20.01	14.35	8.71	20.01
Calcium, %	0.50	0.59	0.68	0.77	0.86	0.68
Phosphorus, %	0.20	0.24	0.27	0.31	0.34	0.27
Potassium, %	0.77	0.72	0.68	0.63	0.59	0.68
Protein:Energy ratio g DP/Mcal DE	30:1	30:1	30:1	30:1	30:1	30:1
Calcium:Phosphorus ratio	1	2.5:1	2.5:1	2.5:1	2.5:1	2

TABLE 3. VITAMIN AND MINERAL PREMIX

Ingredient	Premix %	Premix Contribution To Complete Diets
Sulphur	10.00	0.1% S
Potassium Chloride	19.00	0.1% K
Magnesium Oxide	16.60	0.1% mg
Salt (Plain, Fine Mixing)	49.55	0.5% NaCl
Molasses or Fat	1.50	----
Zinc Oxide	0.274	22.0 ppm
Vitamin A Palmitate[1]	0.068	1,000.0 IU Vit. A/lb
Irradiated Yeast[2]	0.0156	125.0 IU Vit. D_2/lb

[1] Vitamin A Palmitate; 147.4×10^6 IU/lb.

[2] D-Activated Plant Sterol (Source Vitamin D_2 80×10^6 IU/lb).

TABLE 4. SUMMARY OF EFFECT OF MONENSIN ON COCCIDIAL OOCYST NUMBERS

Sampling Time (Days)		Monensin (g/ton)				
		0	5	10	20	30
0	No. lambs with oocysts[1/]	16	17	18	18	17
	Ave. oocysts/g	16,453	15,958	5,559	21,178	12,034
	Range oocysts/g	0-188,094	0-110,055	1001-17,009	1001-135,068	0-36,018
28	No. lambs with oocysts	14	1	5	2	1
	Ave. oocysts/g	7,170	111	922	111	56
	Range oocysts/g	0-52,026	0-2,001	0-8,338	0-1,001	0-1,001
56	No. lambs with oocysts	16	2	0	0	0
	Ave. oocysts/g	2,946	167	0	0	0
	Range oocysts/g	0-9,005	0-2,001	0	0	0

[1/] 18 lambs were sampled at each monensin level for each sampling time.

TABLE 5. EFFECT OF MONENSIN ON OBSERVED FEEDLOT PERFORMANCE OF LAMBS

Criterion	Combined Energy Levels Monensin (g/Ton) 0	5	10	20	30	Statistical Comments
Initial Wt., lb.	73.5	70.2	70.4	71.6	72.4	Not Significant
14 DAY SUMMARY						
Gain, lb/day	0.368	0.570	0.554	0.428	0.299	Quadratic P<.05
Feed, lb/day	3.03	3.01	3.02	2.96	2.80	Not Significant
Feed/Gain	23.80	5.62	4.89	7.40	10.33	Not Significant
28 DAY SUMMARY						
Gain, lb/day	0.439	0.511	0.557	0.466	0.385	Quadratic P<.01
Feed, lb/day	3.16	3.06	3.18	2.99	2.90	Linear P<.05
Feed/Gain	7.37	6.09	5.69	6.46	7.99	Quadratic P<.01
42 DAY SUMMARY						
Gain, lb/day	0.432	0.487	0.534	0.456	0.365	Quadratic P<.01
Feed, lb/day	3.20	3.13	3.25	3.07	2.89	Linear P<.01
Feed/Gain	7.52	6.50	6.11	6.76	8.21	Quadratic P<.01
56 DAY SUMMARY						
Gain, lb/day	0.434	0.488	0.509	0.452	0.392	Quadratic P<.01
Feed, lb/day	3.30	3.22	3.32	3.14	2.95	Linear P<.01
Feed/Gain	7.62	6.66	6.56	7.02	7.58	Quadratic P<.01
70 DAY SUMMARY						
Gain, lb/day	0.373	0.398	0.406	0.379	0.341	Quadratic P<.05
Feed, lb/day	3.37	3.27	3.32	3.17	2.99	Linear P<.01
Feed/Gain	9.16	8.41	8.23	8.41	8.89	Quadratic P<.01

TABLE 6. EQUATIONS FOR THE RELATIONSHIPS BETWEEN LIVE WEIGHT GAIN, FEED INTAKE AND FEED EFFICIENCY (FEED/GAIN) AND MONENSIN CONCENTRATIONS[1/] IN THE DIET

	Equation		Optimum Monensin Level (g/ton)	Predicted Percent Change[2/]
14 Day				
Gain, lb/day	= .419 + .020X - .00082X^2	(P<.05)	12.2	+29.1
Feed, lb/day	- Not Significant	-	-	-
Feed/Gain	- Not Significant	-	-	-
28 Day				
Gain, lb/day	= .454 + .012X - .00050X^2	(P<.01)	12.3	+15.8
Feed, lb/day	= 3.17 - .0084X	(P<.05)		
Feed/Gain	= 7.18 - .214X + .0082X^2	(P<.01)	13.1	-19.4
42 Day				
Gain, lb/day	= .441 + .012X - .00048X^2	(P<.01)	13.0	+17.0
Feed, lb/day	= 3.24 - .0101X	(P<.01)		
Feed/Gain	= 7.39 - .188X + .0072X^2	(P<.01)	13.1	-16.6
56 Day				
Gain, lb/day	= .447 + .0081X - .00034X^2	(P<.01)	11.9	+10.8
Feed, lb/day	= 3.33 - .0114X	(P<.01)		
Feed/Gain	= 7.42 - .118X + .0042X^2	(P<.01)	14.0	-11.2
70 Day				
Gain, lb/day	= .378 + .0041X - .00018X^2	(P<.05)	11.4	+ 6.2
Feed, lb/day	= 3.38 - .0118X	(P<.01)		
Feed/Gain	= 9.05 - .112X + .0036X^2	(P<.01)	15.7	- 9.6

1/ X = Monensin concentration in grams per ton

2/ Equations were used to calculate predicted percentage change. This was done by comparing intercept value (0 g Monensin/ton) with performance at the predicted optimum Monensin level.

TABLE 7. EFFECT OF MONENSIN ON ADJUSTED FEEDLOT PERFORMANCE OF LAMBS[1/]

Criterion	10% Peanut Hulls (1.41 Mcal DE/Lb Feed) Monensin (g/Ton) 0	5	10	20	30
Adjusted Initial Weight (lb)	68.0	67.3	67.0	69.6	69.0
Adjusted Final Weight (lb)	113.0	117.1	113.5	112.5	110.7
Adjusted Live Weight Gain (lb/day)	0.643	0.712 (+10.7)[2/]	0.665 (+3.4)	0.614 (-4.5)	0.596 (-7.3)
70 Day Feed (lb/day)	3.08	3.19 (+3.5)	3.22 (+4.5)	3.02 (-1.9)	2.79 (-9.4)
70 Day Feed/Adjusted Gain	4.78	4.48 (-6.3)	4.85 (+1.5)	4.92 (+2.9)	4.67 (-2.3)

Criterion	30% Peanut Hulls (1.16 Mcal DE/Lb Feed) Monensin (g/Ton) 0	5	10	20	30
Adjusted Initial Weight (lb)	71.2	65.6	66.4	65.9	68.2
Adjusted Final Weight (lb)	105.7	103.6	105.6	104.0	103.2
Adjusted Live Weight Gain (lb/day)	0.492	0.543 (+10.4)	0.560 (+13.8)	0.544 (+10.6)	0.500 (+1.6)
70 Day Feed (lb/day)	3.66	3.35 (-8.5)	3.42 (-6.6)	3.32 (-9.3)	3.20 (-12.6)
70 Day Feed/Adjusted Gain	7.43	6.18 (-16.8)	6.12 (-17.6)	6.11 (-17.8)	6.40 (-13.9)

1/ Initial and final weights adjusted to a dressing percent of 51. Thus, gains reflect carcass rates of gain.

2/ Values in parentheses represent % change compared to control (0 g/ton).

TABLE 8. EFFECT OF MONENSIN ON CARCASS CHARACTERISTICS OF LAMBS

Criterion	Combined Energy Levels Monensin (g/Ton) 0	5	10	20	30	Statistical Comments
Final Live Weight (lb)	99.6	98.0	98.8	98.1	96.3	Not Significant
Carcass Weight (lb)	55.8	56.3	55.9	55.2	54.6	Not Significant
Dressing Percent	56.0	57.4	56.5	56.2	56.7	Cubic P<.05 Residual P<.05
USDA Final Grade	11.8	11.9	11.9	11.8	11.6	Not Significant
Fat Thickness *l dorsi* (in)	0.26	0.24	0.23	0.23	0.21	Linear P<.05
Kidney and Pelvic Fat (est. %)	3.2	3.2	3.7	3.8	3.1	Quadratic P<.01
USDA Yield Grade	3.6	3.5	3.5	3.6	3.3	Linear P<.05
Consumer Cuts (%)	44.4	44.6	44.6	44.5	45.0	Linear P<.05
Fat Color (Score)[1]	3.3	3.2	3.5	3.4	3.3	Not Significant
Fat Firmness (Score)[2]	4.2	3.9	4.2	4.0	4.4	Not Significant

[1] Fat color score: 1 = Yellow, 2 = Slightly yellow, 3 = Creamy white and 4 = White

[2] Fat firmness scores: 1 = Soft and oily, 2 = Moderately soft and moderately oily, 3 = Slightly soft and slightly oily, 4 = Slightly firm and slightly dry, 5 = Moderately firm and moderately dry and 6 = Firm and dry

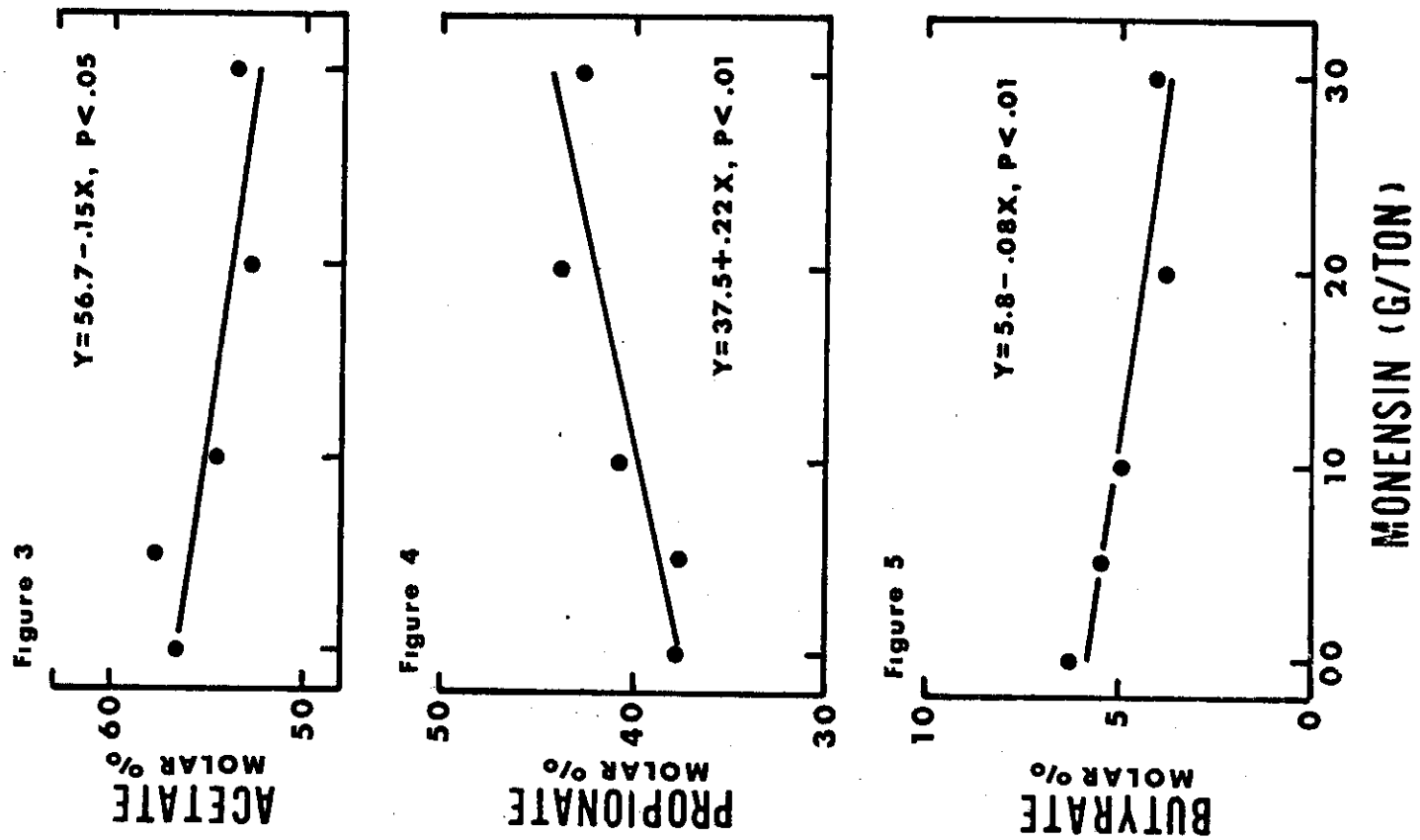
Figure 3
ACETATE
MOLAR %
Y=56.7-.15X, P<.05
60
50
Figure 4
PROPIONATE
MOLAR %
Y=37.5+.22X, P<.01
50
40
30
Figure 5
BUTYRATE
MOLAR %
Y=5.8-.08X, P<.01
10
5
0
00
10
20
30
MONENSIN (G/TON)

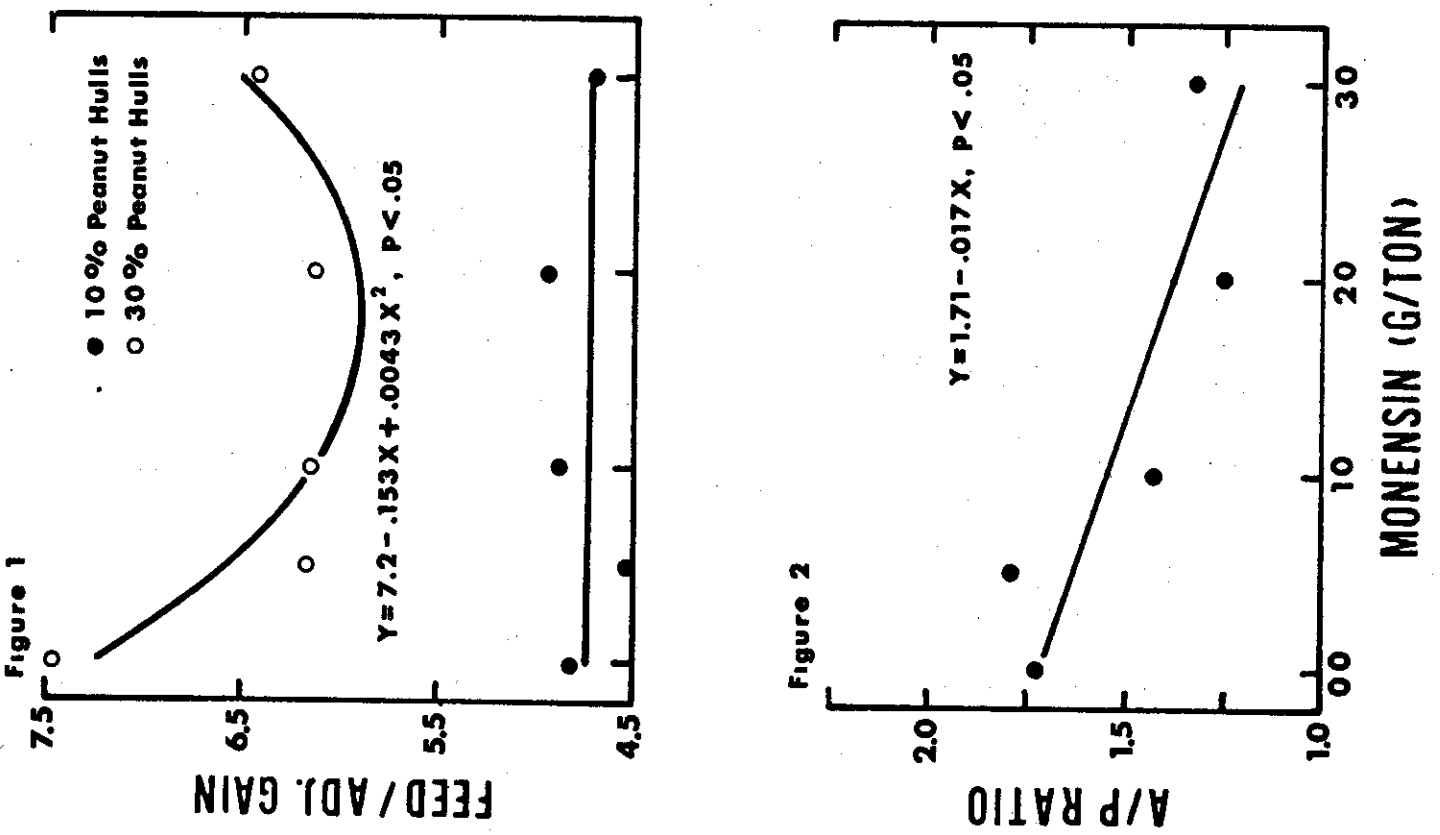
Figure 1
FEED / ADJ. GAIN
● 10% Peanut Hulls
○ 30% Peanut Hulls
Y=7.2-.153X+.0043X², P<.05
7.5
6.5
5.5
4.5
Figure 2
A/P RATIO
Y=1.71-.017X, P<.05
2.0
1.5
1.0
00
10
20
30
MONENSIN (G/TON)

PR-3505

MONENSIN AND THE ESTIMATED METABOLIZABLE AND NET ENERGY VALUES OF SORGHUM GRAIN AND PEANUT HULLS

M.C. Calhoun[1] and L.H. Carroll[2]

The addition of monensin[3] to sheep and cattle feedlot rations decreases the molar percent of acetic acid in the rumen and increases propionic acid (1, 2, 3, 8). This effect is related to the level of monensin added to the feed over the range 0 to 30 grams per ton, and there appears to be a greater shift with higher roughage feeds. It has been suggested that an increased production of propionic acid would be energetically more efficient for the ruminant animal (7, 8). This suggestion is supported by the observed decrease in feed requirements for gain which accompany additions of monensin to feedlot rations (1, 2, 3, 7). This effect of monensin may necessitate adjustment of the energy values of feedstuffs used when formulating diets.

