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DIGESTION STUDIES WITH SHEEP AND WILD ANTELOPE ON A SAGEBRUSH RATION

BY

PAUL KOHLER

Master of Science
South Dakota State University
1950

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This is to certify that, in accordance with the requirements of South Dakota State College for the Master of Science Degree, Mr. Paul Kohler has presented to this committee three bound copies of an acceptable thesis, done in the major field; and has satisfactorily passed a two-hour oral examination on the thesis, the major field, Animal Husbandry, and the minor field, Chemistry.

Advisor

Head of Major Department

Head of Minor Department

Rep. of Graduate Committee

Acknowledgment

The author wishes to express his sincere appreciation to Dr. K. Rasmussen for his helpful suggestions and criticisms during the progress of this study and the preparation of the manuscript.

Acknowledgment is made to the South Dakota Department of Game, Fish and Parks for obtaining and transporting the antelope and feeds, and to Dr. A. L. Moxon and members of the Experiment Station Chemistry Department for the chemical analysis.

The author is especially grateful to Lester M. Berner, Leader of the Big Game Survey, South Dakota Department of Game, Fish and Parks for enthusiasm and material help in this study, and to Robert M. Jordan and George E. Staples, staff members of South Dakota State College, for their material help and criticism while conducting this study and interpreting the data.

Introduction

Those who are responsible for the management of antelope, range livestock, and the range seek to maintain such a balance that all may thrive and reproduce. This is inevitably a difficult objective since the balance in numbers of antelope and livestock may be changed annually, but range flora changes only in long-time cycles. Therefore, the balance between the wild and domestic species and the range must be adjusted frequently by range and livestock management. The adjustment of the number of domestic animals to fit the carrying capacity of the range may be accomplished by changing management and marketing practices but in the case of wild species it must be done by the regulation of hunting. The latter depends on the calculated carrying capacity of the range as determined by experts and the success of regulation depends on the education of the general public to such a knowledge and appreciation of the problem as will assure intelligent cooperation.

The study reported in this paper was made to gain information that would give a basis for improved management of antelope and domestic species residing on a common range. Sagebrush is believed to be an important source of nutrients for antelope and, possibly, for sheep. It is known that antelope eat large quantities of it during the winter, and sheep also depend on it to some extent, particularly during severe winters. During periods of extensive drought, cattle, too, eat sagebrush.

Artemisia tridentata, Big Sage, and Artemisia cana, Silver Sage, are believed to be important constituents of South Dakota antelope's diets. Both species have a wide distribution west of the Missouri River. In seventeen counties of western South Dakota 3,341,000 acres of sagebrush have been mapped. Of this acreage 921,700 acres are considered moderately covered with sagebrush and the remaining acreage, lightly covered. Of the total acreages Artemisia cana represents 90 per cent and Artemisia tridentata 10 per cent.

Availability is an important factor in range plants. During the extremely dry years of the 1930's, sagebrush was one of the few species of range plants able to survive and provide feed for range animals. In winter, when a 3- or 4-inch snow covers the range, sagebrush is available for feed while grasses are not. Figures I and II were taken by the author in Butte county, South Dakota, during the winter of 1950. There was about a 3-inch snow cover on the range, and sagebrush appeared to be the only available forage.

Because of these factors and in view of the present widespread attempts in South Dakota to eradicate sagebrush, it became apparent that more information was needed on the value of sagebrush as winter and emergency feed to our wild and domestic species residing in those areas.

A very limited amount of data pertaining to the chemical analysis of sagebrush appears in the literature, and an even lesser amount on the coefficients of apparent digestibility of sagebrush. No data were found on digestion trials with antelope.

Figure I
Moderately-covered sagebrush range in Butte County, South Dakota.

Figure II
Sagebrush appearing above a three-inch snow covering in Butte County, South Dakota.

For domesticated animals it is relatively easy to determine digestibility and nutritive value of feeds but difficulties are encountered in accomplishing this with antelope. Wild antelope do not easily adapt themselves to close confinement. Because of their extremely selective, browsing-type feeding habits, they do not take readily to a prepared diet.

The feasibility of using wild antelope in digestion studies and comparing the results with sheep with a view to the possibility of using sheep as future test animals for antelope digestion study was a main concern of this investigation.

Since little is known about the requirements of antelope, an attempt was made in this study to gain as much information as possible from the animals that were available.

Review of Literature

Chemical Composition

Chemical composition of sagebrush (Artemisia spp.) is quite limited in the literature. Esplin and associates (1937) found Artemisia tridentata high in phosphorus, 0.25-0.3 per cent. A complete analysis was not included in their work.

Manulkin (1939) reported that Artemisia annus in the air-dry state contained: 9.7 per cent water, 5.6 per cent ether-soluble, 0.8 per cent water-soluble, 11.6 per cent hemicellulose, 8.5 per cent cellulose, 9.6 per cent lignin, 9.3 per cent protein, 10.1 per cent ash, and 2.4 per cent tennides.

Kinney and Sugibora (1943) collected American sagebrush, Artemisa tridentata, in Utah. They found the chemical analysis to be: ether-soluble fat, 10.5 per cent; waxes, 1.6 per cent; carbohydrates, 26.3 per cent; crude fiber, 27.9 per cent; protein, 11.2 per cent; tannine, 4.5 per cent; alkaloids, 0.3 per cent; and ash, 4.9 per cent. These workers stated that the analyses indicate that sagebrush is of high nutritive value for animals, and that the bitter taste of sage is due to a great extent to the presence of a glucoside.

Morrison (1948) states that 75 per cent of the protein and 71 per cent of the nitrogen-free extract in sagebrush is digestible as determined in four digestion trials with cattle and sheep. He states further that sagebrush (listed under green roughages) has an average total composition of protein, 6.6 per cent; fat, 4.7 per cent; fiber, 12.7 per cent; nitrogen-free extract, 22.3 per cent,

and mineral matter, 5.0 per cent. The average for 12 analyses given by Morrison shows that sagebrush contains 51.3 per cent total dry matter, 5.0 per cent digestible protein, 26.6 per cent total digestible nutrients, with a nutritive ratio of 1:4.3 The minerals from these analyses show calcium at 0.52 per cent and phosphorus at 0.13 per cent of the average total composition of sagebrush.

Morrison also gives the percentages of the constituents and their digestibilities of the leaves of sagebrush. As previous knowledge indicates, the leaves were higher than the stems in protein, fat, and total digestible nutrients and lower in crude fiber and minerals. The average total composition of sagebrush leaves from three analyses lists protein, 8.4 per cent; fat, 7.9 per cent; fiber, 6.3 per cent; nitrogen-free extract, 24.0 per cent, and mineral matter, 3.4 per cent; of which the total dry matter was 50.0 per cent; total digestible nutrients, 33.0 per cent; and digestible protein, 6.3 per cent. The nutritive ratio of the sagebrush leaves was 1:4.2.

Digestion Trials and Experimental Feeding with Deer

No previous work was found in the literature on digestion trials with antelope, but digestion trial data were available on deer, another wild ruminant. Forbes and associates (1941) conducted digestion trials at the Pennsylvania Station with young, white-tailed deer, each weighing from 45 to 50 pounds. Various rations were fed and digestion coefficients computed for them. New Zealand white rabbits were fed on similar rations to determine their possible value for use as future test animals for deer digestion work. Low digestion coefficients observed for crude fiber showed that neither deer

nor rabbits digested this feed component especially well, but deer digested it much more efficiently than rabbits did. Also, it was pointed out that the caecum digestion system of the rabbit was relatively inefficient in the digestion of crude fiber, and the conclusion was that the rabbit caecum is not physiologically fully equivalent to the rumen. Forbes and associates obtained negative digestion coefficients for crude protein and crude fiber, and low values for other components when feeding coarse feeds to deer and rabbits with omolene (crushed oats, alfalfa leaf meal, linseed meal, soybean oil meal, molasses, wheat bran, calcium carbonate, and iodized salt). It is stated that the negative values obtained for the coarse feeds may be considered as having been caused by some combination of the following factors:

(1) An actual depression of the digestibility of the omolene by the coarse feeds fed with it.

(2) An abrasive action of the coarse feeds on the intestinal epithelium.

(3) A stimulation of peristalsis, by the coarse products, having the effect of hurrying the food residues along and thus diminishing their apparent digestibility.