The feedlot performance information from a monensin study with lambs (2) was used to estimate the effect of monensin on the energy values of the complete diets, as well as the energy (dry rolled grain sorghum) and roughage (ground peanut hulls) components of the diet. To accomplish this, carcass rates of gain were used along with the reported net energy values for maintenance and gain of growing-finishing lambs (5) to calculate net energy values for the complete diets. Then since each monensin level was fed at two different energy levels (1.41 and 1.16 Mcal digestible energy per pound of feed expressed on an as fed basis), this information was used to calculate energy values for sorghum grain and peanut hulls. This was done for each level of monensin fed to separate out the effect of monensin level on the energy values of the grain and roughage components of the diets. The procedures for making these calculations have been described by Kromann (4) and require 'n' different rations to independently determine the energy values of 'n' ration components using a system of simultaneous equations. Since only two rations corresponding to the two energy levels were fed in this case, the NAS-NRC values (6) for cottonseed meal and molasses were used to facilitate solving these equations.

RESULTS AND DISCUSSION

The effects of monensin on the estimated metabolizable and net energy values of the high (1.41 Mcal DE/lb of feed) and low energy (1.16 Mcal DE/lb of feed) diets which correspond to 10 and 30% peanut hulls, respectively, are shown in Table 1. Monensin was without effect on the estimated energy values of the high energy diets but increased ($P<.05$) the low energy diets.

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[1] Texas Agricultural Experiment Station, Texas A&M University System, San Angelo, Texas.
[2] Lilly Research Laboratories, Eli Lilly and Company, Dallas, Texas.
[3] Monensin is an experimental drug obtained from Eli Lilly and Company and is not cleared for use in lambs.

The response on the low energy diets occurred at 5 g/ton of monensin with no further increase as the level of monensin was raised to 30 g/ton.

The effect of monensin on the energy value of the diets appeared to be due to its effect on the peanut hull component of the diets. The metabolizable energy value of peanut hulls increased from -.02 Mcal/lb on the 0 g/ton monensin diets up to .49 Mcal/lb at the 10 g/ton level. The relationship between the estimated metabolizable energy value of the diet (Y in Mcal/lb on an as fed basis) and monensin concentration in the diet (X in g of monensin/ton of feed) was $Y = .021 + .063x - .0019x^2$. Using this equation, the optimum level of monensin was estimated to be 16.7 g/ton, a value in reasonably close agreement with that estimated from the effect of monensin on feedlot performance information for lambs (2). In contrast, monensin had little effect on the energy values for sorghum grain.

For purposes of comparison, the reported NAS-NRC values for the metabolizable energy of sorghum grain and peanut hulls are 1.37 and .54 Mcal/lb, respectively (6).

The observation that monensin only alters the energy value of the roughage component of the diet is of practical interest, since it would only be necessary to adjust the energy value of the roughage when formulating monensin supplemented diets. Additional studies are desirable to confirm this observation and define the effect of monensin on the energy value of different roughage materials fed in diets at varying concentrate-to-roughage ratios.

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TABLE 1. EFFECT OF MONENSIN ON THE CALCULATED METABOLIZABLE AND NET ENERGY VALUES OF LAMB DIETS AND INGREDIENTS (AS FED BASIS)

Criterion	Monensin Level (g/Ton) 0	5	10	20	30
High Energy Diets					
Metabolizable Energy, Mcal/Lb	1.29	1.30	1.27	1.28	1.34
Net Energy (Maintenance), Mcal/Lb	0.87	0.88	0.85	0.86	0.90
Net Energy (Gain), Mcal/Lb	0.59	0.60	0.58	0.58	0.62
Low Energy Diets					
Metabolizable Energy, Mcal/Lb	0.99	1.08	1.09	1.09	1.09
Net Energy (Maintenance), Mcal/Lb	0.63	0.70	0.71	0.71	0.70
Net Energy (Gain), Mcal/Lb	0.39	0.45	0.46	0.46	0.45
Sorghum Grain					
Metabolizable Energy, Mcal/Lb	1.57	1.54	1.47	1.48	1.59
Net Energy (Maintenance), Mcal/Lb	1.09	1.07	1.01	1.02	1.11
Net Energy (Gain), Mcal/Lb	0.78	0.76	0.71	0.72	0.79
Peanut Hulls					
Metabolizable Energy, Mcal/Lb	- 0.02	0.34	0.49	0.47	0.24
Net Energy (Maintenance), Mcal/Lb	- 0.18	0.11	0.23	0.21	0.03
Net Energy (Gain), Mcal/Lb	- 0.29	- 0.05	0.05	0.04	- 0.11

PR-3506

SUCCESSFUL UTILIZATION OF PASTURES CONTAINING A HIGH PROPORTION OF KLEINGRASS BY SHEEP

J.E. Huston*

Kleingrass is a highly productive and widely adapted range grass that was introduced to the United States from Africa. It has gained widespread popularity and has been seeded on several hundred thousand acres of either pure or mixed stands in Texas. Extensive plantings have been established in the traditional sheep and goat region. While the plant has been remarkable in supplying high quality forage for cattle, sheep producers are skeptical about its value.

Reports of photosensitization (swellhead) began to surface about 1972 in the San Angelo area. Studies at the Texas A&M University Research and Extension Center at San Angelo, as well as producer case studies, confirm that the plant and/or factors associated with the plant can cause swellhead. It has been noted that the malady usually occurs in weaned lambs that are grazing the plant during the growing season. It is of such serious concern that widespread establishment of kleingrass in the sheep and goat region may eliminate these areas for raising sheep. This report presents results of production of a flock maintained on a mixed stand of plants, including kleingrass, over a four-year period.

EXPERIMENTAL PROCEDURE

The study area consisted of four hundred thirty acres of a mesquite-infested, previously cultivated land that was root plowed and seeded during the spring of 1974. The seeding mixture is shown in Table 1. One hundred commercial yearling Rambouillet ewes were placed on the area in October 1974. Fifty-six similar ewes were added in May 1975, and twelve more in May 1976. The ewes were managed in two experimental groups. One group was bred in the fall for late winter lambs, while the second group was given opportunity to breed at eight-month intervals (September, January, May). As a result, most lambs were weaned in May or early June, but some lambs were on the study area during most of the year. Lambs were always removed from the area at weaning and placed in drylot for finishing or sold as milk lambs. Vegetation composition was determined during August of 1975, 1976 and 1977. Species composition for 1976, which is fairly representative of the three-year period, is given in Table 2.

RESULTS AND DISCUSSION

Kleingrass became well established in the experimental area and by August 1976, comprised 47% ground cover (Table 2). The ewes were maintained permanently on the experimental area, and since other reports indicate a high palatability for kleingrass, it is a safe assumption that a substantial amount of the plant was being consumed. Only one ewe death

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was confirmed during this four-year period to be a result of swellhead. In addition, one ewe was diagnosed as having swellhead, but she recovered without confinement or treatment. No lamb losses were attributed to the disease nor were any sublethal cases observed. Losses from unconfirmed causes is a concern. However, only nine losses occurred during the expected "swellhead season", and the lack of observed cases and the normal probability of death rate (parasitism, dogs, etc.) suggest swellhead losses to be minimal.

This report is not to suggest that kleingrass will not cause swellhead nor that the hazard has been overemphasized. Serious losses among weaned lambs have occurred on an adjacent pasture at the San Angelo Center. Based on present data, it is recommended that kleingrass areas be utilized by ewes and ewes nursing lambs only. Weaned lambs should not be allowed to graze kleingrass areas, especially during the summer months. Furthermore, sheep grazing kleingrass may carry a subclinical level of liver damage and should be removed quickly, if swellhead cases are observed.

TABLE 1. SEEDING MIXTURE FOR AN EXPERIMENTAL AREA AT THE TEXAS A&M UNIVERSITY RESEARCH AND EXTENSION CENTER AT SAN ANGELO

Seeded Plants	Seed Applied (lbs. pls/acre)
Buffalograss	1.77
Gahi pearl millet	.14
Green sprangletop	.17
King Ranch bluestem	.11
Kleingrass 75	.26
Madrid clover	.14
Plains bristlegrass	.14
Sideoats grama (El Reno)	1.87
Sorghum almum	.39
Vine mesquite	.59
	5.58

TABLE 2. SPECIES COMPOSITION TWO YEARS FOLLOWING ROOT PLOWING AND SEEDING AT THE TEXAS A&M UNIVERSITY RESEARCH AND EXTENSION CENTER AT SAN ANGELO

Plant Species	% Ground Cover
Buffalograss	0.1
Gahi pearl millet	0.0
Green sprangletop	5.4
King Ranch bluestem	3.1
Kleingrass 75	47.0
Madrid clover	0.1
Plains bristlegrass	13.8
Sideoats grama (El Reno)	24.4
Sorghum almum	0.8
Vine mesquite	0.3
	95.0

TABLE 3. DEATH LOSSES OF EWES ON THE EXPERIMENTAL AREA OVER A FOUR YEAR PERIOD

	Year Added		
	1974	1975	1976
Number of ewes added	100	56	12
Number dead or removed			
Swellhead	1	0	0
Other confirmed losses (mastitis, parasites, injury, pregnancy disease, dogs, etc.)	18	5	1
Unknown losses			
Fall	1	2	0
Winter	3	1	0
Spring	1	1	0
Summer	2	4	0
Total	26	13	1

PR-3507

ELECTRIC FENCING AS A DETERRENT TO COYOTE PREDATION

Maurice Shelton[1,2]

INTRODUCTION

The problem of coyote predation remains a major deterrent to an efficient sheep or goat industry in this state and much of the Nation. It appears that all approaches should be taken to solving or alleviating this problem. Fencing, especially electric fencing, is one of the approaches which should be considered. The use of net fencing to deter predation is as old as the sheep industry in this area, as coyote fences can be located which were built over 50 years ago. At present most of the fences in the state do not provide a significant deterrent to coyote passage, and the likelihood of refencing the large areas of Texas with a new net fence likely to deter coyotes does not seem very realistic at present. Electric fencing was one of the first approaches taken by the author in a study of this problem, but without significant success. The apparent reason for failure of these early efforts was that the nature of the chargers available and poor grounding conditions throughout much of the year simply did not provide assurance of an adequate shock to the invading predator. These difficulties have been partially overcome by the availability of new energizing units and the realization that under dry conditions, a provision must be made to assure an adequate ground to complete an electric circuit.

Electric fencing as a means of deterring coyote predation may be approached as new fencing or as an adjunct to existing fencing. Some of the basic considerations involved were reviewed by Shelton (1977). One type of new fencing which has been shown to be successful under the conditions in which it was tested was reported by Gates *et al.* (1978). The present report will deal only with the use of electric fencing used as an adjunct to existing fencing which is adequate to contain sheep or goats but does not provide protection from coyotes or dogs. This would normally be assumed to be a net fence, but some testing has been done with a seven-wire barbed wire fence.

MATERIALS AND METHODS

Two styles of fencing have been tested on a limited scale. These are shown in diagramatic form in Figure 1 and in photographic form in Figures 2 and 3. These designs were somewhat arbitrarily chosen in that it has not been possible to test under field conditions the large number of designs which might be proposed. The design shown as Option 1 in Figure 1 consists of the use of an energized trip wire placed approximately eight inches away from the existing fence and six inches off the ground level. This wire is intended to discourage passing under

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[2]The author wishes to acknowledge the cooperation of personnel of the McGregor and Spur Research Stations and the Wagstaff and Eckert ranches in Fisher County.

or digging under the fence. The top wire is an energized wire somewhat similarly located relative to the top of the fence and is intended to discourage jumping or climbing. The term discourage is significant in that the dog or coyote must only dig one inch deeper or jump one inch higher in order to circumvent these wires. Option number 2, consists of a two-or three-wire fence much as might be used as a temporary sheep fence, placed outside (2-2.5') the existing fence relative to the route of coyote travel. The wire spacings used have been somewhat arbitrary, but the values used have been 6-8". This fence is designed to require that the invading animal dig under or jump both fences without making contact between an energized and grounded wire. Fence type A would be used under dry conditions where a center grounded wire would be needed. Fence type B would be used under more moist conditions. In all of the options indicated, the existing fence and the earthed wire in fence type A should be well grounded. Under dry conditions, this may require driving one or more metal stakes several feet in the ground to an assured moisture level. It is important to place energized and grounded wires in such a manner as to maximize the likelihood that an invading predator complete a circuit in attempting to pass the fence. It is also important that an adequate charge be maintained on the energized wire. A charge of 5,000 volts has been used in experimental studies. Insofar as is known, the type of charger used is not important so long as a charge is maintained. However, some charging units do have markedly improved resistance to grounding. It is probably important to use equipment which is less likely to initiate a range fire. One mechanism to do this is to use a unit with a short duration charge on the line.

RESULTS

The fence designs shown in Figures 1 and 2 have been tested at one or more sites in this state during the past two years. This work has been concentrated in Dickens, Fisher and McLennan counties.

The fence type known as Option number 1 has been tested at only one site in McLennan county. In this case, no confirmed coyote kills occurred over a six-month period. Control animals were not maintained concurrently on the same site because it appeared that unprotected animals in the same area would prejudice the experimental test. However, this is an area where coyote predation had been a long-term problem (Shelton-1972). Also, during a control period prior to the experimental period in question, one lamb (weaned feeder lambs were used) was lost for each 7.1 days in control pastures. The type shown as Option number 2 has been tested in Fisher and Dickens counties with the following results:

Fisher County:
Control fence---one goat lost each 1.4 days.
Electric fence--one goat lost each 18.8 days

Dickens County:
Control fence---one lamb lost each 16 days.
Electric fence--no losses to coyotes in 72 days.

The work in Fisher County was conducted on two ranches in sandy country. The test fence consisted of good net fence with a buried apron. During the test period, all losses occurred as a result of one dig under the fence. In a subsequent test, the fence design suggested was evaluated in an attempt to protect goats behind a seven-wire barbed fence. This proved to be a total failure as coyotes readily dug under both fences. These experiments suggest that it is difficult to use fencing of any type to protect sheep and goats in sandy country where digging under is easy and where most coyotes are oriented to this method of gaining passage. Future work with electric fencing should be concentrated in other areas.

In Dickens County, the fence was more successful. For a period of over six months losses were controlled except in cases of equipment failure. However, over a period of close to a year, coyotes did eventually defeat the fence and kill the eight lambs which were exposed. The primary problem at this site was maintenance of the electric fence. Coyotes appeared to be able to sense if the fence was operable. The primary problems encountered were equipment failure (in some cases, due to lightening) and the presence of cattle in adjacent pastures damaging the fence. If cattle exposure is constant, they apparently learn to respect the fence. However, in the case involved, there was a large "in and out" movement of cattle which contributed to their damaging the fence.

CONCLUSION

These studies appear to indicate that electric fencing can be used to provide a significant deterrent to coyote predation, and that where applicable, producers should avail themselves of this tool. However, in our preliminary studies, protection has not been complete, and because of this, other approaches to this problem should not be abandoned.

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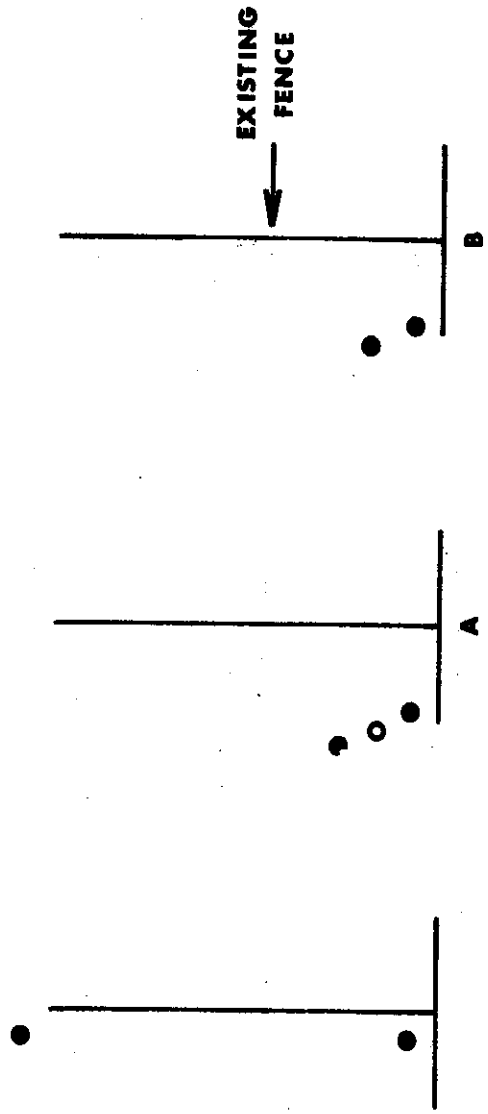

Figure 1. Diagramatic illustrations of the type of fences tested.

Figure 2. Simulated models of the type of fences utilized. Metal stakes made of construction steel were used for supports except for the top wire. Plastic posts make it easier to maintain a charge, but are expensive. In recent tests hardwood stakes without insulators have been used with good results during a very dry time. However, they need to be evaluated during a wet season.

PR-3508

FACTORS AFFECTING SHEEP LOSSES TO PREDATORS IN TRANS-PECOS TEXAS

S. L. Beasom and D. R. Gober*

Future research may provide additional tools for reducing sheep losses to predators. Improved technology may add successful fencing techniques and/or chemical repellents to the predator control options which livestock producers now use. Since 1972 when the use of chemical toxicants was restricted, the protection of sheep flocks from predators in Texas has been limited to conventional predator removal programs which include the use of traps, snares, and shooting. Sheep producers have suggested that limitations of predator control techniques add to a variety of problems which are contributing to a decline in the number of sheep and sheep ranches across the United States. This decline fosters a deteriorating condition where many producers cease to raise sheep. Those ranchers who continue to stock sheep have increased difficulties with predator control once denied the cooperative removal efforts of their neighbors. Land managers who do not pasture sheep or goats often do not engage in active predator control programs. Sheep producers in areas where most of the ranchers do not have sheep and goats find that it is virtually impossible to eliminate predators from their sheep ranges. If complete removal of predators from an area is accomplished, then obviously there cannot be any sheep losses to predators. Although an isolated producer may expend as much effort as possible in predator control operations, it is likely that some predators will continue to inhabit his sheep pastures. Under these conditions the availability of natural prey for predators may influence the number of sheep lost to predation.

The Trans-Pecos region of Texas is an area where isolated sheep producers have great difficulty in controlling predator numbers. This Trans-Pecos region occurs at the western boundary of the Edwards Plateau which is the major sheep producing center of the state. Sheep producers in the far western part of Texas have unique problems. They contend with predator populations much less repressed than those of the Edwards Plateau. These producers occupy an unstable fringe on the edge of the more contiguous sheep distribution of the central part of the state. Predation may force some isolated producers to terminate their operations under the pressure of excessive sheep losses. It has been suggested that this "fringe" is deteriorating and may move eastward into the Edwards Plateau. This research was conducted as an effort to investigate the ecological interrelationships of predator numbers, predator control, and natural prey availability as they affect the problems of fringe area sheep producers.