A comparison of the data of the digestion of feeds by deer with published digestion coefficients of feeding stuffs by cattle, sheep, and goats shows that the ability of all these ruminants to digest feeding stuffs in general, including crude fiber, are of much the same order of efficiency, though with minor specific differences.

Nichol (1938) summarized experimental work conducted with native Arizona deer over a three-and-one-half year period. During

this time, thirty-eight deer were fed experimentally to determine the food requirements necessary for growth, maintenance, and reproduction. It was found that the coefficient 2.35 multiplied by the hundredweight of deer will give in pounds the amount of air-dry forage consumed daily by deer to maintain their vigor and health. The water requirements of deer vary greatly with the temperature, evaporation, water content of the feed, and exercise. Nichol found that in January, the daily water consumption of deer on a semi-succulent ration was 1.2 quarts per hundredweight. Salt requirements, much like water, were found to vary with the environment and ten deer consumed a pound of salt per month in the summer and approximately one-half that amount in winter. Palatability tests were run on 168 different native species of plants. These tests showed that shrubs made a dependable and substantial part of the deer diet, but that the tree forages, grasses, weeds, and annuals also were very important.

Forage Value of Sage

Stoddard and Smith (1943) state that the Forest Service has estimated that, though only about 2.8 acres were necessary to support one animal unit for a month on the climax sagebrush land on the intermountain area of the United States, now, because of overgrazing, an average of 8.9 acres are necessary. Since sagebrush lands are primarily spring and fall range due to the dry climates they are found in, and since these seasons are marked by lower carrying capacity, heavy-over-grazing on this type has been almost universal. It is also cited that sheep show a much greater preference for sagebrush than do cattle.

Correspondence with the Office of the Director of the Chicago Zoological Park states that they have not had any success in keeping pronghorn antelope alive in the park. The short time that antelope lived at the park they appeared to prefer timothy hay to alfalfa hay, and also ate rolled oats and rolled barley.

Materials and Methods

The digestion trials were conducted at the Agricultural Experiment Station, South Dakota State College, Brookings, South Dakota. Four yearling sheep – two rams and two wethers – and two wild male antelope (Antilocapra americana) were used as experimental animals to determine, and compare between the two species, the digestibility of sagebrush.[1] The sagebrush fed during the trials was collected as needed in the vicinity of Sturgis, South Dakota, by the South Dakota Department of Game, Fish and Parks throughout the period from December 5, 1949, to February 1, 1950. Clipped by hand and packed in burlap bags, the sagebrush used arrived in a relatively fresh condition.

The antelope were provided and transported by the South Dakota Department of Game, Fish and Parks. They arrived at the college direct from a trap in the vicinity of Roundup, Montana on December 6, 1949. Four young antelope from the 1949 kid crop were selected at the trap site. Two were dead upon arrival at the college. A post mortem was held by the college veterinarian, who determined that the cause of death was the rupture of the lung alveoli, probably due to over-exertion.

The two remaining antelope were placed in a pen with a tame antelope. The tame antelope was obtained from Custer State Park two months prior to the arrival of the wild antelope. The two and one-half year old tame animal had little fear of humans, but was

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1. Artemisia cana and A. tridentata mixed, primarily A. cana

excited by horses and dogs. The dietary predilection of the tame antelope was leaves and browse, but he would readily consume corn, oats, alfalfa hay, and soybean oil meal pellets. The tame animal seemed to be an important factor in the taming of the wild ones to eat from a trough and drink from a pail.

A pen, 12 1/2 feet by 14 feet, was constructed in a corner of the State College sheep barn. Slat cornercribbing was used for the walls on two sides of the pen, the other two sides being walls of the barn. The cornercribbing was nailed all the way to the 7 1/2 foot ceiling. To obscure the sheep in the adjoining pen from the antelope's view, a binder canvas, 4 feet wide, was tacked around the bottom of the wall, making it impossible for them to see out.

On their arrival the wild antelope were very frightened and nervous. They were carried from the panel truck into the pen and when first released in the pen, they jumped head-first into the sides of the pen in an effort to escape. It appeared that if handled at night less attempts at escape would be made, and consequently less injury to the animals as they quieted after dark. The rump patch, the erected hairs surrounding the tail of the animals, was fully erected when they were released in the pen. Any sudden movement or noise would set them jumping and running within the pen. They frequently hit the 7 1/2 foot ceiling with their head while jumping. The tame antelope appeared to be little concerned with the escape attempts of the wild ones, and had a very apparent quieting influence on them. They ate sagebrush from the floor of the pen the second day after their arrival. On the third day they ate from a shallow wooden trough and drank water. Cud-chewing was first

observed on the third day after their arrival.