PROCEDURES

Study areas were located in west Texas near the Pecos-Brewster county line between Ft. Stockton and Alpine. This region is located at

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the western fringe of the major sheep raising section of the state. Few sheep were raised near study areas during this experiment, but many producers had once operated in the region. The last ewe-lamb operation in the area was terminated in June 1974. Field work began in January 1975. Three pastures of approximately 3,000 acres were selected. The pastures were separated by several miles. One hundred and fifty bred ewes were placed in these pastures by March 1 in 1975, 1976 and 1977. These sheep were natives of Pecos County. Ewes lambed about April 1 of each year. Sheep survival was followed by intensive daily searches conducted from horseback. Predator control was initiated in January of each year and continued until summer while sheep were pastured on study areas. Areas within and around two of the experimental sheep pastures were treated with predator control in each year. The remaining sheep pasture was used as a "control" area. This study area was used to establish a base line condition measured by the number of sheep lost to predators in the absence of a predator control program. On one treated study area (the "M-44" area) only the M-44 device was used to remove predators. On the other treated study area (the "Combination" area) all legal means of predator removal were used including traps, snares, M-44's, helicopter gunning and ground shooting. Target predators were coyotes and bobcats. Study area treatments were alternated for each year of the experiment. Experimental predator control accounted for most of the predators removed from ranches near study areas. Since ranchers in the immediate vicinity did not stock sheep, none were involved in any intensive predator removal operations. Study area conditions appeared similar to those of an isolated, fringe area sheep ranch. Important natural prey of predators in the area included cottontails, jackrabbits and rodents. Fluctuating numbers of these animals were enumerated by standard wildlife census techniques to determine their influence on the intensity of predation on sheep.

RESULTS AND DISCUSSION

Ecological factors affecting sheep losses to predators in this region cannot be limited to a single appraisal of numbers of predators removed. Assessment may be difficult, but the only rational means of judging the success of a predator control program is by the number of sheep it saves-not by the number of predators killed. Removing one half the predators from an area does not insure that a producer may expect one half the sheep losses which would have occurred had the original number of predators remained. A few predators may inflict as much damage on a sheep flock as many predators. In this experiment the number of available natural prey on study areas appeared to affect the likelihood of predators killing sheep.

In 1975 and 1976 experimental results for all study areas indicate drastic differences in lamb crop survival (83 vs 15 percent) despite the fact that about the same number of predators were removed each year. Interviews with fringe area producers in Pecos County indicated a similar pattern for both years. Since predator removal in the region had not

changed greatly from 1975 to 1976, it appeared that there must be some overriding factor affecting sheep losses. Range conditions were very different in 1975 and 1976. Abundant precipitation in 1975 allowed luxuriant vegetative growth and a concurrent increasing population of natural prey for predators. In 1976 there was little precipitation and poor range conditions (57 percent less forage produced than in 1975). This situation contributed to a low availability of the natural prey of predators (30 percent fewer rodents than in 1975). Although more lambs were saved in both years where intensive predator control operations were conducted, the degree of advantage was markedly different between years. In 1975 the treated "Combination" study area produced a 78-percent lamb crop in mid August while in 1976 the "Combination" area produced only a 29-percent lamb crop two months earlier in June. It appeared that predators were moving into treated areas faster than they could be removed in 1976. Increased predator movement and infiltration may have been associated with low natural prey availability.

In 1977 similar numbers of predators were removed from treated study areas as had been in 1975 and 1976. On the "Combination" area 43 coyotes and 21 bobcats were removed. Few predators remained on this type of treated area relative to other areas ("M-44" and "Control") in all research years.

Nine coyotes were removed in 1977 on the "M-44" area. M-44's did not remove a substantial number of predators present on study areas in any research year. The exclusive use of the M-44 device on the "M-44" area in 1977 did not provide any advantage in lamb crop survival over the "Control" area where no predators were removed (21 versus 53 percent). These results were similar to 1976. The use of M-44's without the concurrent use of other techniques probably results in more coyotes killed by M-44's, but affords an overall lower degree of predator removal than a "Combination" treatment.

Early in the lambing period of 1977 lamb losses to predators were severe. Ewe losses to predators which had been minimal in 1975 and 1976 began to occur more frequently. These losses occurred when range conditions were the poorest and when natural prey populations were at the lowest levels of all study years. By docking (mid-May), precipitation had improved range conditions (forage production for 1977 averaged about mid way between the high of 1975 and the low of 1976 study years) and prey populations were increasing. Predation losses after the first months of lambing continued but at a lower rate than earlier in the year. It appears that differences in prey availability between and within years affected the intensity of predation on sheep.

Prey population levels for 1977 averaged intermediate to the high levels of 1975 and the low levels of 1976 study years (15 percent more rodents than 1976, 15 percent less rodents than 1975). Availability of rabbits to predators did not follow their population levels but was associated with numbers of young produced which generally followed the pattern of rodent populations. Lamb losses

in 1977, averaged between the severe early period and more moderate later period, fell between the loss figure of 1975 and 1976. Lamb crop survival in 1977 was 30 percent for all study areas (intermediate compared to 83 and 15 percent for 1975 and 1976, respectively). Again in 1977 the "Combination" study area saved more lambs than other study areas. Nevertheless, the ultimate number of lambs produced in any given year was influenced more by natural prey population levels than by predator control efforts.

Table 1. Interrelated factors affecting sheep losses to predators in Trans-Pecos, Texas, 1975-1977.

	1975	1976	1977
%Lamb Survival[1]			
Control area	64	13	51
M-44 area	86	5	24
Combination area	69	31	39
No. of predators removed[2]			
Control area	0	0	0
M-44 area	2	4	9
Combination area	39	38	65
Range condition: forage production[3]	1533	606	1000
Rodent numbers[4]	15.4	11.1	13.1
Lagamorph availability[5]	(High)	(Low)	(Int.)
Lagamorph numbers[6]	3.6	5.1	3.1
Predator abundance[7]	(Low)	(Int.,High)	(Int.,High)

[1] expressed as a percent of lambs born, affected by shipping date (see text).

[2] approximately equal on per area basis for all years.

[3] expressed in kg/ha.

[4] expressed as no. captured per o.33 ha grid.

[5] based on sightings of young and their occurrence in coyote stomachs.

[6] expressed as no. per km, of transect.

[7] based on composite estimate of all predator evidence recorded on study area.

PR-3509

EXTENDED CONTROL OF BITTERWEED WITH HERBICIDES

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Bitterweed (Hymenoxys odorata), a poisonous, annual cool-season forb, periodically causes severe economic losses to sheep producers in the Edwards Plateau resource area of Texas. Good grazing management and grazing with a combination of livestock species are the best and most economical long-term methods for avoiding bitterweed problems (1) for a large portion of the bitterweed area. However, effective herbicides are essential for control of bitterweed on sacrifice areas such as in the vicinity of watering and feeding facilities, roadways, livestock bedding areas, pipeline rights-of-way and in drier parts of the western Edwards Plateau where plant succession is slow and where droughts are more frequent. Aerial application of 2,4-D [(2,4-dichlorophenoxy)acetic acid] has been the standard practice for bitterweed control on Texas rangelands for over 20 years. However, 2,4-D has severe limitations because "second crops" of bitterweed may germinate and become established since 2,4-D does not have extended residual life in the soil and because 2,4-D has limited herbicidal activity against bitterweed when growing conditions are unfavorable. Ranchers who apply herbicides for bitterweed control need season-long control and residual effect the next bitterweed season to justify the high costs of herbicides. One objective of our bitterweed research program is to evaluate herbicides with adequate soil residual lives to extend control of bitterweed infestations which develop with rainfall subsequent to the initial herbicide application. Results from experiments in 1975-76 indicated that picloram (4-amino-3,5,6-trichloropicolinic acid) at 0.5 to 1.0 lb/acre (acid equivalent) effectively controlled bitterweed for over 300 days (2). Six additional experiments were conducted in 1976-77 to further evaluate herbicides for long-term control of bitterweed.

METHODS

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

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

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

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

Permanent transects were established in each plot, and pretreatment and post-treatment bitterweed densities were taken from 10, permanently-marked quadrats in each plot. Quadrat sizes were 0.11 ft^2 for ground plots, and 0.22 ft^2 for aerially-sprayed plots. All treatments applied with ground equipment were replicated three times in completely randomized designs. Treatments applied by airplane were not replicated, but three permanent transects were located within each plot.

RESULTS

The research plan called for evaluation of residual herbicide activity on bitterweed populations at all six locations at 365-days post-treatment. However, drought conditions prevented emergence and establishment of bitterweed at four locations. Evaluations were made in April, 1978 at the James Powell Ranch near Fort McKavett (354 days post-treatment) where herbicides had been applied on April 22, 1977 and at the Bill Pfluger Ranch near San Angelo (489 days post-treatment) where herbicides had been applied on December 7, 1976.

All herbicide treatments continued to reduce population density of bitterweed at 354 days post-treatment at the James Powell Ranch (Table 1). There was a definite trend showing that residual control of bitterweed increased as the amount of picloram applied increased from 0.25 to 1.0 pound per acre. However, residual control on plots receiving

up to 0.5 pound per acre of picloram was not significantly greater than that achieved with 1.0 pound per acre of dicamba + 2,4-D (1:3) or with 1.0 pound per acre of 2,4-D ester. Bitterweed control was 92.1% or greater at 354 days post-treatment on plots receiving 0.5 pound per acre to 1.0 pound per acre of picloram, compared to 77.2% for dicamba + 2,4-D (1:3) at 1.0 pound per acre and to 81.2% for 2,4-D ester at 1.0 pound per acre (Table 1).

All herbicide treatments except 2,4-D ester at 1.0 pound per acre reduced bitterweed density at the Bill Pfluger Ranch at 489 days post-treatment (Table 2) although degree of control was less for all herbicides than was seen at 354 days post-treatment at the Powell Ranch. Also, the trend of increased residual control as amount of picloram applied increased, which was evident at the Powell Ranch, was not evident at the Pfluger Ranch. Picloram at 1.0 pound per acre resulted in 90% control of bitterweed at 489 days post-treatment. Tebuthiuron, which had no herbicidal effect on the live bitterweeds initially (2) resulted in 93.5% to 96.2% control on the 1977-78 crop of bitterweeds.

These results confirm our earlier studies that excellent control of bitterweed may be achieved for one year by application of 0.5 to 1.0 pound per acre of picloram, and suggest that 0.25 pound per acre of picloram, 1.0 pound per acre of 2,4-D ester, and 1.0 pound per acre of dicamba + 2,4-D may give good to excellent control of bitterweed for one year under very dry conditions. Excellent control of bitterweed may be achieved for over 16 months following initial application of picloram at 1.0 pound per acre and with tebuthiuron at 0.5 to 1.0 pound per acre during dry years.*

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*The authors express sincere appreciation to The Texas Agricultural Extension Service personel who assisted with these studies, including George Sultemeier, Billy Reagor, Robert Steger, Arthur Barlemann, Jerry Swift, and Rex Jones.

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Table 1. Mean Control (%) of Bitterweed on James Powell Ranch Near Ft. McKavett at 354 Days After Application of Various Herbicides and Herbicide Combinations on April 22, 1977.

Herbicides	Rate (lb/acre)	Control[1/] at 354 days (%)
Check (untreated)	-	50.7 a[2/]
Dicamba + 2,4-D (1:3)	1.0	77.2 b
2,4-D ester	1.0	81.2 b
2,4,5-T + picloram (1:1)	0.5	88.4 bc
Picloram	0.25	89.1 bcd
Picloram	0.5	92.1 bcd
2,4,5-T + picloram (1:1)	1.0	96.9 cd
Picloram	1.0	98.8 d

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

[2/] Means followed by similar lower case letters are not significantly different at the 5% probability level.

Table 2. Mean Control (%) of Bitterweed on Bill Pfluger Ranch Near San Angelo at 489 Days After Application of Various Herbicides and Herbicide Combinations on December 7, 1976.

Herbicides	Rate (lb/acre)	Control[1/] at 489 days (%)
Carrier (diesel oil)	1.0 gal/acre	40.5 a[2/]
Check (untreated)	-	38.7 a
2,4-D ester	1.0	47.0 ab
2,4,5-T + picloram (1:1)	0.5	68.6 bc
2,4,5-T + picloram (1:1)	1.0	69.1 bc
Picloram	0.5	69.0 bc
Dicamba + 2,4-D (1:3)	1.0	71.2 bc
Picloram	0.25	73.8 bcd
Picloram	1.0	90.0 cd
Tebuthiuron	0.5	93.5 cd
Tebuthiuron	1.0	96.2 d

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

[2/] Means followed by similar lower case letters are not significantly different at the 5% probability level.

PR-3510

ASSOCIATION BETWEEN BITTERWEED DOSE, VOLUNTARY FEED INTAKE AND SOME BLOOD SERUM CONSTITUENTS OF SHEEP

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INTRODUCTION

Bitterweed (*Hymenoxys odorata*) poisoning has been described as the most important poisonous plant problem in sheep production in Texas (1). A number of excellent research papers have defined the bitterweed problem and described the pathology of acute, subacute and chronic bitterweed poisoning (1,4,6,7). The toxicity of bitterweed has been routinely assessed by determination of its LD_{50} value (dose required to kill 50% of the sheep). Reported acute LD_{50} values for air-dried bitterweed vary from 0.36 to 0.65% of body weight. The reason for this variation is unknown, but most likely involves both plant and animal factors. Plant factors may be phenological stage, growing conditions, location at which the plant was collected, manner in which the plant was dried and stored and portion(s) of the plant fed. Animal factors would be related to individual differences in susceptibility to bitterweed toxicity, type of diet and age and condition of the sheep. LD_{50} determinations are time consuming and expensive. An alternative physiological or biochemical measurement responsive to bitterweed dose (hymenoxon concentration) would be of considerable value in screening bitterweed treatments.

Unfortunately, aside from death of the animal, reliable biochemical and/or physiological measurements indicative of chronic bitterweed toxicity have not been identified. In acute poisoning, a number of biochemical constituents of blood have been reported to change. Packed cell volume, hemoglobin, total serum protein, blood urea nitrogen and serum glutamic-oxalacetic transaminase reportedly were increased in some poisoned sheep (1). And, in another study in which a single oral dose of bitterweed was administered to produce acute poisoning, the major physiopathologic changes prior to death

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were a decrease in blood sugar and pH and an increase in blood lactic acid and pyruvic acid levels (7). In addition to the above, bitterweed intake has also been reported to suppress appetite (4). Apparently, no attempt has been made to quantify the dose-response relationships between bitterweed and these observed biochemical and/or physiological changes to determine their suitability for assessing toxicity of bitterweed and response to bitterweed treatments.

The purpose of this research was to examine these relationships under defined laboratory conditions during subacute bitterweed toxicity.

EXPERIMENTAL PROCEDURE

The bitterweed used in these studies was obtained from two locations. Material for the first study was collected on the Bill Pfluger Ranch in south-central Tom Green County on March 11, 1977. The second collection was made at H & H Cattle Co. Ranch on the Robert Lee Highway about 2 miles N.E. of Sterling City on April 25, 1977. Bitterweed plants collected from both locations were 6 to 9" tall. Few flowers were evident in plants from the Pfluger Ranch, but the bitterweed was in full flower at the H & H Cattle Co. location. After initially drying for several days at room temperature (spread out on screens to allow air movement), the bitterweed was dried overnight at 60° C in a force-draft oven and then ground to pass through a 1 mm screen.

The first experiment involved 12 lambs (62.8 ± 2.1 lb initial live weight) fed material collected from the Bill Pfluger Ranch; 12 lambs (65.2 ± 2.6 lb initial live weight) were fed material from H & H Cattle Co. in the second experiment. In both experiments, lambs were individually restrained and fed a 70% concentrate - 30% peanut hull ration [1/], which was available *ad libitum* from 8:00 a.m. to 4:00 p.m. each day. Lambs were then released for the remainder of the day for exercise and to allow easier observation of signs of bitterweed toxicity.

Four levels of bitterweed (air-dry basis) were used: 0, .066, .132 and .264% of live weight. The bitterweed was administered as a single dose (by stomach tube in a water suspension) at approximately 8:30 a.m. each day for 10 days. Control lambs (0 level of bitterweed) were given an equivalent amount of water and dehydrated alfalfa via stomach tube.

Lambs were observed for signs of bitterweed toxicity at 8:30 a.m., 4:30 p.m. and one hour after administration of the daily bitterweed dose. More frequent observations were made when deemed desirable as the experiments progressed. All lambs that were moribund or found dead were posted.

[1/] The complete percent ingredient composition of the experimental diet was sorghum grain (dry rolled), 55.1; peanut hulls, 30.0; cottonseed meal, 7.5; molasses, 4.0; calcium carbonate, 1.4; salt, 0.5; vitamin and mineral premix, 1.0 and ammonium chloride, 0.5.

Blood samples (for serum) were collected by jugular venipuncture, initially, just prior to the first bitterweed dose, and again when the majority of the lambs on the highest bitterweed dose showed definite signs of toxicity (the morning of the 6th day for Experiment 1 and on the 7th day for Experiment 2). Serum samples were stored frozen and sent to the Texas Veterinary Medical Diagnostic Laboratory at College Station, Texas, to be run on their automated serum analyzer (SMA 12). Measurements were made of the following blood serum constituents: total protein, albumen, calcium, inorganic phosphorus, glucose, blood urea nitrogen, creatinine, alkaline phosphatase, creatine phosphokinase, lactic dehydrogenase, glutamic-oxalacetic transaminase and total bilirubin.

Lambs were weighed at the beginning and end of each experiment and feed intake was recorded daily.

Hymenoxon concentrations of the bitterweed were determined by gas chromatography (3).

In the statistical treatment of the data, covariance analyses were used to test the association between initial and final blood values and adjust final values to remove variation due to differences in initial values (2,5). The analysis of variance was run on the adjusted values. Regression analyses were used to separate the linear, quadratic and residual effects of bitterweed dose.

Since a reduction in feed intake due to bitterweed dose might also change the concentrations of blood serum constituents, in a separate experiment, feed was removed from four lambs and both feed and water removed from another four lambs for a four-day period, to determine the effect on blood serum values.

RESULTS

The hymenoxon concentrations of the bitterweed used were 2.33 and 1.24% for Experiments 1 and 2, respectively.

Administration of bitterweed as a single dose by stomach tube produced an immediate reaction, particularly at the highest dose (.264%). The sheep's ears drooped and the neck and head were slightly extended. However, this was a temporary resonse as subsequent checks on the sheep during the first day of dosing revealed no apparent ill effects. A similar response was observed on subsequent days when the sheep were dosed. In Experiment 1, all sheep on the highest bitterweed dose were completely off feed after the third dose. They appeared listless or depressed and unless disturbed, remained lying most of the time. Vomiting of rumen-bitterweed contents was evident in a couple of instances but did not appear to be a serious problem, as the sheep kept most of the bitterweed dose down. By the fourth day, foaming at the mouth was evident and sheep on the highest bitterweed level were unsteady. Administration of the daily bitterweed dose was continued and

the sheep receiving bitterweed at the level of .264% of their live weight died on days 7, 8 and 9 of the first experiment. Post-mortem examination in each case revealed gross pathological changes typical of bitterweed poisoning. Actual cause of death was generally aspiration pneumonia. Sheep on the two lower bitterweed levels (.066 and .132%) showed little effect and none died.