Rump patch activity declined rapidly. On the third day when entering the pen, it was noticed that only one antelope's rump patch showed erection activity. After the fourth day, little rump patch activity was noticed during routine feeding operations, but sudden loud noises and unusual activities such as switching lights on and off brought forth rump patch activity and jumping and running occurred. Whenever the attendant approached the pen the wild antelope appeared to be more quieted if talked to in a low, continuous monotone.

On December 23, seventeen days after the antelope arrived, they were placed in individual pens. The pens were slightly over four feet wide and fourteen feet long with a board floor at one end. The board floor was necessary to facilitate the collection of any feed that might drop from the feed box during feeding. The floor and the feed box may be seen in Figure III. The sheep were fed in digestion crates, but it did not appear feasible to place the wild antelope in digestion crates. A few days prior to the preliminary feeding period, the antelope were allowed to get accustomed to their new pens. They could see between the slats of the corncribbing partitions to the other antelope, but not outside into the sheep pen. They were fed from a wooden box constructed about six inches off the floor and were watered from a pail. Although the floor was new, they ate while standing on it the first night after it was constructed.

The sheep were fed a 1400 gram ration (700 grams per feed). The antelope were fed a 3200 gram ration (1600 grams per feed).

Figure III
End view of antelope feeding pen showing feed box and board floor.

Figure IV
Chopped sagebrush prepared for feeding.

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The sheep were native and dry-lot fed, and did not take readily to a sagebrush diet even though it was introduced gradually in a normal ration. Consequently, they were fed considerably less than the antelope. Range sheep, that had been grazing in a sagebrush area, probably would have been much more satisfactory for use in this trial. The sagebrush was chopped in 2 to 3 inch lengths with a hand-operated chopper. This coarse chopping gave the animals selectivity as to portion of the plant that they desired to consume. The sheep were allowed in the digestion crates for approximately a three-hour period at feeding time. Because of their intermittent nature of feeding, the antelope were allowed to eat all day on the morning's feed and all night on the afternoon's feed. Feeding time was 8 A.M. and 4 P.M. Water was before the sheep and antelope at all times. The water and salt consumption was recorded for the antelope. Water consumption is shown in Table VII.

The refused feed or orts (Figures V and VI) was weighed after each feeding period and put in a covered metal container where it was saved for chemical analysis. A sample from each bag of sagebrush also was saved in a like manner and a sample of the composite was used for chemical analysis. The preliminary or constant-level-of-intake feeding period lasted for 7 days, and the collection period was 12 days in length.

Similar fecal collection bags (Figure VII) designed by Fraps with adaptations by Jordan (1949) were used on the antelope and sheep. To make the harnesses fit the antelope, it was necessary only to adjust the length and girth straps. This was accomplished

Figure V
Portion of sagebrush ration refused by the antelope. Compare with Figure VI and note that the finer parts of the plants have been consumed.

Figure VI
Portion of the sagebrush ration refused by the sheep. Note that the finer parts and the very coarse parts have been refused.

by punching new holes in them.

The fecal collections were made daily. The antelope were caught and held while the feces were being emptied from the bag. They were nervous the first few days they were caught and bleated similarly to sheep in distress. After being caught and held 3 or 4 times, they settled down to the procedure with a minimum of struggling. The fecal collection bags had no apparent effect on the antelope's feeding or resting activities. They ate and lay down soon after the bags were first put on them.

The feces were weighed and thoroughly mixed after being removed from the bags; 1/40 aliquot samples were preserved with thymol in gallon glass jars and refrigerated. At the close of the trials, chemical analyses,[2] (A.O.A.C. 1940) were made on composite aliquoted samples of feed offered, refused feed, and the feces. Hair from the antelope's rump patches was found clinging to the feces (Figure VIII). It was picked off with a tweezers prior to chemical analysis, as it would have raised the nitrogen content of the feces. The nitrogen of the feces was determined previous to drying by methods developed by Gallup and Hobbs (1944), Cochrane, Fries, and Bramar (1925), French (1930).