The hymenoxon concentration of the bitterweed used in Experiment 2 was much lower. Lambs on the highest bitterweed level continued to consume some feed until the 7th day. Other signs of bitterweed toxicity were less dramatic than observed in Experiment 1 and none of the lambs died.

Bitterweed depressed feed intake in both experiments (Figures 1 and 2). Although there were considerable day to day variations in feed intake, from the second day on, reductions in voluntary feed intake were proportional to bitterweed levels within experiments (Figure 3) and to hymenoxon levels when the data from both experiments were combined (Figure 4).

The association between bitterweed levels, X, expressed as air-dry bitterweed administered daily as a percent of live weight, and total feed intake, in pounds, for a four day period (days 2 through 5), Y, for Experiment 1 was $Y = 11.6 - 66.5X$, $r = -.79$, $P<.05$; the equation for Experiment 2 was $Y = 10.5 - 34.6X$, $r = -.90$, $P<.01$. Since in Experiment 1, appetite was completely suppressed by the highest level of bitterweed, the data from these three lambs were excluded from these calculations. The ratio of the slopes of these two equations is 1.92, a value very close to the ratio of the hymenoxon concentrations of the bitterweed used in these studies (1.88). Based on this, it appears that measurement of feed intake suppression might be useful in assessing bitterweed toxicity. Additionally, such measurements could be made in a five-day period, providing a convenient, short-term assay for screening response to bitterweed treatments.

The association between hymenoxon dose, X, (in mg hymenoxon per pound live weight per day) and total feed intake, Y, (in pounds for the period day 2 through 5) is linear up to the point where feed intake ceases. The response is $Y = 11.0 - .62X$, $r = -.83$, $P<.01$.

A summary of the average initial values, range in values and standard error of the mean (SEM) for the blood biochemical constituents analyzed are presented in Table 1. The effect of feed and water restriction on the same blood serum constituents are given in Table 2. The effects on serum constituents were similar, regardless of whether feed or feed and water were withdrawn; therefore, the data from the eight lambs were pooled in Table 2.

A summary of the effects of bitterweed dose on the blood serum constituents measured are presented in Table 3, for Experiment 1, and Table 4, for Experiment 2. A number of significant linear and quadratic responses were obtained. The bitterweed used in Experiment 1, with a 1.09% higher hymenoxon level, gave a greater number of significant

responses. However, considerable variation in individual susceptibility to bitterweed toxicity is evidenced in both experiments by the range in values observed. This is particularly noticeable at the highest level of bitterweed and probably is the major factor for the inconsistency in significant responses observed between experiments.

There was a linear decrease in total protein and albumen with increasing bitterweed dose in both experiments. This response is particularly significant, since feed and water restriction increased both parameters. However, comparison of the response slopes for the two experiments does not show the correlation with hymenoxon level demonstrated by the voluntary feed intake data (Table 5 and Figure 3).

Serum urea nitrogen, creatinine and total bilirubin levels were increased as bitterweed dose increased. However, the responses were only significant for Experiment 1 (Tables 3,4 and 5). Feed and water restriction did not change urea nitrogen but increased slightly creatinine and total bilirubin levels (Table 2). The increases in both creatinine and total bilirubin were much greater with bitterweed administration than was caused by feed and water restriction.

Alkaline phosphatase, lactic dehydrogenase and glutamic-oxalacetic transaminase enzyme activities were increased, particularly at the highest bitterweed dose (Tables 3 and 4). These effects were due to bitterweed, as they were not changed by feed and water restriction (Table 2).

Changes in calcium, inorganic phosphorus, and glucose concentrations and alkaline phosphatase enzyme activity were similar to those produced by feed and water restriction and probably were unrelated to bitterweed treatments.

The experimental approach used in this study involving dosing sheep with known amounts of bitterweed instead of feeding it as part of the diet effectively eliminates variation in bitterweed and feed intake related to the effect of bitterweed on the palatability of the diet. This approach allows measurement of the effect of constant daily bitterweed dose on voluntary feed intake independent of its effect on feed palatability. The dose related depression in *ad libitum* feed consumption observed in this study shows promise as a basis for a short-term assay for assessing the value of various treatments for reducing bitterweed toxicity. Although depression in voluntary feed intake appears to be more sensitive than the blood serum constituents measured, a number of these, such as total protein, urea nitrogen, creatinine and the serum enzymes, lactic dehydrogenase and glutamic-oxalacetic transaminase are relatively easy to measure and would provide additional insight into the reduction in toxicity related to various bitterweed treatments or other preventative management practices.

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TABLE 1. AVERAGE INITIAL VALUES, RANGES, AND STANDARD ERRORS (S.E.M.) FOR A NUMBER OF BLOOD SERUM CONSTITUENTS IN SHEEP

CRITERION	EXPERIMENT 1	S.E.M.	EXPERIMENT 2	S.E.M.
Total Protein, g/100 ml	6.08 (4.9-7.5)	.194	6.01 (5.4-6.8)	.113
Albumen, g/100 ml	2.96 (2.51-3.40)	.075	3.09 (2.58-3.38)	.064
Calcium, mg/100 ml	10.06 (9.61-10.42)	.078	10.13 (9.30-11.38)	.179
Inorganic Phosphorus, mg/100 ml	8.18 (6.89-10.67)	.30	8.91 (6.20-10.32)	.358
Glucose, mg/100 ml	75.9 (62-91)	2.74	89.3 (72-101)	2.57
Urea Nitrogen, mg/100 ml	11.18 (7.8-21.2)	.91	10.09 (5.8-15.5)	.92
Creatinine, mg/100 ml	.73 (.61-.90)	.027	.82 (.70-.94)	.017
Total Bilirubin, mg/100 ml	.30 (.18-.57)	.052	.13 (.09-.20)	.011
Alkaline Phosphatase, IU/1	234 (84-378)	26.6	180 (100-293)	14.4
Creatine Phosphokinase, IU/1	179 (138-251)	11.0	179 (125-330)	17.0
Lactic Dehydrogenase, IU/1	578 (406-682)	26.8	510 (464-630)	16.7
Glutamic-Oxalacetic Transaminase, IU/1	132 (97-164)	6.06	135 (98-239)	10.7

TABLE 2. EFFECT OF FEED AND WATER RESTRICTION ON MEANS, RANGES, AND STANDARD ERRORS OF A NUMBER OF BLOOD SERUM CONSTITUENTS

CRITERION	INITIAL	S.E.M.	FINAL	S.E.M.
Total Protein, g/100 ml	6.02 (5.3-7.0)	.203	7.14 (6.0-8.0)	.236
Albumen, g/100 ml	3.01 (2.77-3.19)	.053	3.30 (3.00-3.62)	.078
Calcium, mg/100 ml	10.08 (9.43-11.00)	.170	9.40 (9.20-9.67)	.053
Inorganic Phosphorus, mg/100 ml	7.83 (4.75-10.31)	.615	9.74 (7.51-11.39)	.523
Glucose, mg/100 ml	120 (95-140)	6.01	65 (47-772)	2.97
Urea Nitrogen, mg/100 ml	21.7 (19.0-30.4)	1.34	22.4 (19.5-28.9)	1.24
Creatinine, mg/100 ml	.82 (.70-1.00)	.034	1.00 (.88-1.05)	.022
Total Bilirubin, mg/100 ml	.11 (.09-.12)	.003	.32 (.25-.40)	.016
Alkaline Phosphatase, IU/1	171 (43-452)	43.8	111 (57-193)	15.6
Creatine Phosphokinase, IU/1	164 (124-204)	9.69	176 (114-227)	15.5
Lactic Dehydrogenase, IU/1	497 (364-700)	40.6	474 (385-617)	26.2
Glutamic-Oxalacetic Transaminase, IU/1	130 (78-186)	12.0	142 (120-193)	7.95

TABLE 3. EFFECT OF BITTERWEED DOSE ON SOME BLOOD SERUM CONSTITUENTS (EXPERIMENT 1)[a/]

CRITERION	BITTERWEED DOSE (AIR DRY BASIS) % Live Weight 0.0	.066	.132	.264	S.E.M.	Statistical Comments[b/]
Total Protein, g/100 ml	6.3 (6.2-6.5)	5.9 (5.7-6.4)	5.7 (5.4-5.8)	5.5 (5.0-5.9)	.10	L, P<.05
Albumen, g/100 ml	3.1 (2.7-3.3)	2.9 (2.7-3.0)	2.8 (2.6-2.9)	2.7 (2.6-2.7)	.06	L, P<.05
Urea Nitrogen, mg/100 ml	13.3 (10.3-16.2)	14.7 (11.4-15.3)	20.4 (17.2-26.4)	53.2 (49.9-58.4)	1.3	Q, P<.01
Creatinine, mg/100 ml	.65 (.54-.78)	.75 (.71-.78)	.85 (.77-.96)	1.72 (1.22-2.16)	.08	L, P<.01
Total Bilirubin, mg/100 ml	.18 (.15-.20)	.23 (.17-.28)	.20 (.15-.23)	.57 (.40-.92)	.05	L, P<.05
Creatine Phosphokinase, IU/1	158 (132-175)	176 (104-244)	149 (125-166)	207 (199-205)	12.5	N.S.
Lactic Dehydrogenase, IU/1	554 (408-726)	504 (467-560)	466 (452-491)	854 (501-1070)	56.6	N.S.
Glutamic-Oxalacetic Transaminase, IU/1	163 (94-274)	139 (124-147)	126 (103-146)	456 (251-660)	36.7	Q, P<.05

[a/] Final blood serum values adjusted by covariance for initial values.

[b/] L = Significant linear effect; Q = Significant quadratic effect and N.S. indicates no significant bitterweed dose response.

TABLE 4. EFFECT OF BITTERWEED DOSE ON SOME BLOOD SERUM CONSTITUENTS (EXPERIMENT 2)[a/]

CRITERION	BITTERWEED DOSE (AIR DRY BASIS) % Live Weight 0.0	.066	.132	.264	S.E.M.	Statistical Comments[b/]
Total Protein, g/100 ml	6.6 (6.4-6.8)	6.5 (6.2-6.8)	5.8 (5.4-6.1)	5.7 (5.2-6.3)	.12	L, P<.05
Albumen, g/100 ml	3.3 (3.2-3.3)	3.2 (3.1-3.3)	3.1 (2.9-3.2)	2.7 (2.8-3.0)	.07	L, P<.05
Urea Nitrogen, mg/100 ml	20.9 (15.3-25.0)	21.1 (17.7-24.2)	18.3 (12.0-28.9)	36.8 (23.6-61.9)	3.9	N.S.
Creatinine, mg/100 ml	.98 (.79-1.31)	.68 (.12-1.01)	1.39 (0-2.86)	2.66 (1.41-4.88)	.40	N.S.
Total Bilirubin, mg/100 ml	.16 (.12-.19)	.11 (.08-.13)	.15 (.10-.21)	.75 (.21-1.82)	.15	N.S.
Creatine Phosphokinase, IU/1	147 (139-152)	186 (161-214)	180 (160-200)	235 (186-298)	10.8	L, P<.05
Lactic Dehydrogenase, IU/1	476 (402-602)	538 (448-612)	551 (461-648)	634 (520-742)	32.2	N.S.
Glutamic-Oxalacetic Transaminase, IU/1	143 (119-172)	140 (114-156)	297 (140-598)	374 (141-623)	57.5	N.S.

[a/] Final blood serum values adjusted by covariance for initial values.

[b/] L = Significant linear effect; Q = Significant quadratic effect and N.S. indicates no significant bitterweed dose response.

TABLE 5. EQUATIONS FOR THE RELATIONSHIPS BETWEEN DAILY BITTERWEED INTAKE (EXPRESSED AS AIR DRY BITTERWEED AS A PERCENT OF LIVE WEIGHT) AND SOME BLOOD SERUM CONSTITUENTS OF SHEEP

Criterion	Experiment 1		Experiment 2	
	Equation	C.D.[a/]	Equation	C.D.[a/]
Total Protein, g/100 ml	$Y = 6.2 - 3.1X$, $P<.05$	.562	$Y = 6.6 - 3.8X$, $P<.05$	.533
Albumen, g/100 ml	$Y = 3.0 - 1.6X$, $P<.05$	.449	$Y = 3.3 - 2.1X$, $P<.05$	.593
Urea Nitrogen, mg/100 ml	$Y = 13.5 - 37.9X + 713X^2$, $P<.01$	.960	Not Significant	
Creatinine, mg/100 ml	$Y = .52 + 4.2X$, $P<.01$	.722	Not Significant	
Total Bilirubin, mg/100 ml	$Y = .12 + 1.5X$, $P<.05$	.490	Not Significant	
Creatine Phosphokinase, IU/1	Not Significant		$Y = 163 + 1040X$, $P<.05$	.476
Glutamic-Oxalacetic Transaminase, IU/1	$Y = 171 - 1482X + 9659X^2$, $P<.10$	.672	Not Significant	

[a/] Coefficient of determination. This value is an estimate of the variation in Y (change in Y values) due to variation in X (increasing bitterweed dose).

FIGURE 1. (EXPERIMENT 1)

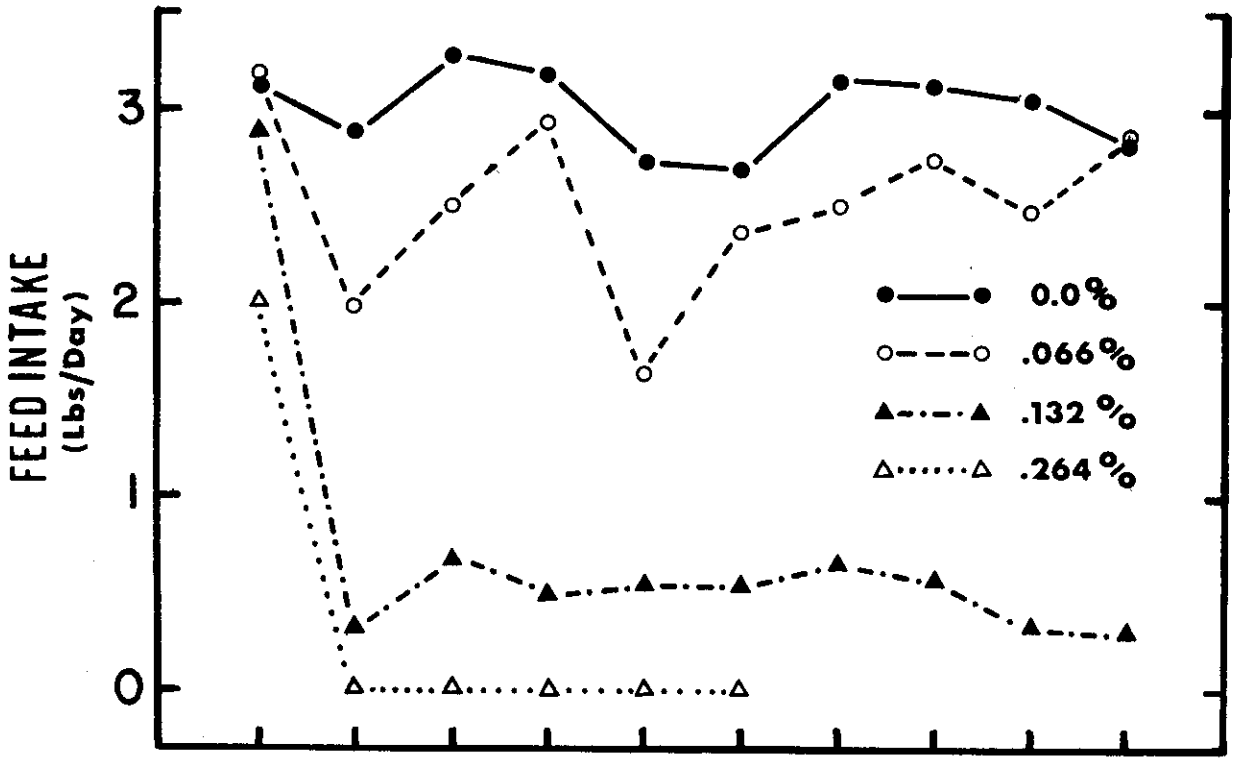


FIGURE 2. (EXPERIMENT 2)

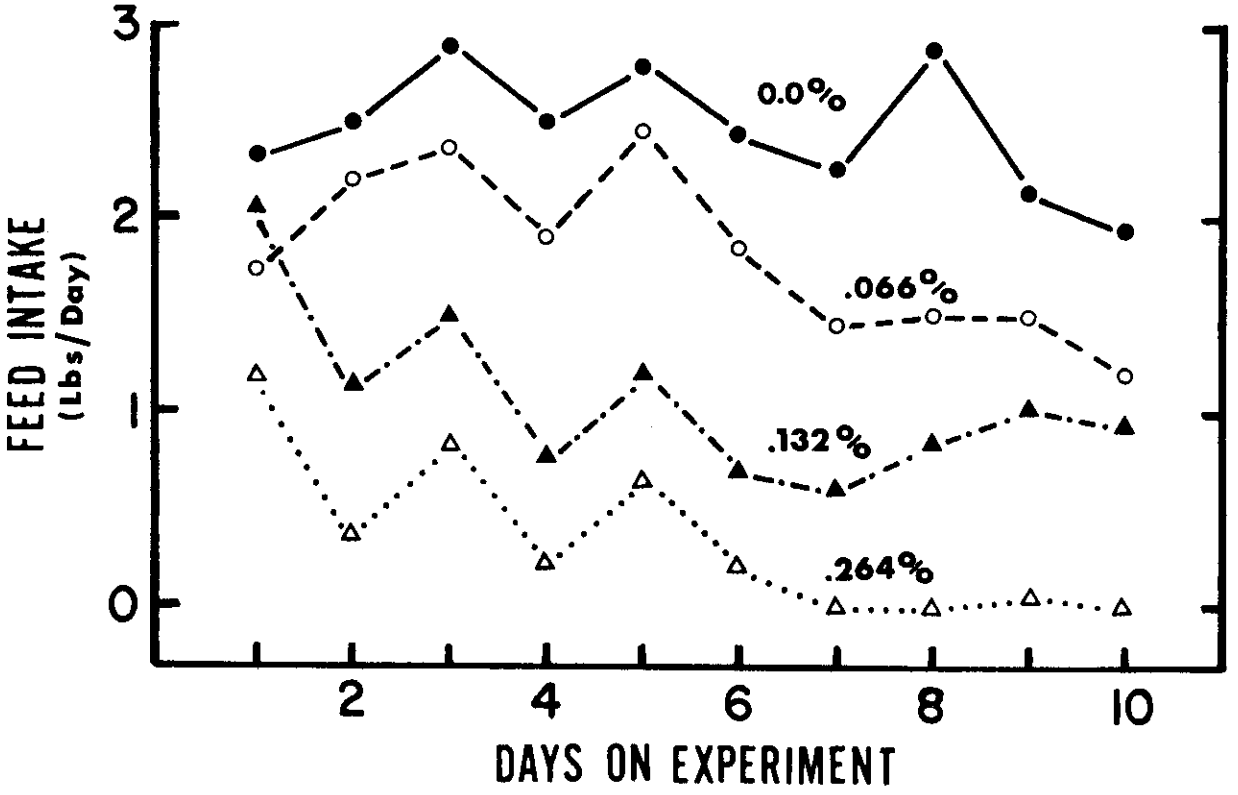


FIGURE 3.

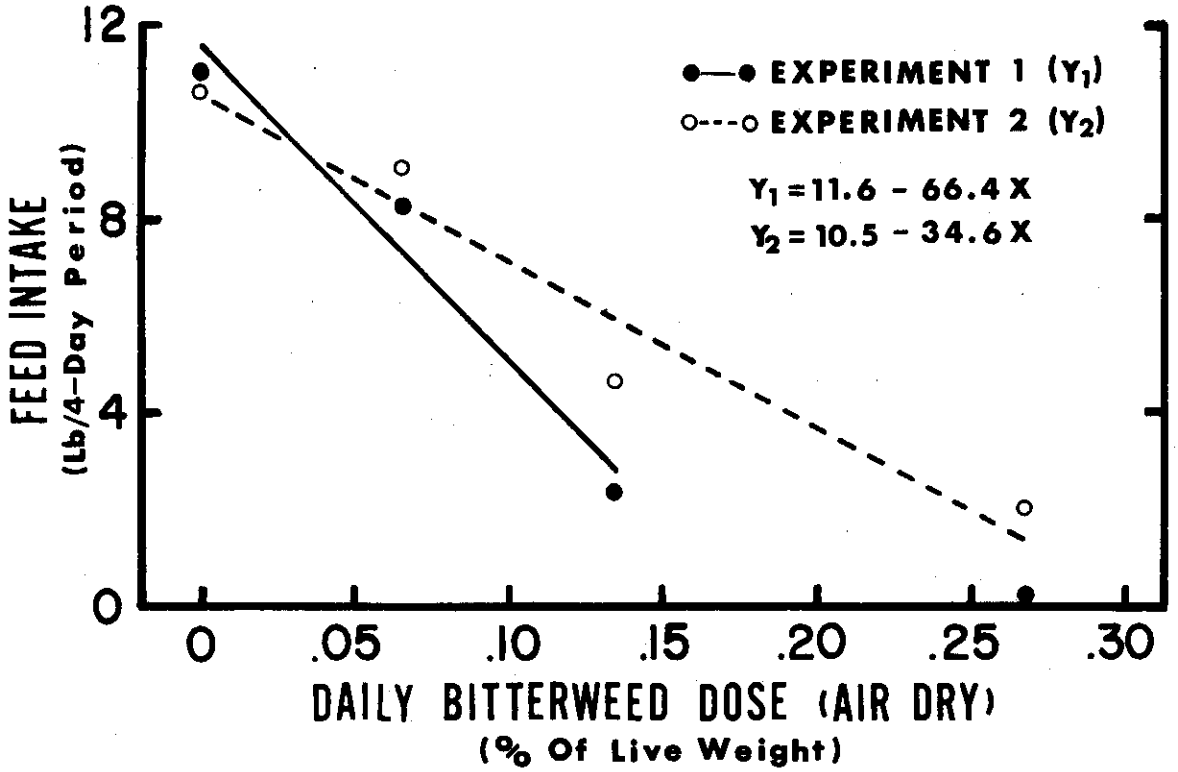
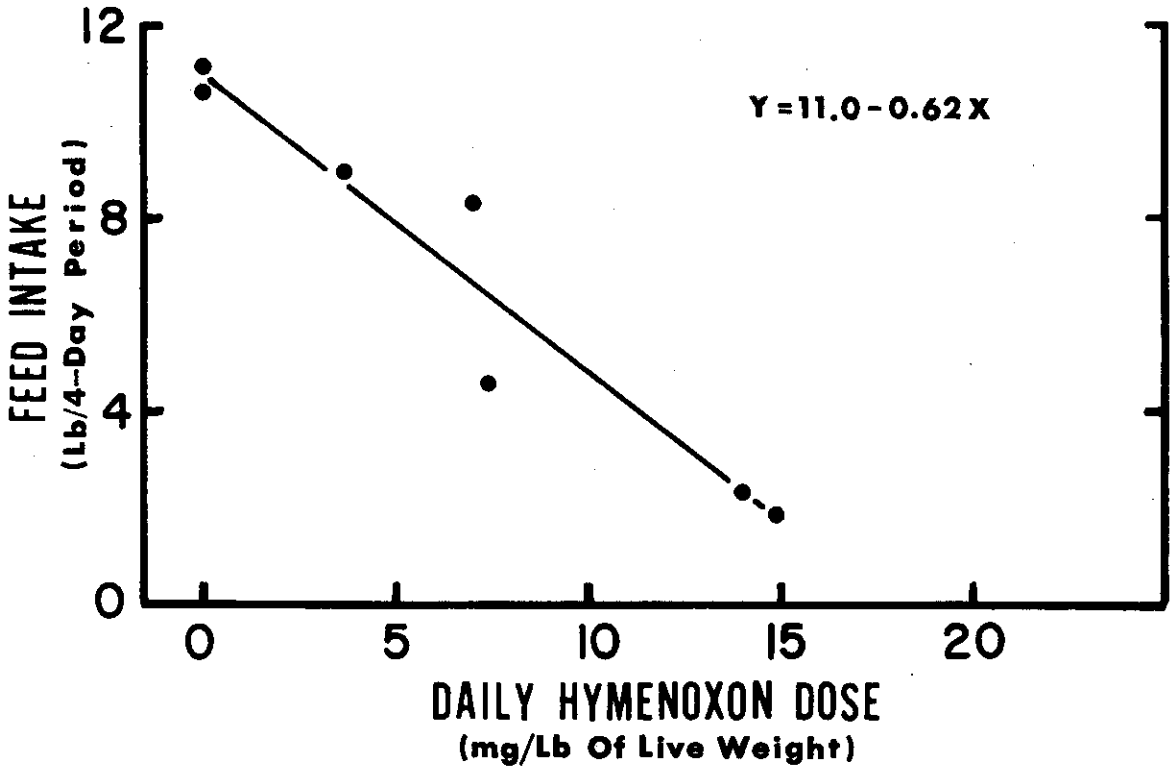


FIGURE 4.



PR-3511

EFFECT OF SPRAYING WITH 2,4-D ON HYMENOXON CONCENTRATION AND TOXICITY OF HARVESTED BITTERWEED FED TO SHEEP

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INTRODUCTION

In certain years, bitterweed poisoning is a severe problem to sheep producers in Texas. A report of the Southwestern Animal Health Research Foundation, issued in 1962, estimated the annual loss from bitterweed poisoning to be $3,570,000. Because of this, the Texas Agricultural Experiment Station and the Texas Agricultural Extension Service have conducted studies to examine management practices for reducing bitterweed toxicity problems. These have ranged from those involving grazing systems, herbicide treatments and various range supplements and feed additives to more basic studies to define the toxic principle present in the bitterweed plant. Although grazing a combination of cattle and sheep, use of deferred rotation systems and herbicide treatments have been effective in reducing bitterweed problems; as yet, there is not an effective means of preventing losses when sheep are consuming bitterweed.

Recently, Merrill (5) reported that spraying bitterweed with 2,4-D at 1 pound/acre (acid equivalent) enabled sheep to consume the weed without apparent harm to the animals and greatly increased the palatability of bitterweed. This observation was made initially in 1974, when a ewe flock was allowed to intensively graze a bitterweed pasture one day after spraying with 2,4-D. It was estimated each ewe consumed a minimum of 100 pounds of bitterweed during a 50-to 60-day period following spraying.

Boughton and Hardy (1) determined that the acute median lethal dose (LD_{50}) of fresh green seedling plant growth during a year of normal rainfall and range vegetation was approximately 1.3% of a sheep's body weight. During drought conditions, the acute LD_{50} may

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Appreciation is expressed to Dr. C.J. Scifres, Professor, Department of Range Science, College Station, Texas for determination of the 2,4-D (2,4-dichlorophenoxyacetic acid) concentrations of bitterweed used in these experiments and to Dr. John C. Reagor (Texas Veterinary Medical Diagnostic Laboratory) for analyses of serum constituents. The cooperation of Bill Pfluger and S.K. Horwood (H and H Cattle Co.) in allowing collection of bitterweed plants from their respective ranches is also appreciated.

be 0.5% of a sheep's body weight. In addition, the bitterweed toxin has been demonstrated to be cumulative when less than the acute LD_{50} is consumed for a number of days (6).

Therefore, the level of intake observed by Dr. Merrill should have been lethal to sheep. This study was repeated in 1975 and 1976, with similar results. However, because of palatability problems with bitterweed in unsprayed plots, the sheep ate much less of the unsprayed weeds present, and no deaths occurred among sheep grazing unsprayed bitterweed.

The purpose of this research was to confirm the observation that spraying bitterweed with 2,4-D decreases its toxicity. To determine this, sheep were force-fed sprayed and unsprayed bitterweed under controlled conditions in confinement.

EXPERIMENTAL PROCEDURE

Bitterweed growing at two locations was sprayed with 2,4-D during the spring of 1977. These collections were handled separately and subsequently force-fed to sheep in two experiments to determine the effect of spraying with 2,4-D on bitterweed toxicity.

The material for the first experiment was collected from the Bill Pfluger Ranch in south-central Tom Green County. Four separate plots ranging in size from .05 to .1 acre were sprayed with 2,4-D on March 7, 1977. The herbicide used was Transvaal Weed-Rhap A-4D (dimethylamine salt of 2,4-D), which was applied at a rate of one pound acid equivalent per acre. Water was used as a carrier (150 gal/acre) with 0.1% non-ionic type spreader and activator (Chevron's Ortho X-77 Spreader).

Four days later (March 11), when the bitterweed showed definite signs of herbicide phytotoxicity (epinasty and turgidity), the sprayed bitterweed was hand clipped and dried and stored as previously described (2). Approximately equal amounts were collected from each of the four plots. A similar amount of unsprayed bitterweed was collected from areas adjacent to the sprayed plots.

Bitterweed for the second experiment was collected from the H and H Cattle Co. Ranch on the Robert Lee Highway about 2 miles N.E. of Sterling City, Texas. In this case, the herbicide used was Transvaal Weed-Rhap LV-4D (ethylhexyl ester of 2,4-D) applied at a rate of one pound 2,4-D acid equivalent per acre. The carrier was a diesel oil-water emulsion (15 gal/acre), with a dispersant-activator-emulsifier (Tryad, 0.05%) added. A 20 ft. x 300 ft. plot was sprayed on April 20, 1977. At five days post-spraying, bitterweed was collected from the sprayed plot and at the same time from an adjacent unsprayed area. The sprayed bitterweed showed slight to moderate epinasty of floral parts. Signs of herbicide phytotoxicity at this location were slight, compared to the 4-day post-spraying signs at the Pfluger Ranch.

The bitterweed sprayed and collected from both locations were 6-9" tall. Few flowers were evident in material from the Pfluger Ranch, but the bitterweed was in full flower at the H and H Cattle Co. location.

Animals and Feeding

The procedures for handling and feeding the sheep in these experiments were the same as previously described (2).

In Experiment 1 (using bitterweed collected from the Bill Pfluger Ranch), 12 lambs were assigned to the unsprayed material and 12 to the 2,4-D sprayed bitterweed. The levels used were 0.0, .066, .132 and .264% of the sheeps' live weight (based on air dry weight of bitterweed). Three lambs were assigned to each level.

In Experiment 2 (H and H Cattle Co.), 12 lambs were assigned to unsprayed bitterweed; however, only enough 2,4-D sprayed material was available to feed three sheep at the highest level (.264%). Three were also assigned to be controls (0 level) for this group. The bitterweed was administered as a single dose (by stomach tube in a water suspension) at approximately 8:30 a.m. each day for a 10-day period (2).

Blood samples (for serum) were collected by jugular venipuncture, initially and again when the majority of the lambs on the highest bitterweed dose showed definite signs of toxicity (6 days, Experiment 1 and on the 7th day for Experiment 2). Serum samples were sent to the Texas Veterinary Medical Diagnostic Laboratory at College Station, Texas to obtain values on the following blood serum parameters: albumen, calcium, inorganic phosphorus, glucose, blood urea nitrogen, creatinine, total serum protein, creatine phosphokinase, lactic dehydrogenase, serum glutamic-oxalacetic transaminase and total bilirubin.

All lambs were weighed to the nearest pound at the beginning and end of each experiment. Feed intake was recorded daily for each lamb. Lambs were observed for signs of bitterweed toxicity at 8:30 a.m., 4:30 p.m. and one hour after administration of the daily dose of bitterweed. More frequent observations were made when deemed desirable as the experiment progressed. Lambs that died were posted by Dr. Charles Livingston to ascertain the cause of death.

Samples of fresh bitterweed from sprayed and unsprayed plots were frozen and later analyzed by gas chromatography for concentrations of 2,4-D. Hymenoxon concentrations of the dried bitterweed were also determined (4).

In addition to the above, 10 individual bitterweed plants were harvested at random from the 2,4-D sprayed area at H and H Cattle Co. on May 9, 1977 (19 days post-spraying) and 10 from the adjacent unsprayed area. Hymenoxon concentrations of the individual plants were measured to provide an estimate of the range in hymenoxon concentrations in individual plants from a single site, as well as an estimate of the effects of 2,4-D on hymenoxon concentrations.

The analysis of variance for a completely random design was used for the statistical treatment of the data (7). Covariance analysis was used to adjust final blood values for variation in initial values. For both experiments, the complete model includes 2,4-D treatment, bitterweed levels and the interaction between 2,4-D treatment and bitterweed levels.

RESULTS AND DISCUSSION

The average live weight of the 24 lambs used in Experiment 1 was 64.2 ± 2.0 pounds. In Experiment 2, the 18 lambs averaged 63.1 ± 1.5 pounds.

Spraying bitterweed with 2,4-D amine in Experiment 1 decreased the hymenoxon content from 2.33 ± .18% to 1.64 ± .05%. The hymenoxon concentration of the more mature bitterweed collected from the H and H Cattle Co. location (Experiment 2) was much lower, 1.24 ± .02%. Spraying with the ethylhexyl ester of 2,4-D only decreased the hymenoxon concentration in this case to 1.08 ± .05%.

Concentrations of 2,4-D (2,4-dichlorophenoxyacetic acid) on the external surface of bitterweed plants, as well as in the plant tissues, were 20.5 and 71.2 ppm for the leaf rinse and tissues, respectively, from material collected for Experiment 1. The calculated plant absorption of 2,4-D was 78%. For the bitterweed sprayed on April 20, collected on April 25 at the H and H Cattle Co. location, the 2,4-D concentrations were 7.6 and 8.0 ppm for the leaf rinse and tissues, respectively; 2,4-D absorption was 51%.

Variation in the hymenoxon levels of individual plants collected at the H and H Cattle Co. Ranch on May 9, 1977, 19 days post-spraying with 2,4-D and the effect of 2,4-D on these toxin levels are shown in Table 1. Average hymenoxon level of the unsprayed bitterweed was similar to that collected earlier from the same site (1.21 ± .073%). However, hymenoxon in sprayed bitterweed had decreased to .65 ± .066%.

Administration of bitterweed as a single dose by stomach tube produced an immediate reaction, particularly at the highest dose (.264%), regardless of 2,4-D treatment. The sheep's ears drooped, and the neck and head were slightly extended. However, this was a temporary response, as subsequent checks on the sheep during the first day of dosing revealed no apparent ill effects. A similar response was observed on subsequent days when the sheep were dosed. In Experiment 1, all sheep on the highest bitterweed dose were completely off feed after the third dose. They appeared listless or depressed, and unless disturbed, remained lying most of the time. Vomiting of rumen-bitterweed contents was evident but did not appear to be a serious problem. By the fourth day, foaming at the mouth was evident, and sheep on the highest bitterweed level were unsteady when standing. Aside from decreased feed intake, sheep on the two lower bitterweed levels (.066 and .132%) showed little effect. The observed response was essentially the same for sheep fed either 2,4-D sprayed or unsprayed bitterweed.

In Experiment 1, the 3 sheep administered the highest bitterweed level, both unsprayed and 2,4-D sprayed, died from bitterweed poisoning. Sheep fed unsprayed bitterweed died on days 7, 8 and 9. Those fed the 2,4-D sprayed bitterweed died on days 6, 7 and 9. Post-mortem examination in each case revealed gross pathological changes typical of bitterweed poisoning. Immediate cause of death, however, was generally aspiration pneumonia.

The hymenoxon concentration of the bitterweed used in Experiment 2 was much lower. Lambs on the highest bitterweed level continued to consume some feed until the 7th day. Other signs of bitterweed toxicity were less dramatic than observed in Experiment 1, and none of the lambs died. Observation of the sheep indicated no differences due to 2,4-D treatment of the bitterweed.

Spraying with 2,4-D did not increase voluntary feed intake. In fact, in Experiment 1, there was a slightly greater reduction in feed intake when the 2,4-D sprayed bitterweed was administered. The associations between bitterweed dose and 4-day total feed intake for the unsprayed and sprayed bitterweed are shown in Figure 1. Each 0.1% increase in bitterweed dose (based on air dry bitterweed as a percent of sheep live weight) decreased total feed intake 8.4 pounds/4-day period, when 2,4-D sprayed bitterweed was administered, but only 6.6 pounds/4-day period, when unsprayed bitterweed was administered. In Experiment 2, only 2 points (each point represents an average of 3 sheep) were available for comparison of the effect of 2,4-D, but these points fell very close to the response line established for the lambs fed unsprayed bitterweed. This is not unexpected, considering the small reduction in hymenoxon level observed in Experiment 2, as a result of 2,4-D spraying. In Experiment 1, on the other hand, previous experience (2), as well as the dose response relationships observed in the present report, suggest an improvement in voluntary feed intake should have been apparent when 2,4-D sprayed bitterweed was administered. The reason that this did not occur is presently unknown. However, hymenoxon is not the only toxic compound that has been isolated from bitterweed. The chemistry and interrelationships of the sesquiterpene lactones is complex, and the effect of 2,4-D on the plant metabolism of these compounds is unknown (3).