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2. Experiment Station Chemistry Department, South Dakota Agricultural Experimental Station, Brookings, South Dakota

Figure VII
Side view of the No. I antelope showing
sack for feces collection.

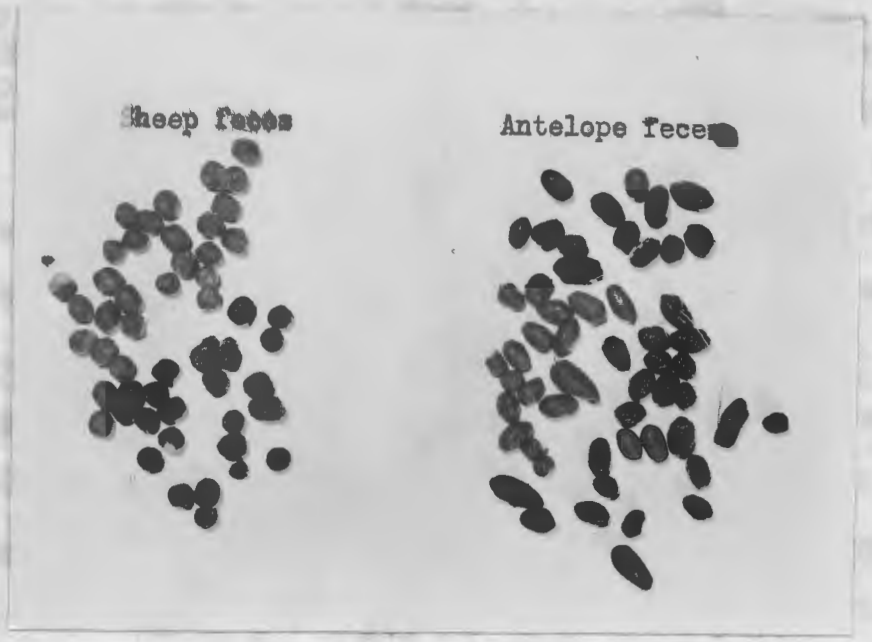

Figure VIII
Sheep and antelope feces showing a higher percentage
of oblong pellets in antelope feces.
Note hair from rump patch clinging
to the antelope feces.

Results and Discussion

In a preliminary investigation of this kind with wild animals, a relatively small number of animals could be obtained and used. This study was complicated further by the sparsity of information on the habits and reactions of antelope in confinement and by the fact that two of the original animals died before arriving at the Experiment Station. The data obtained in the digestion trials were limited by these factors but they can serve as a guide to what may be expected in more comprehensive trials at a later date.

Table I
Per Cent Chemical Composition of Sagebrush
Fed to Sheep and Antelope

(Cut in December, 1949, and January, 1950)

Dry Matter	Crude Protein	Ether Extract	All Carbohydrates	Ash
77.26	6.18	1.87	65.92	3.28

The chemical composition of the sagebrush fed in the trials is shown in Table I. Crude fiber and nitrogen-free extract (N.F.E.) were calculated together in these data under "all carbohydrates". According to Wilcox and Moxon (1949), the total digestible nutrients of the feed remain the same since the N.F.E. values vary inversely with the crude fiber values. They also state that the ideal method for crude fiber analysis would be one in which all fractions except cellulose and lignin would be removed. They state further that under the A.O.A.C. (1940) method of analysis it is possible for the lignin fraction to remain with the crude

fiber or be calculated in the N.F.E. fraction. Therefore, in these data crude fiber and N.F.E. have been calculated together under "all carbohydrates."

Table II
Total Sagebrush Consumed and Feces Voided
In the 12-Day Collection Period

	Sagebrush			Feces Voided	
	Grams Offered	Grams Refused	Grams Consumed	Grams Wet	% Moisture
Antelope					
I (male)	24,000	13,269	10,731	13,397	57.98
II (male)	24,000	11,969	12,031	13,701	55.57
Average	24,000	12,619	11,381	13,549	
Sheep					
I (ram)	16,800	8,459	8,341	12,858	62.52
II (ram)	16,800	8,086	8,714	13,591	63.26
III (wether)	16,800	9,226	7,574	10,613	57.39
IV (wether)	16,800	10,594	6,206	7,047	52.58
Average	16,800	9,091	7,708	11,027	

Table II shows the sagebrush offered to the sheep and antelope, the amount they refused, and their actual intake or consumption. Also the feces voided and the percentage of moisture in the feces are shown.

Table III
Per Cent Chemical Composition of Sagebrush Refused

	Dry Matter	Crude Protein	Ether Extract	All Carbohydrates	Ash
Antelope					
1	77.09	4.17	1.13	69.58	2.22
2	77.40	4.19	1.03	70.03	2.15
Average	77.25	4.18	1.08	69.81	2.18
Sheep					
1	77.49	4.71	1.77	67.80	3.20
2	78.03	5.76	2.09	66.23	3.95
3	79.98	5.55	2.12	68.76	3.54
4	79.46	4.81	2.32	69.43	2.90
Average	78.74	5.21	2.07	68.05	3.40

The antelope ate the finer parts, the florets and leaves, while the sheep ate the coarser stems, leaving the florets (Figures V and VI). On December 23, 1940, a chemical analysis was made to determine the crude protein content of the complete sagebrush plants in one shipment and on only the florets from the sagebrush. The sagebrush sample contained 5.1 per cent crude protein and the florets contained 8.0 per cent. This explains the difference that Table III shows in the average crude protein content of the refused sagebrush for sheep at 5.21 per cent, as compared to the antelope's 4.18 per cent. Also it would indicate that because of the difference in choice of the plant parts by the two species, the antelope consumed material with a higher protein content than that the sheep consumed.

Table IV
Per Cent Chemical Composition of Feces Voided

	Dry Matter	Crude Protein	Ether Extract	All Carbohydrates	Ash
Antelope					
1	42.02	2.67	1.04	35.63	2.66
2	44.43	2.69	1.30	37.84	2.60
Average	43.22	2.68	1.17	36.74	2.63
Sheep					
1	37.48	2.03	0.48	33.34	1.53
2	36.74	2.01	0.41	32.67	1.65
3	42.61	2.24	0.45	37.93	1.99
4	47.42	2.62	0.73	41.97	2.19
Average	41.06	2.24	0.52	36.50	1.84

Chemical composition of the feces voided is shown in Table IV

Analysis of variance between apparent coefficients of digestibility (Snedecor, 1946) was calculated on the chemical composition of each of the classes of nutrients in the sagebrush. For an

analysis of variance to be valid, the test animals used must be a true sample of the population. The few animals used in collecting these data cannot be considered to be a fully reliable sample of the populations, but some interesting comparisons between antelope and sheep may be pointed out.

Table V
Coefficient of Apparent Digestibility of Sagebrush Fed

	Coefficients				
	Dry Matter	Crude Protein	Ether Extract	All Carbohydrates	Ash
Antelope					
1	32.28	61.53	53.38	27.55	27.31
2	35.85	62.83	45.75	36.70	33.51
Average	34.06	62.18	49.56	32.12	30.41
Sheep					
1	24.99	58.20	62.47	19.71	27.53
2	25.14	52.28	61.61	17.14	3.19
3	19.26	54.82	59.72	36.46	8.30
4	26.74	65.08	24.77	20.48	39.30
Average	24.03	57.60	52.14	53.45	19.58
Differences Antelope-Sheep	+10.03*	+4.58	-2.58	-21.33	-10.83

* Significant at the 5 per cent level.

In studying Table V, it appears that the antelope and sheep may have had significant difference in the digestibility of crude protein had it not been for sheep No. IV. This sheep consumed the least amount of sagebrush during the trial (1.14 pounds per day). Morrison (1949) gives the minimum digestible protein requirements of an 80 pounds lamb as 0.25 pounds per head daily. This sheep was consuming only 0.07 pounds of digestible protein daily which is considerably below minimum requirements. Increased efficiency due to the low plane of nutrition may account for the high coefficient of digestibility of protein of the No. IV sheep in comparison to the

other sheep.

Nichol (1938) states that the factor 2.33 multiplied by the hundredweight will give in pounds the amount of air-dry forage eaten daily by Arizona deer. A similar computation for antelope is given in Table VI.