Spraying bitterweed with 2,4-D had no significant effect on any of the blood serum constituents measured in either experiment. However, increasing the bitterweed level significantly decreased serum albumen ($P<.10$), but increased urea nitrogen ($P<.01$), creatinine ($P<.05$), lactic dehydrogenase ($P<.01$) and glutamic-oxalacetic transaminase ($P<.01$) in Experiment 1. In Experiment 2, increasing the bitterweed level decreased total serum protein ($P<.01$) and serum albumen ($P<.01$), but increased lactic dehydrogenase ($P<.05$) and glutamic-oxalacetic transaminase ($P<.01$). These effects of increasing bitterweed levels during development of subacute bitterweed toxicity are consistent with those previously reported (2) and have been demonstrated to be due to the administration of bitterweed and not to the fact that sheep force-fed bitterweed go off-feed.

Although, it is evident from this research that spraying bitterweed with 2,4-D significantly reduces the chemically determined hymenoxon level of bitterweed, the results of these studies do not confirm the observations of Merrill (5) that spraying bitterweed with 2,4-D decreases its toxicity. Additional research is required to resolve the difference observed in this study between chemically determined hymenoxon levels and actual toxicity of the material when fed to sheep under controlled experimental conditions, as compared to the results observed over several years with grazing animals (5).

Also, additional measurements are desirable to examine the relationship between time after spraying and hymenoxon levels.

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TABLE 1. HYMENOXON CONCENTRATION (%) OF INDIVIDUAL BITTERWEED PLANTS AND EFFECT OF 2,4-D ON HYMENOXON CONCENTRATIONS

Sample	Unsprayed (%)	2,4-D Sprayed (%)
1	1.23	.68
2	.93	.92
3	1.19	.37
4	1.35	.68
5	1.33	1.05
6	1.27	.61
7	.71	.55
8	1.43	.69
9	1.17	.49
10	1.47	.45
Ave.	1.21	.65
S.E.M.	.073	.066

FIGURE 1. (EXPERIMENT 1)

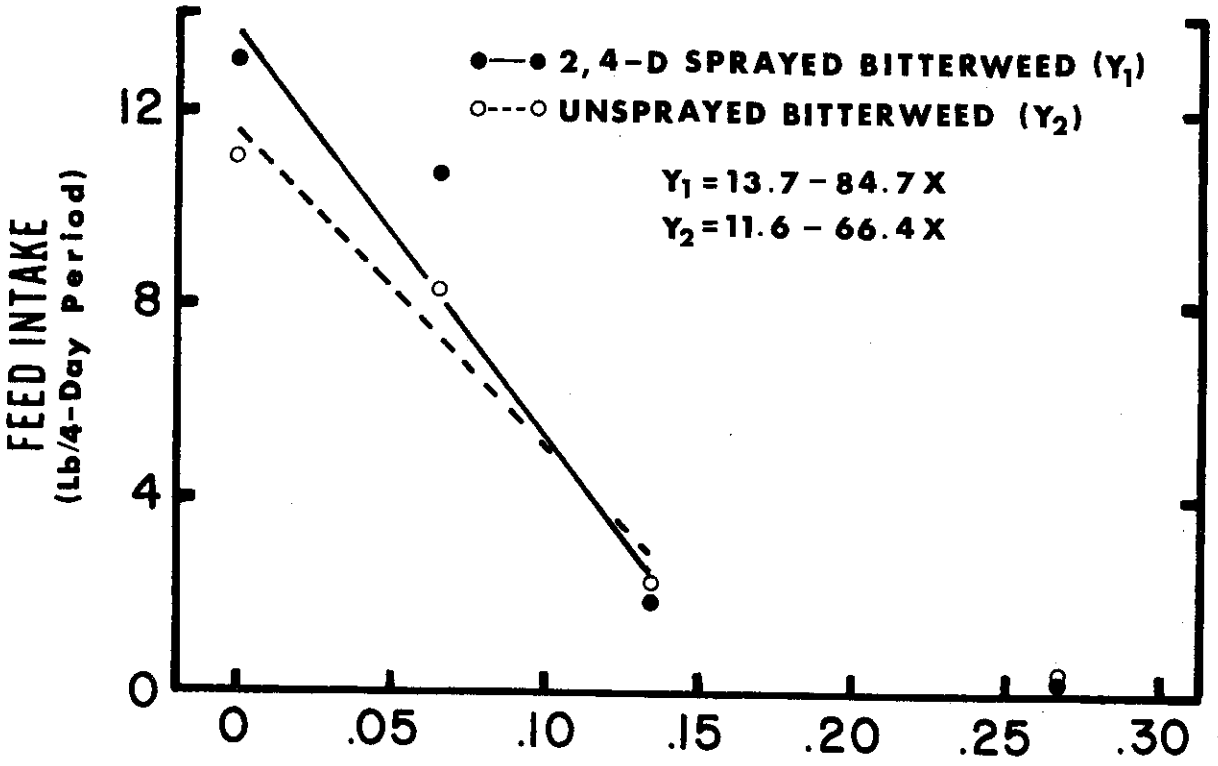
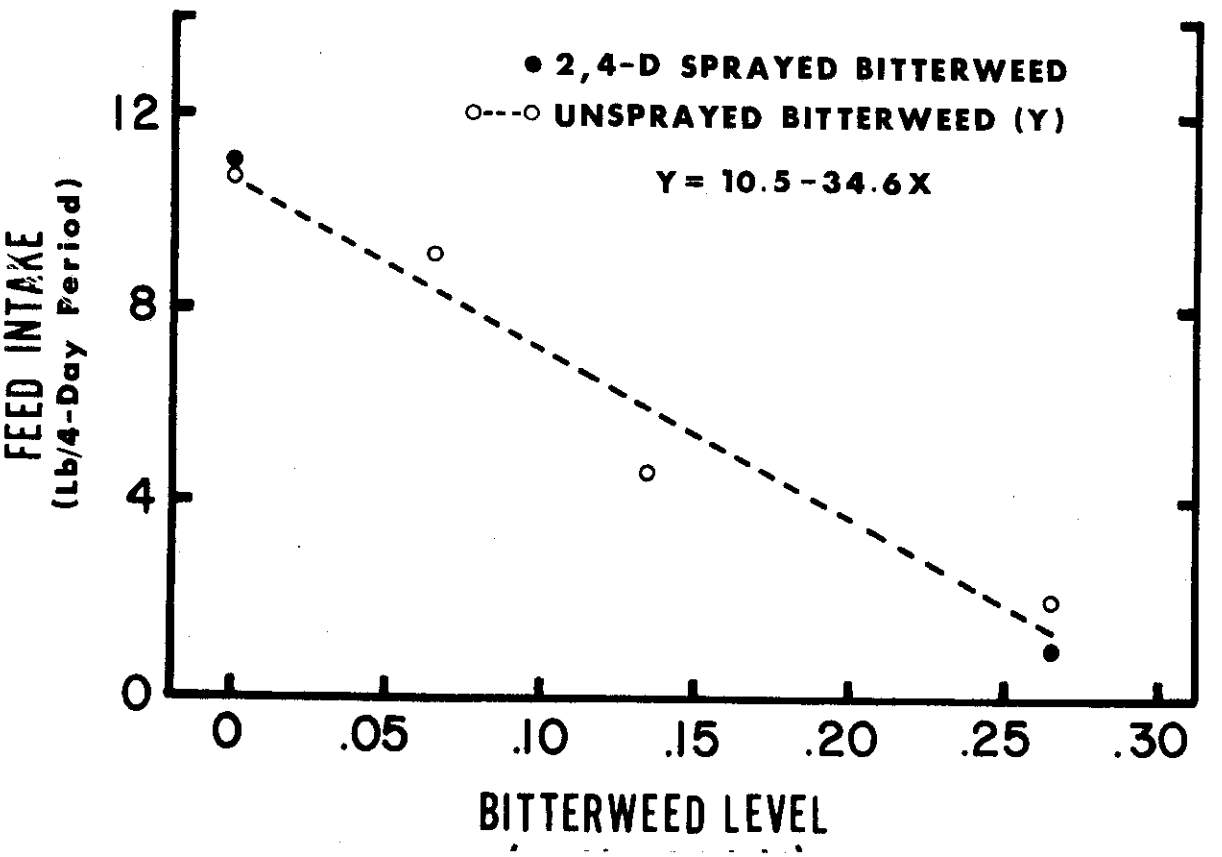


FIGURE 2. (EXPERIMENT 2)



PR-3512

REDUCTION IN BLOOD THIOLS IN SUBACUTE BITTERWEED TOXICITY

M.C. Calhoun, B.C. Baldwin, Jr.
and C.W. Livingston, Jr.*

INTRODUCTION

Ingestion of bitterweed (*Hymenoxys odorata* DC.) by grazing sheep results in toxicity and death. A poisonous α-methylene-γ-lactone (hymenoxon, $C_{15}H_{22}O_5$) has been isolated from bitterweed and demonstrated to be the major toxic principle (7,9). The toxicity of α,β-unstaturated-γ-lactones, such as hymenoxon, is apparently linked to their ability to alkylate sulfhydryl groups of body metabolites and key enzymes (6). Evidence in support of this mode of action of the toxic principle of bitterweed is the systemic antagonistic effect of ℓ-cysteine on the toxicity of hymenoxon administered to dogs (13), hamsters (7) and sheep (1).

Two important thiol compounds present in blood are the amino acid ℓ-cysteine and the tripeptide, glutathione. ℓ-cysteine is present in the plasma, but almost all the reduced (-SH) glutathione is located in the red blood cells (2).

It is not known to what extent hymenoxon penetrates red blood cells, but normally present blood levels of ℓ-cysteine should provide a degree of protection against hymenoxon toxicity. Because of this, it was felt of interest to measure the blood concentrations of thiol compounds in sheep during subacute dosing with varying levels of bitterweed.

A bitterweed dose-related reduction in blood thiol levels would be a more specific blood biochemical change than those previously reported during bitterweed administration, such as serum total protein, blood urea nitrogen and creatinine and the enzymes, creatine phosphokinase, lactic dehydrogenase and glutamic-oxalacetic transaminase (3).

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Appreciation is expressed to Drs. Bennie J. Camp and Hyeong L. Kim (professor and research chemist, respectively, Department of Veterinary Physiology and Pharmacology, College Station, Texas) for suggestions and assistance with the procedure for blood thiol determinations and to Dr. John C. Reagor (Texas Veterinary Medical Diagnostic Laboratory) for analyses of serum constituents.

EXPERIMENTAL PROCEDURES

The experimental procedures followed in feeding and handling the lambs and administering the daily bitterweed dose were essentially as previously described (3,4). The only exceptions were that water consumption was measured, as well as daily feed intake, and an additional three lambs were restricted to the feed and water intake of the three lambs on the highest bitterweed level. Bitterweed (air dry basis) levels were 0, .066, .132 and .264% of live weight, with three lambs assigned to each level of bitterweed. Average initial live weight of the 15 lambs used in this study was 83.7 + 1.6 pound.

Blood samples for determination of thiol concentrations were taken by jugular venipuncture, initially and at 2, 4 and 6 days. Osmolality and hematocrit determinations were obtained on blood samples taken at these times, as well. Serum samples from collections at 0 and 6 days were sent to the Veterinary Medical Diagnostic Laboratory at College Station, Texas, for analyses of serum constituents, as previously described (3).

Determination of blood thiol concentrations was based on the reaction of 6,6'-dithionicotinic acid with free sulfhydryl groups (10), using a procedure suggested by Kim (8).

Total blood thiol concentrations were determined after hemolysis of red blood cells. This procedure measures all free sulfhydryl (-SH) groups reacting with 6,6'-dithionicotinic acid. Extracellular blood thiol concentrations were determined on an unhemolyzed sample of blood. Intracellular concentrations of thiols were obtained by subtracting the amount of extracellular thiols from total blood thiols and then adjusting for variations in hematocrit (packed blood cell volume). This procedure was followed because of the reported increase in hematocrit in lambs poisoned with bitterweed (5) and because it was felt desirable to have an estimate of the effect of hymenoxon on free sulfhydryl concentrations within the red blood cells, which was independent of variations in the percentage of red blood cells present in the sample.

In the statistical treatment of the data, the analysis of variance for a completely random design was used, along with covariance analysis to adjust final serum values for variation in initial values. Regression analysis was used to separate out linear and quadratic effects of increasing bitterweed levels. The least significant difference (lsd,.05) was the criterion used to test for differences in response between lambs administered the .264% bitterweed level and those placed on a restricted feed and water intake (12).

RESULTS AND DISCUSSION

The observed lambs' response to daily bitterweed administration was essentially as previously described (3). One lamb force-fed the highest bitterweed dose (.264% of live weight, air dry basis) died on the fifth day. Cause of death was diagnosed as bitterweed toxicity.

The average initial packed cell volume (hematocrit) was 38.7 ± .67%. There was not a significant increase in hematocrit until the 6th day and then only at the highest bitterweed level. The average hematocrit value for the two remaining lambs on the .264% bitterweed level on day 6 was 49.8%. Restricting feed and water for a 6-day period was without effect on hematocrit values.

Serum osmolality (milliosmols/kg H_2O) averaged 301 ± 1.1, initially. These values, after 6 daily bitterweed doses, were 301, 299, 305, and 314 mOs/kg H_2O for the 0, .066, .132 and .264% levels of bitterweed, respectively. Thus, there was a significant increase in serum osmolality at the two highest bitterweed levels. Feed and water restriction for the same period was without effect on serum osmolality. The final value for the restricted lambs was 302 mOs/kg H_2O.

The values for total, intracellular and extracellular blood thiol concentrations are summarized in Table 1. Thiols measurable within the red blood cells represented 95% of the total thiols present in blood, with only 5% in the extracellular fluid (primarily in the plasma, but also free sulfhydryl groups on the outside surface of blood cells) available for reaction with hymenoxon. Total blood thiols were increased ($P<.05$) on day 4 at the highest bitterweed level (.264%). However, this was due to a hematocrit value of 68% for one lamb, which died the following day. When correction was made for hematocrit, this was no longer the case. On the 6th day, total blood thiols were reduced at the .132 and .264% bitterweed levels, but the difference was not significant ($P>.05$) (Figure 1).

The only effect on intracellular blood thiols was a reduction ($P<.05$) at the .264% bitterweed level on the 6th day. In contrast, there was a tendency for a reduction in extracellular blood thiol levels by the 2nd day. By the 4th day, there was a linear decrease ($P<.10$) in extracellular blood thiols with increasing bitterweed level. This linear relationship was even more apparent on day 6 ($P<.01$). On day 6, the association between daily bitterweed dose, X, (air dry bitterweed as a % of live weight) and extracellular blood thiol levels, Y, (mg-SH/100 ml blood) was expressed by the equation $Y = 1.14-2.49X$, $r = -.91$.

Total feed intake in pounds for the 4-day period, days 2 through 5, was decreased ($P<.01$) by increasing bitterweed levels. Serum albumen was decreased ($P<.05$), whereas blood urea nitrogen ($P<.05$), creatinine ($P<.01$), lactic dehydrogenase ($P<.05$) and glutamic-oxalacetic transaminase ($P<.01$) were increased by increasing bitterweed levels (Table 2). The results in this study are consistent with previous reports on the effects of subacute bitterweed toxicity in sheep (3,4).

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TABLE 1. EFFECT OF FORCE-FEEDING A CONSTANT DAILY BITTERWEED DOSE ON TOTAL, INTRACELLULAR AND EXTRACELLULAR BLOOD THIOL CONCENTRATIONS

	Bitterweed Dose (Air Dry Basis) % Live Weight					
	Day	0	.066	.132	.264	Feed and Water Restricted[a]	S.D.
Extracellular Blood Thiols, mg-SH/100 ml	0	1.18	1.18	1.15	1.16	1.21	.12
	2	1.01	1.02	.91	.89	1.08	.14
	4	1.07	1.01	.92	.85	.99	.13
	6	1.13	.98	.75	.52[c]	1.06	.11
Total Blood Thiols, mg-SH/100 ml	0	25.1	26.8	23.9	23.5	25.6	1.3
	2	24.4	25.2	23.8	25.6	21.8	3.1
	4	24.9	21.2	25.9	29.7[c]	21.3	4.6
	6	20.1	22.8	19.5	19.7	23.7	3.2
Intracellular Blood Thiols, mg-SH/100 ml[b]	0	23.8	24.4	23.3	22.3	25.7	1.7
	2	23.8	23.5	23.1	22.8	20.8	1.7
	4	24.4	20.4	25.6	22.4	21.2	2.3
	6	19.1	20.8	18.6	16.5[c]	23.0	2.8

[a] Feed and water intakes restricted to the amounts consumed by lambs fed .264% level of bitterweed.

[b] Intracellular blood thiol concentrations were adjusted for variation in hematocrit (packed cell volume) after subtracting extracellular blood thiols from total blood thiols.

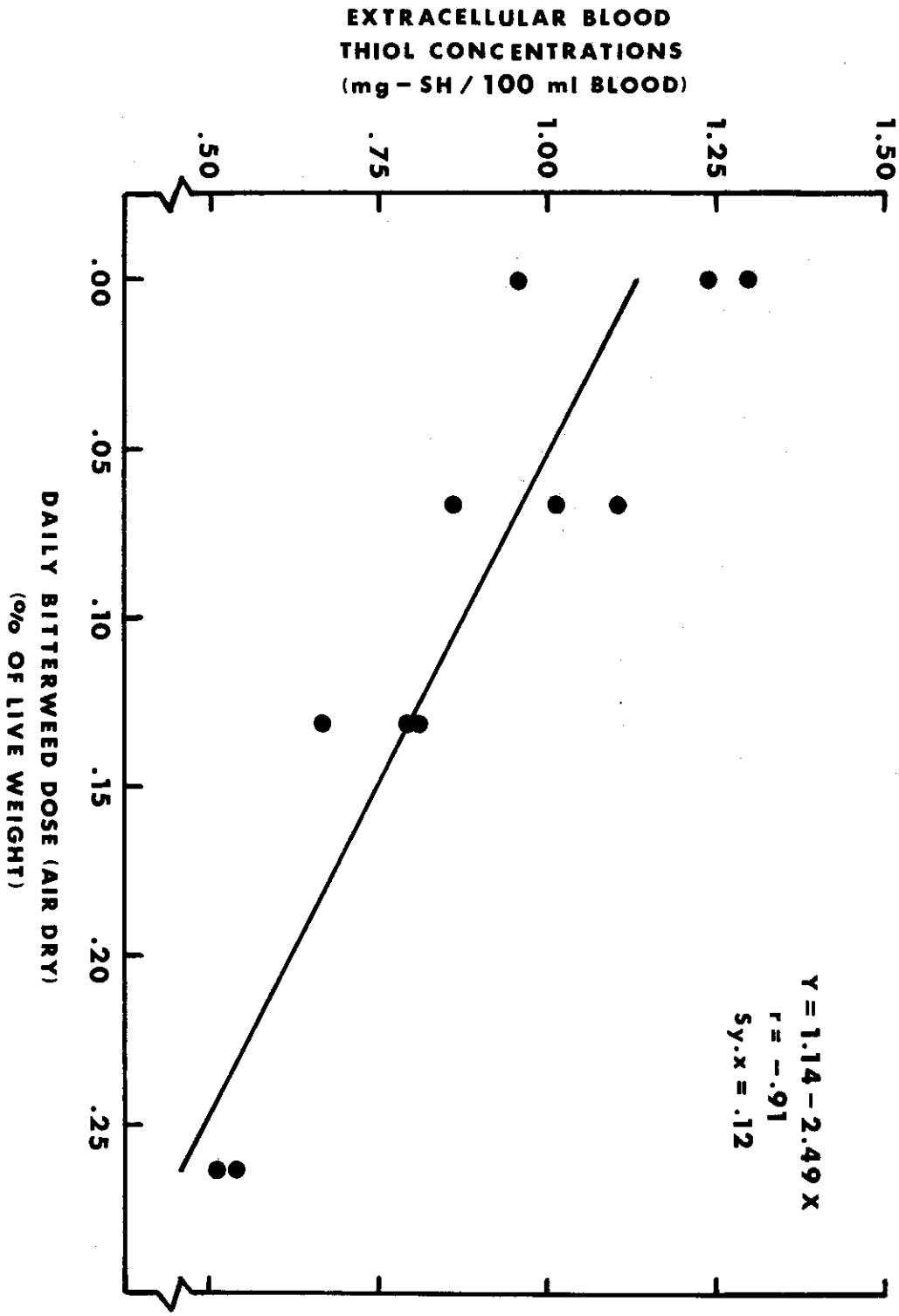
[c] The least significant difference (Steel and Torrie, 1960) was used to compare the effect of feed and water restriction with that produced by the .264% level of bitterweed. The superscript "c" indicates a significant difference due to bitterweed ($P<.05$).

TABLE 2. RELATIONSHIPS BETWEEN DAILY BITTERWEED DOSE[a/] AND FEED INTAKE, EXTRACELLULAR BLOOD THIOL CONCENTRATIONS AND SOME SERUM CONSTITUENTS

Criterion	Equation	Coefficient of Determination[b/]
Total Feed Intake, Lb/4-Day (Y_1)	$Y_1 = 11.8 - 42.3X$, $P<.01$	.876
Extracellular Blood Thiols, mg-SH/100 ml (Y_2)	$Y_2 = 1.14 - 2.49X$, $P<.01$	.831
Serum Albumen, g/100 ml (Y_3)	$Y_3 = 3.10 - 1.85X$, $P<.05$	.401
Blood Urea Nitrogen, mg/100 ml (Y_4)	$Y_4 = 23.1 - 84.7X + 1128.4X^2$, $P<.05$	.852
Creatinine, mg/100 ml (Y_5)	$Y_5 = 1.07 - 11.1X + 94.1X^2$, $P<.01$	.956
Lactic Dehydrogenase, IU/1 (Y_6)	$Y_6 = 508.1 + 882.6X$, $P<.05$	.517
Glutamic-Oxalacetic Transaminase, IU/1 (Y_7)	$Y_7 = 28.0 + 2490.8X$, $P<.01$	.619

[a/] Daily bitterweed dose, X, equals air dry bitterweed as a percent of live weight.

[b/] The coefficient of determination provides an estimate of the variation in Y (change in Y values) due to variation in X (increasing bitterweed dose).


EXTRACELLULAR BLOOD
THIOL CONCENTRATIONS
(mg – SH / 100 ml BLOOD)
.50
.75
1.00
1.25
1.50
.00
.05
.10
.15
.20
.25
DAILY BITTERWEED DOSE (AIR DRY)
(% OF LIVE WEIGHT)
Y = 1.14 – 2.49 X
r = –.91
Sy.x = .12

PR-3513

DIETS OF SHEEP IN THE WESTERN EDWARDS PLATEAU IN RELATION TO HARD YELLOW LIVER DISEASE

D. N. Ueckert, E. M. Bailey, Jr., S. G. Whisenant, and G. L. Adams*

Hard yellow liver disease (hepatic fatty cirrhosis) affects sheep, cattle, goats and antelope in parts of five to seven counties of the western Edwards Plateau resource area of Texas. The disease appears to be of toxic origin. However, about 80 different plants from this area have been fed in various amounts to sheep but have not reproduced the disease symptoms (1). Ohlenbusch (3) speculated that hard yellow liver was caused by a toxic substance or substances in the forages forming the animals' major diet during wet winters and dry spring seasons. He reported that four factors appearing to be correlated with occurrence of the disease were (1) a dominance of Reagan silty clay loam soil; (2) above-normal rainfall in August-October and a wet winter followed by a dry spring; (3) relatively light grazing pressure; and (4) fluctuating nutritional levels in animal diets.

This study was initiated to determine the diets of sheep grazing in the hard yellow liver area and to document the vegetation present in an area in which hard yellow liver frequently occurs.

METHODS

Twenty-five pregnant ewes purchased by the Hard Yellow Liver Committee were placed in a 137-acre pasture furnished by Mr. E. G. Cauble, Jr. in central Reagan County in November 1976. Vegetation surveys were made at approximately monthly intervals on ten permanent sampling transects to determine cover and frequency of plants within the experimental pasture. Fecal samples were collected from all the sheep at approximately monthly intervals and approximate dry weight composition of plants in the sheep diets were determined by microscopic examination of plant epidermal tissues in the samples.[1/] Soil moisture and precipitation were above-normal for most months of the first year of the study (November 1976 through October 1977).

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

1/ Diet determinations were conducted on a contract basis by Dr. Richard M. Hansen's Composition Analysis Laboratory at Colorado State University, Fort Collins, Colorado 80523.

RESULTS

Thirty-three different plants were identified in sheep fecal samples in this study. Diet diversity was highest in February 1977 (18 different foods) and lowest in September and October 1977 (11 different foods). Grasses contributed 53% of the average yearlong diet while forbs contributed 47%. Grasses were most important in sheep diets in December 1976, February, July, August and October 1977, whereas forbs were most important in March, April, May, June, and September 1977. Grasses and forbs were eaten in equal amounts in November 1976.

Buffalograss (Buchloe dactyloides) was the most important single plant in sheep diets, contributing 33.8% of the average annual diet (Table 1). Buffalograss was most important in sheep diets in August 1977 (70.9%) and least important in April 1977 (3.9%). Threeawns (Aristida spp.) contributed 5.1% of the annual diet of sheep (range: 21.0% in February 1977 to 0.7% in October 1977) while burrograss (Scleropogon brevifolius) contributed 3.4% (range: 14.0% in February 1977 to 0% in April through October 1977). Sixteen species of grasses were identified in the sheep diets (Table 1).

Croton (Croton spp.) and filaree (Erodium texanum and E. cicutarium) were the most important forbs in sheep diets, contributing 20.2% and 16.3% of the annual diet, respectively (Table 1). Croton was highly important in sheep diets during November, March, June, July, September and October. Filaree was highly important in sheep diets in April, May and June. Filaree contributed 86.3% of the diet in May 1977. Bladderpods (Lesquerella spp.) made up 3.3% of the annual diet, and Nuttall milkvetch (Astragalus nuttallianus) contributed 2.7%. A total of 15 forb species were identified in sheep diets (Table 1).

DISCUSSION

Croton spp. are known to have caused livestock losses in other parts of the United States (2,4). Two species of croton (C. pottsii and C. dioicus) were common in the experimental pasture and C. texensis also grows in the western Edwards Plateau. Croton made up as much as 61.5% of the monthly sheep diet in this study. Many species of Astragalus are known to be toxic to livestock (2,4). Nuttall milkvetch contributed as much as 18.6% to the monthly sheep diet in this study. Tansymustard (Descurainia pinnata) can be toxic to livestock when consumed in large quantities (2). This plant contributed 0.8% of the March 1977 diet of sheep in the experimental pasture. Silverleaf nightshade (Solanum elaeagnifolium) is also toxic to sheep and other livestock (2,4). This plant contributed 1.1% of the sheep diet in February 1977 and 0.6% in July 1977. Other plants that occurred on vegetation transects or that were observed in the pasture that are known to be toxic to livestock (2,4) included threadleaf groundsel (Senecio longilobus), locoweed (Astragalus sp.), bitterweed (Hymenoxys odorata), trecul queensdelight (Stillingia treculiana), and honey mesquite (Prosopis glandulosa). Tobosagrass

(Hilaria mutica) was a dominant plant on clay flat range sites within the pasture and tobosagrass ergot (Claviceps cinerea) is known to be toxic to cattle (4). Burrograss was heavily infested with fungi in some parts of the pasture in December 1976 and January 1977. Fungal spores were so abundant in localized areas that our boots and lower pants became blackened. Plant samples infested with fungi have been collected periodically since then and sent to mycologists for examination and evaluation. Microscopic examination of plants in sheep fecal samples has revealed heavy infestations of fungus in epidermal tissues of croton, buffalograss, threeawns, bladderpods and tobosagrass throughout the study period. Muenscher (2) indicated that several plants may be toxic only when infected by fungus.

The Reagan silty clay loam soil type made up over 70% of the area within the experimental pasture. Other soils and the range sites within the pasture are shown in Table 2.

Typical symptoms of hard yellow liver were detected in all sheep on the 137-acre pasture in October 1977. A modification of this study is being conducted in 1977-78 (initiated November 1977).

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Table 1. Dry Weight Composition (%) of Sheep Diets Nov. 1976 Through Oct. 1977 in Reagan County, Texas

Plants	Month											
Grasses and grass-like plants	Nov.	Dec.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Mean
Threeawns	5.8	6.0	21.0	8.7	1.7	1.3	2.7	3.8	1.7	2.2	0.7	5.1
Silver bluestem	0.9	2.2	2.0	0.4	-	-	-	2.5	-	-	-	0.7
Sideoats grama	0.2	0.7	0.3	0.6	-	-	2.1	2.1	9.0	0.9	0.9	1.5
Rescuegrass	0.2	-	0.9	-	-	0.8	-	0.2	1.2	-	0.1	0.3
Buffalograss	25.5	69.3	26.6	14.6	3.9	6.1	6.9	55.6	70.9	29.8	62.4	33.8
Sedge	-	-	-	-	-	0.2	0.6	0.2	-	-	-	0.1
Inland saltgrass	0.9	0.2	6.0	0.4	0.3	-	-	-	1.0	0.1	-	0.8
Tobosagrass	1.8	1.8	0.6	8.0	-	0.8	3.0	2.1	0.2	0.6	0.3	1.8
Sand muhly & ear muhly	0.9	2.9	2.6	2.7	-	-	-	5.4	0.7	1.0	2.7	1.7
Vine mesquite & Hall's panicum	-	-	3.2	-	0.3	-	-	-	3.1	0.2	-	0.6
Burrograss	11.3	3.4	14.0	9.0	-	-	-	-	-	-	0.1	3.4
Foxtail barley	-	-	0.3	-	3.2	1.1	-	0.4	-	-	-	0.5
Sand dropseed	0.7	2.7	6.3	-	0.6	-	4.3	4.2	4.2	3.0	3.4	2.7
Texas wintergrass	-	-	-	-	-	-	0.3	-	-	-	-	t*
Slim tridens & white tridens	1.6	1.1	1.1	-	-	-	-	-	0.5	0.5	0.1	0.5
Unknown grass	-	-	-	-	-	-	-	-	-	0.1	-	t
Forbs and other items												
Nuttall milkvetch	-	-	9.5	1.2	18.6	0.8	-	-	-	-	-	2.7
Thistles	-	-	-	-	-	-	-	-	0.3	-	-	t
Croton	46.4	6.3	3.5	22.6	0.9	0.2	26.8	18.2	6.9	61.5	29.1	20.2
Tansymustard	-	-	-	0.8	-	-	-	-	-	-	-	0.1
Filaree	0.5	-	-	2.9	54.4	86.3	33.2	1.8	-	-	-	16.3
Slender janusia	-	-	-	-	-	0.2	0.6	0.6	-	-	-	0.1
Prairie pepperweed	-	-	-	-	0.5	-	-	-	-	-	-	0.1
Bladderpods	1.6	3.6	-	27.0	3.2	-	-	0.4	-	-	0.1	3.3
Common horehound	-	-	-	-	-	0.2	-	-	-	-	-	t
Pricklypear	-	-	0.3	-	-	-	-	-	-	-	-	t
Redseed plantain	-	-	-	-	-	0.2	3.7	-	-	-	-	0.4
Prairie coneflower	1.4	-	-	-	-	-	-	1.8	-	-	-	0.3
Clubmoss	-	-	0.9	0.4	-	-	-	-	-	-	-	0.1
Silverleaf nightshade	-	-	1.1	-	-	-	-	0.6	-	-	-	0.2
Globemallow	-	-	-	0.6	2.7	1.9	-	-	-	-	-	0.5
Crownbeard	-	-	-	-	9.7	-	8.6	-	-	-	-	1.7
Unknown forb	-	-	-	-	-	-	-	-	0.5	-	-	0.1
Seeds	0.2	-	-	-	-	-	7.2	0.2	-	-	-	0.7

* t=trace

Table 2. Range Sites and Soil Types in 137-Acre Experimental Pasture on E. G. Cauble, Jr. Ranch in Reagan County, Texas *

Range Site	Soil Types	Area (%)
Loamy	Reagan silty clay loam	71.4
Shallow	Conger loam, undulating	19.4
Clay flat	Tobosa clay	5.6
Lakebed	Lipan clay	3.5

* A detailed soil survey was conducted by Mr. C. C. Wiedenfeld, Soil Scientist, U.S.D.A. - Soil Conservation Service, San Angelo, Texas.

PR-3514

MYCOPLASMA OVIPNEUMONIAE IDENTIFIED IN TEXAS SHEEP

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

Mycoplasmas were associated with pneumonia in Texas sheep during outbreaks investigated by Livingston and Gauer (1973) from 1971 through 1973. One type of mycoplasma producing colonies without the characteristic nippled appearance could not be serologically identified by these workers using antiserum available at that time. This mycoplasma did appear to be similar culturally and biochemically to mycoplasmal isolates obtained by Cottew (1971) and St. George *et al.* (1971) from sheep in Australia. Carmichael *et al.* (1972) characterized one of these isolates and proposed the name *Mycoplasma ovipneumoniae* with Y-98 as the biotype. St. George and Carmichael (1975) identified a mycoplasmal isolate from New York sheep as *M. ovipneumoniae*. A culture of this isolate of *M. ovipneumoniae* was obtained from Dr. Leland Carmichael at Cornell University, Ithaca, New York for comparative purposes. Also a culture of *M. ovipneumoniae* biotype Y-98 was obtained from Dr. Joseph Tully, National Institutes of Health, Bethesda, Maryland.

MATERIALS AND METHODS

The cultural and biochemical procedures were identical to those described by Livingston and Gauer (1973). The growth inhibition test was performed using paper discs as described by Clyde (1964). Antiserum was produced according to Livingston (1974). An attempt was made to obtain representative isolates from each outbreak of pneumonia in sheep investigated since 1970. Thirteen mycoplasmal isolates were selected from 145 specimens.

RESULTS AND DISCUSSION

All thirteen mycoplasmal isolates were serologically, biochemically and culturally identical to *M. ovipneumoniae* biotype Y-98 (Table 1). *M. ovipneumoniae* appears to be widely distributed in sheep flocks in Texas and can be isolated with regularity from the respiratory tract of sheep with pneumonia. It should be noted that one isolate was obtained from Clay Center, Nebraska. The pathogencity of these isolates is questionable, but in combination with other agents it may be greatly enhanced. Therefore, *M. ovipneumoniae* should be considered as a possible etiologic agent when investigating outbreaks of pneumonia in sheep.

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TABLE 1. MYCOPLASMAL ISOLATES COMPARED WITH *M. OVIPNEUMONIAE* BIOTYPE Y-98

Specimen #	Date	Y-98 antiserum Growth inhibition	Glucose fermentation	Tetrazolium reduction	Location
7	3-25-70		+	+	Sonora
188	8-19-71	+	+	+	Packing plant
274	1-21-72	+	+	+	Clay Center-NB
323	5-24-72	+	+	+	Packing plant
328	5-30-72	+	+	+	SA Feed yards
329	5-30-72	+	+	+	SA Feed yards
341	6-08-72	+	+	+	Packing plant
374	7-26-72	+	+	+	Packing plant
382	7-27-72	+	+	+	Packing plant
403	9-21-72	+	+	+	Packing plant
438	11-21-72	+	+	+	Packing plant
567	8-08-73	+	+	+	Exp. St. SA
2030	4-06-77	+	+	+	Bushland, TX
Y-98		+	+	+	

PR-3515

PREPARATION OF A BLUETONGUE MULTIVALENT MODIFIED LIVE VIRUS VACCINE

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

Bluetongue is an important disease condition of Texas sheep. Widespread outbreaks of bluetongue causing severe economic losses occur in Texas at intervals of 3 to 4 years. Bluetongue infections may be seen yearly affecting only a few isolated flocks. Four distinct virus types or strains of bluetongue have been identified in the United States. The vaccine presently available to the producer is prepared from only a single virus type (type 10) and does not afford protection to the other three virus types. For this reason the commercial bluetongue vaccine has not been used extensively in Texas during recent years. In fact, virus type 10 had not been identified in Texas since 1970. However, in August of 1977 virus type 10 was isolated from a group of lambs with bluetongue at San Angelo, Texas. Since virus type 10 has reappeared in Texas, it may be advisable for producers to vaccinate susceptible sheep for bluetongue during the 1978 season.

Meanwhile the Texas Agricultural Experiment Station is attempting to attenuate the four virus types of bluetongue virus in order that an effective vaccine may be available to Texas sheep producers. At the present time apparently all four virus types have been attenuated. Two virus types have been attentuated to a sufficient degree that only a slight temperature rise is noted after inoculation. All virus types are producing complete protection to a challenge with the specific unattenuated bluetongue virus. Sheep passage of the attenuated virus apparently does not cause a reversion of virulence of the attenuated virus. If progress continues favorably, a bluetongue vaccine should be ready for field evaluation no later than 1979.

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PR-3516

COMPARISON OF SHEEP-SHOWER AND SPRAY-GUN FOR CONTROL OF BITING LICE ON ANGORA GOATS [1]

Nick L. Wilson, Maurice Shelton and Phil Thompson*

INTRODUCTION

Angora goats provide a major source of income for many ranchers in the Edwards Plateau and adjacent regions. Additionally, goats provide a means of brush control and utilization of marginal rangeland that otherwise might not be used efficiently by cattle or sheep.

Lice have long been recognized as an important external parasite of Angora Goats, and ranchers usually apply an insecticide immediately after shearing for control of this parasite. There is a natural reduction of lice populations after shearing; this reduction aided by an insecticide application reduces lice population for a short time. The hand-held livestock spray-gun treatment, however, has not proven to be an effective technique for ranchers in reducing lice numbers for extended periods.