Table VI
Sagebrush Consumption by Antelope (Dry Weight)

Animal weight in lbs.	Consumed daily in lbs.	Consumed daily in lbs. per cwt.
58	2.41	4.15
56	2.71	4.84
Average 57	2.56	4.50

The antelope's intake of sagebrush in dry weight per cwt. is almost double that of deer under the conditions of this test. The deer data were collected throughout three years in Arizona. The antelope data were collected in mid-winter; consequently, one might expect that the antelope's consumption would be somewhat greater because of the severity of the weather.

The water consumption of the antelope was tabulated over an eight day period.

Table VII
Daily Water Consumption by Antelope in Quarts

Antelope #I	Antelope #I	Outdoor temperature in degrees Fahrenheit High	Low
1.81	2.32	10	-11
2.52	2.76	21	- 4
3.86	1.47	33	5
0.51	0.84	35	- 2
1.35	2.07	30	- 5
0.92	1.45	31	-10
1.05	1.55	27	6
0.68	0.90	8	- 4
Average 1.59	1.67	24	- 3

The average water consumption per hundredweight of the antelope was 2.86 quarts per day.

The water was offered in pails and weighed in and out each day to the gram unit. Due to the cold temperatures, it was difficult to keep the water free of ice, although it was approximately 10° warmer in the barn, out of the wind, than outside. Nichol (1938) gives the water consumption of deer on a semi-succulent diet in January (comparable to this test) as 1.2 quarts daily per hundredweight as compared to 2.86 for the antelope. Exercise, temperature, and feed appear to greatly affect the water consumption. Morrison (1949) gives the water requirements of lambs being fattened on dry feed as 1.2 to 2 quarts or more of water per day.

Fine granulated salt was made available to the antelope in 4-by-6-inch metal boxes. The No. 1 antelope consumed no measureable amount of salt during the 12-day fecal collection period. The No. 2 antelope consumed 12.25 grams per day (at this rate 1 pound in 37 days.) It is possible that this antelope was salt hungry and consumed much more than it ordinarily would. Nichol (1937) states that 10 deer will consume a pound of salt per month (about 1.5 grams per deer per day) in the summer and about one half this amount in the winter.

The body temperatures of the antelope were taken each afternoon about 4:00 P.M. for four consecutive days. The average temperature of the animals was 102.05° F., which is very nearly the average body temperature of sheep. Dukes (1947) gives the average temperature for sheep as 102.3° F., with a range from 100.9 to 103.8° F.

Although water and salt were available to the sheep at all times, records were not kept on the consumption. The sheep were weighed prior to the fecal collection period and at the close of it. The four sheep lost 2 pounds in aggregate weight during the 12-day fecal collection period on the sagebrush ration.

The tame antelope died on the sagebrush diet before the start of the fecal collection period. This antelope weighed 81 pounds on arrival. He had one eye that appeared to have been punctured by a sharp object and the sight was lost from it. Sulfa urea was used as the treatment on it to rid it from the infection. At first this animal was reluctant to eat alfalfa hay and could never be induced to eat prairie hay. He appeared to be salt-hungry on arrival, and after consuming quite a quantity of it, his feed consumption increased. Within three days he was eating corn, oats, and soybean meal, but was slow at starting to eat this ration. He always showed a marked preference for leaves and weeds.

This tame antelope arrived during rutting season. On entering his pen he would butt and utter a low bugle. The rut had no apparent effect on his feed consumption. He ate the grain and soybean meal readily but some days he would eat very little alfalfa hay, while on others he would consume a great deal. This tame antelope, as the wild ones did, preferred to have his feed up off the floor. They would seldom eat anything that had fallen on the floor. The tame animal ate more hay at night than in the daytime. Within a month after his arrival, the tame animal was eating over 3 pounds of alfalfa per day, and at the end of 59 days had gained 11 pounds. He shed his horns one day apart, leaving the soft,

black spike. He was noticeably quieter after shedding his horns and less odor was apparent. About ten days previous to the arrival of the wild antelope, the oats and soybean meal were gradually reduced from his ration.