The objective of our study was to evaluate the effectiveness of a sprayer known as a "sheep-shower" for control of biting lice on Angora Goats. The "sheep-shower" is a unit built in Australia for use in control of external parasites of sheep. This study was conducted to test this equipment in the hope of providing ranchers with a method of obtaining effective control of lice for extended periods.

MATERIALS AND METHODS

The "sheep-shower" is a portable unit in which the animals are enclosed in a compact area and sprayed on an alternating basis from above or below. The coverage appears to approach that of a plunge dip. The excess material runs back into holding tank and is recycled into the spray units.

The species of biting lice involved in this study were Bovicola limbata (Gervais) and Bovicola crassipes (Rudow). However, no effort was made to separate species when population counts were made.

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[1]The "sheep-shower" utilized in these studies was provided courtesy of Mr. David Pankhurst Hughes Holding Group, Dubbo, N.S.W. Australia, and Wohler Livestock Products Co. of San Angelo.

Three classes of Angora Goats were used in this test and included aged does, aged billies, and doe kids. Ten animals were included in each treatment and in an untreated control. A pretreatment count of lice was made on all groups of goats. The hair was parted by hand and one-inch section on the side of the face, neck, body, and back legs was examined, and the number of motile forms recorded. Treatment consisted of 0.5 percent solution of malathion applied using the hand-held livestock spray-gun, or with the sheep-shower equipment. Spraying time in the sheep-shower was two minutes.

After treatment, all groups were held separately, except aged does that were treated with the sheep-shower and spray-gun were placed together after the 56-day post treatment count. The aged does and billies were pastured on native rangeland, while the doe kids were held in pens on feed.

Population counts of biting lice were made 9, 36, and 56 days after treatment. A 120 day post treatment count was made on the aged does.

RESULTS AND DISCUSSION

Biting lice population levels were reduced by both the spray-gun malathion treatment as well as the sheep-shower malathion treatment. However, the sheep-shower equipment appears to be more effective in reducing lice numbers and also appears to control lice populations for a longer period. (Table I, II, III) The 120-day post treatment count on aged does revealed the same population levels on animals treated with spray-gun as with "sheep-shower" equipment (Table III). The 120-day post treatment count was made after the two groups had been pastured together for 64 days and some transfer of lice from one group to another may have occurred.

Fifty-six days after treatment no lice were found on animals sprayed with the "sheep-shower" while an average of 2.0, 1.2 and 1.2 were found on kid goats, aged does, and aged billies, respectively, treated with the spray-gun. Fifty-six days after treatment the control group had an average of 15.1, 14.7, 14.1 on kid goats, aged does and aged billies, respectively.

The lice population levels were considered light even within the control group. More tests are needed to accurately determine the real value of "sheep-shower" equipment. There appears to be a possibility that this type of equipment could be used to provide excellent control of lice on isolated flocks of goats from one shearing to the next.

TABLE I

AVERAGE NUMBER OF LICE (*BOVICOLA* SPP.)
FOUND ON DOE KIDS ON FOUR DIFFERENT AREAS OF BODY

		MALATHION TREATMENT	
	CONTROL	SHEEP SHOWER	SPRAY-GUN
PRETREATMENT	11.3	14.55	12.3
9-DAY POST TREATMENT	10.9	0.0	0.8
36-DAY POST TREATMENT	15.66	0.0	0.9
56-DAY POST TREATMENT	15.11	0.0	2.0

TABLE II

AVERAGE NUMBER OF LICE (*BOVICOLA* SPP.)
FOUND ON AGED BILLIES ON FOUR DIFFERENT AREAS OF BODY

		MALATHION TREATMENT	
	CONTROL	SHEEP SHOWER	SPRAY-GUN
PRETREATMENT	14.14	5.8	7.4
9-DAY POST TREATMENT	7.85	0.0	0.3
36-DAY POST TREATMENT	7.42	0.0	0.4
56-DAY POST TREATMENT	14.71	0.0	1.2

Figure 1. Sheep shower equipment used in experiments on lice control on goats.

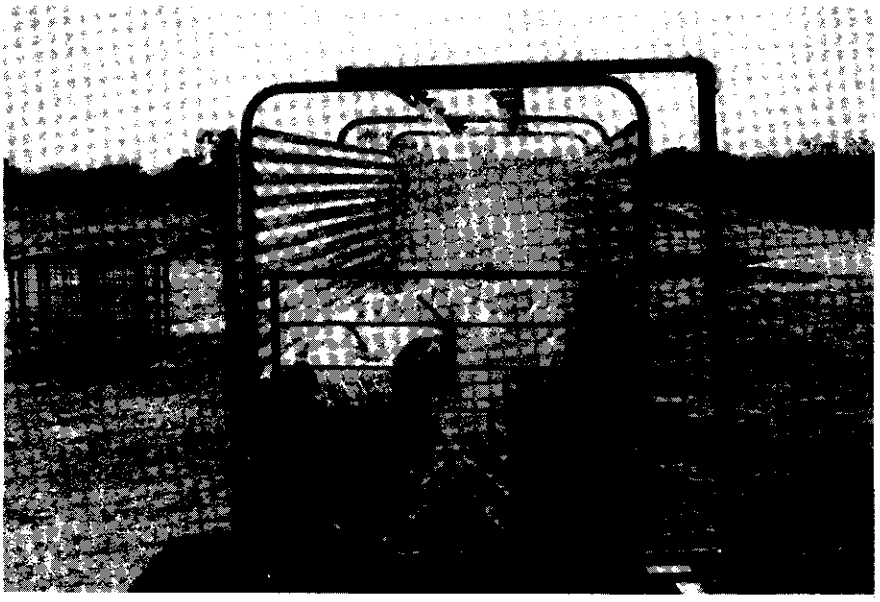

TABLE III

AVERAGE NUMBER OF LICE (*BOVICOLA* SPP.)

FOUND ON AGED DOES ON FOUR DIFFERENT AREAS OF BODY

		MALATHION TREATMENT	
	CONTROL	SHEEP SHOWER	SPRAY-GUN
PRETREATMENT	11.7	9.9	9.2
9-DAY POST TREATMENT	13.4	0.0	0.4
36-DAY POST TREATMENT	11.5	0.0	1.3
56-DAY POST TREATMENT	14.1	0.0	1.2
120-DAY POST TREATMENT[2]	31.8	3.5	3.5

[2]CONTROL AND TREATED DOES PASTURED TOGETHER FOR 64 DAYS BEFORE COUNT.

TENDERIZATION OF GOAT CARCASSES

F.K. McKeith, G. C. Smith, T. R. Dutson
Z. L. Carpenter and M. Shelton*

Electrical stimulation is one of the most recently researched methods for increasing tenderness in lamb and goat carcasses (Savell et al., 1977). It has been suggested that electrical stimulation is effective because of the associated increase in the rate of pH decline and/or the reduction in cold shortening of myofibrils (Carse, 1973; Chrystall et al., 1976; Davey et al., 1976). Savell et al., (1978) reported that electrical stimulation increases tenderness by several methods, one of which is physical disruption of the myofibrils.

The present study was designed to further characterize electrical stimulation of goat carcasses with regard to the stage in the slaughtering process at which stimulation should be performed and to compare electrical stimulation with high temperature conditioning with regard to ultimate effects on cooked meat tenderness.

EXPERIMENTAL

Ninety-six goats of similar age, weight, quality grade and yield grade were slaughtered and assigned to one of six treatments: (1) Electrical stimulation (ES) immediately following exsanguination, (2) ES immediately following pelt removal, (3) ES immediately following evisceration (4) ES immediately following splitting (down the center of the vertebral column), (5) not electrically stimulated, conditioned at 15°C for 24 hours postmorten and (6) not electrically stimulated (untreated control).

Electrical stimulation consisted of 25 impulses (one second duration) of 440 volts (total time 50 seconds). Carcasses in treatments 1, 2, 3, 5 and 6 remained whole (unsplit) for the first 24 hours postmortem. The loin and leg were removed from the left side of each carcass and frozen (-34°C) at 7 days postmortem. Loin chops (3 cm. thick) were removed from the cranial end of the loin, and center leg chops (4 cm. thick) were removed from each leg roast. Chops from the leg and loin were thawed and cooked to an internal temperature of 75°C. Cores were taken from the longissimus muscle in loin chops, and from the semimembranosus and biceps femoris muscle in leg chops.

RESULTS AND DISCUSSION

Mean shear force values for cooked muscles from goat carcasses are presented in Table 1. Mean shear force values for loins stored one day revealed that loins from treatment 3 (ES, after evisceration)

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were ($P<.05$) more tender than loins from treatments 1, 5 and 6. Semimembranosus and bicepts femoris muscles from treatment 3 (ES after evisceration) were ($P<.05$) more tender than those from the control (not ES) treatment after one day.

Cooler storage for an additional six days (after seven days) was more effective in increasing tenderness of muscles from leg roasts (semimembranosus and bicepts femoris) than was the case for muscles from the loin (longissimus). Mean shear force values for loins stored seven days revealed that loins from goats which were electrically stimulated (treatments 1, 2, 3, 4) or conditioned for 24 hours at 15°C (treatment 5) were ($P<.05$) more tender than loins from carcasses in the control (not ES) treatment. For muscles from leg roasts, electrical stimulation after evisceration seemed to be slightly more effective than ES at other points in the slaughter sequence, but differences were not always consistent enough for statistical significance.

These data confirm the hypothesis that electrical stimulation is not merely a method of accelerated aging; if such were the case, cooked samples from control (not ES) carcasses would be as tender as those from treated carcasses after seven days of cooler aging. These data suggest that (a) aging of goat carcasses for seven days does not reduce the difference in tenderness between electrically stimulated and non-stimulated carcasses, and (b) provided distribution requires seven or more days prior to consumption, ES will increase tenderness and can be performed on sides or unsplit carcasses at any time in the slaughter sequence.

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Table 1. Mean shear force values (kg) for cooked muscles from goat carcasses

Treatment	Longissimus muscle		Semimembranosus muscle		Biceps femoris muscle	
	After 1 day	After 7 days	After 1 day	After 7 days	After 1 day	After 7 days
ES, after exsangiunation	6.5^{b}	5.6^{a}	6.5^{a}	5.9^{ab}	6.8^{ab}	5.8^{ab}
ES, after pelt removal	5.6^{ab}	5.1^{a}	7.6^{a}	6.8^{bc}	6.6^{a}	5.4^{a}
ES, after evisceration	5.1^{a}	4.7^{a}	7.0^{a}	5.6^{a}	6.4^{a}	5.0^{a}
ES, as sides	5.1^{a}	4.9^{a}	7.6^{a}	6.3^{ab}	7.9^{c}	6.2^{ab}
Not ES, 24 hr at 15°C	6.5^{b}	5.5^{a}	7.2^{a}	6.4^{ab}	7.8^{bc}	6.6^{b}
Not ES, control	7.8^{c}	7.6^{b}	9.5^{b}	7.7^{c}	10.4^{d}	8.9^{c}

$^{a\ b\ c\ d}$ Means in the same column with a common superscript letter are not different

PR-3518

AN EVALUATION OF THE AIR DRIVEN HANDPIECE FOR SHEARING SHEEP AND GOATS

Maurice Shelton and W. H. Aldred[1,2,3]

The labor involved in shearing of sheep and goats or the cost or unavailability of contract shearers represents one of the problems of these industries. This may be a particular problem in areas where sheep or goat density is not adequate to support professional shearing crews. A number of totally new approaches, such as chemical shearing, have been tried as a means of alleviating this problem, but none appear to offer promise for the near future. One development which has occurred in recent years has been the development of an air driven handpiece, and it appeared to be desirable to evaluate this piece of equipment for its potential contribution to the sheep and goat industries.

MATERIALS AND METHODS

The handpiece or shearing head in question was developed in Australia and is illustrated in Figure 1 in comparison with a more conventional handpiece. In addition to the handpiece, the other components of the system are an air compressor, appropriate hose connections, air pressure regulator, and automatic oiling device. These additional components are shown in Figure 2. When functioning properly, the automatic oiling procedure does prevent the necessity for hand oiling the shearing head except for perhaps at the initial start up. The air pressure requirements are stated at 50-60 PSI with an airflow of 8-12 CFM per handpiece. When this is calculated to provide for a crew size such as six shearers, a compressor of the type shown in Figure 2 is required.

Four shearing heads along with the associated equipment were acquired by the station for evaluation. The evaluation procedure consisted of making the equipment available to professional as well as beginning shearers, and obtaining their reaction to the suitability of the equipment as well as the shearing times using air operated as well as conventional equipment. The professional shearers were from crews shearing station-owned sheep. The amateur shearers were employees working for the Experiment Station.

RESULTS AND DISCUSSION

Some shearing times (for sheep) are shown in Table 1. Although shearing speed for only six shearers is shown, a much larger number of people have actually evaluated the equipment. It proved difficult to get professional shearers to use the equipment adequately to obtain

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[2]The authors wish to acknowledge the assistance of J. D. Naler and Donald Spiller in evaluating the equipment.

[3]The equipment used in these studies was purchased utilizing funds provided by the Natural Fibers and Food Protein Commission of Texas.

comparative shearing speeds. Nevertheless, the data shown in Table 1 appear to justify the conclusion that shearing can be done faster utilizing conventional equipment. The reason for the slower shearing speed with the air equipment is not clear, but it appears to be a soft type of power in which the cutting rate is slowed down when the handpiece is loaded as it is being forced through the fleece. In addition to the slower shearing speeds, the professional shearers objected to the equipment because of the large size of the handpiece, unfamilarity with the hand control, and the fact that the handpiece did not turn in the hand when grip was released.

The beginning or amateur shearers expressed a preference for the air equipment because of the freedom the air hose provided as compared to the down tube.

Both professional and beginning shearers evaluated the two types of equipment for shearing goats. All parties involved found it difficult to shear goats with the large cumbersome handpiece. The smaller conventional handpiece was easier to use with the small goat which was well covered with mohair.

CONCLUSION

The air operated equipment was considerably more expensive than conventional equipment (several multiples). This applies to both the handpieces and power source. The power requirements and the fuel costs are higher for the air equipment, but this is thought to be minor (one or two cents per head) at current fuel prices. These complications plus the slow shearing times and the adverse reaction of professional shearers suggest that it would be unwise or counterproductive to attempt to introduce this type of equipment to the United States sheep and goat industries at the present time. The preference of the beginning shearers for the freedom provide by the air hose suggests that this aspect might make it easier to introduce new shearers to the profession or to interest small producers in doing their own shearing. However, the current approach is to obtain this freedom in some other manner such as the use of a totally flexible shaft attached to a conventional electric motor.

Table 1. Comparative Sheep Shearing Times for Professional and Beginning Shearers Utilizing Air Operated as Compared to Conventional Shearing Equipment

Shearer No.	Experience	Equipment	No. Animals	Shearing Time Min.
1	Professional	Air	10	3.40
		Conventional	12	3.27
2	Professional	Air	10	4.62
		Conventional	12	3.83
3	Professional	Air	4	4.59
		Conventional	9	3.87
4	Beginner	Air	11	7.37
		Conventional	9	6.93
5	Beginner	Air	11	7.89
		Conventional	12	8.10
6	Beginner	Air	5	8.89
		Conventional	17	7.60
Summary		Air	51	6.13
		Conventional	71	5.60

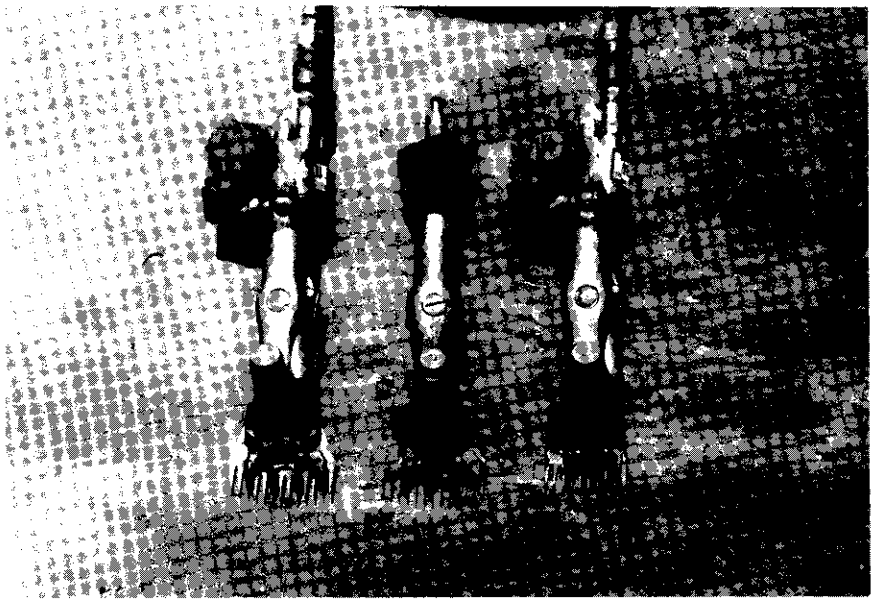

Figure 1. Air Operated Shearing Head (Outside) Compared to Conventional Handpiece (Center) Cutters, Combs and Forks are Interchangeable Between the Handpieces.

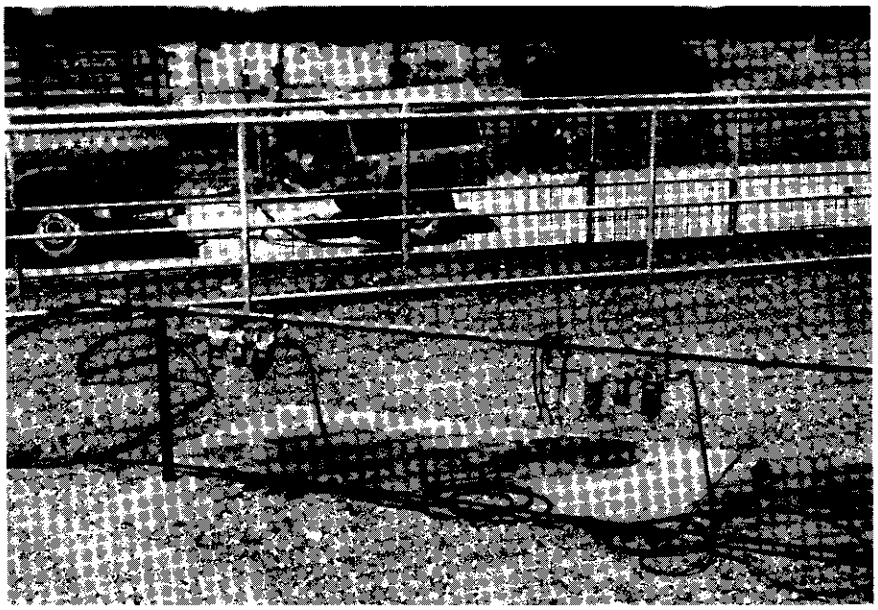

Figure 2. Total Equipment Required for Air Shearing Including Compressor Air Hoses, Automatic Oiling and Pressure Regulating Device and Handpiece.