After the arrival of the wild antelope, the tame antelope was put on a sagebrush diet with them. He ate the sagebrush, but continually lost vigor and weight. He lived for 25 days on sagebrush, but lost 14 pounds in that time. On the twenty-fourth day, he began to wheeze and a slight nasal discharge was noticed. Pennicillin was injected and sulfa was fed orally. He refused to eat on the twenty-fifth day of the sagebrush ration and died that night. Diarrhea was observed a day or so prior to death. The post-mortem examination found gastritis, enteritis of the large colon, and edema of the lungs. All post-mortem examinations were performed by Dr. G. S. Harshfield, Director of the Animal Health Laboratory, South Dakota State College, Brookings, South Dakota. It appears that the abrasive action of the somewhat coarse sagebrush may have caused the inflammation of the digestive tract, and his weakened condition probably made him susceptible to respiratory infection. Apparently the tame antelope died because of the inability to utilize sagebrush, after receiving another ration, or the shift from one ration to the other was too rapid. Another factor that must be considered is the environment. The barn where the antelope were kept was drafty and cold. In this period the temperatures fluctuated quite rapidly. In Table VII it may be noticed that the temperature changed from above freezing to below zero in a 24-hour period.

After the sagebrush fecal collection period was completed, the next trial to be run with sheep and antelope was a mixture of sagebrush and good quality prairie hay. The hay was sent to the college by the South Dakota Department of Game, Fish and Parks from an antelope area of the state. The hay was run through the hand-operated chopper, the same as the sagebrush, to make a more homogeneous mixture. The first feed of the mixture of sagebrush and hay to the antelope consisted of 300 grams of hay and 100 grams of sagebrush per feed. The low level of feed offered was to induce the antelope to eat the hay. The antelope consumed about 150 grams of hay and all the sagebrush from the first feed. After this initial feed, the antelope would eat all of the sagebrush offered but refused the hay. The sheep were also fed an 800 gram ration, but it consisted of 300 grams of sagebrush and 100 grams of hay per feed. The sheep ate all of the hay and about one-half of the sagebrush.

Three days after the sagebrush-hay mixture was offered, antelope No. 1 refused to eat any of the feed offered. The amount of sagebrush was immediately increased, and the hay was taken out of the ration in an attempt to build up his reserve strength. The sick animal had a slight nasal discharge. He was fed sulfa orally with no apparent effect. This antelope died 24 hours after first refusing to eat. He died, as the same one did, in a state of teeth gritting and convulsions. The weather warmed up to above freezing in this week, leaving the pens damp. It appeared that in the three days that this antelope was on the sagebrush-hay ration his resistance had been greatly lowered. A post-mortem was held, and the necropsy

read:

"Carcass thin, no body fat.

Roughage in rumen.

Hemorrhage from mesenteric veins of large colon apparently resulting from thrombosis of vein. Few small hemorrhages in wall of large colon."

Diagnosis: "malnutrition."

The remaining antelope was changed from the sagebrush-hay ration to all the sagebrush that he would eat, and he was bedded with straw. He ate some leafy alfalfa hay fed to him by hand on the first night that he was taken off the sagebrush-hay ration. Although alfalfa hay was constantly before him, and further attempts were made to feed it by hand, he refused to eat any more of the hay. It appears that the ability to digest alfalfa hay was lacking and perhaps an appetite for it also was lacking. Soybean meal pellets, oats, and corn were offered cafeteria style, but all were refused. This antelope lived eight days after the other wild one died. During this time he ate sagebrush, drank water, and chewed his cud. The post-mortem examination showed seven broken ribs that had healed, pneumonia in the lower portion of the lobe of each lung (Figure IX), and a rumen full of sagebrush (Figure X). The advanced stage of pneumonia in both lungs was found just opposite the healed ribs, and apparently was induced by the fractured ribs. The healed ribs were probably broken during trapping or hauling operations some 50 days previous.

It is the opinion of the author that the liveability of wild

Figure IX
Lungs of antelope No. II showing advanced stage of pneumonia (dark portion) in lower part of each lobe.

Figure I
Rumen from No. II antelope filled with sagebrush.

species used in digestion studies would be increased if older and stronger animals (perhaps yearlings) were used, even though handling them would be more difficult. An outdoor exercise pen with a solid fence at least seven feet high for antelope would be desirable. A temperate season of the year would minimize susceptibility to respiratory infections and be more conducive to the general health of the animals.

SUMMARY

To determine the coefficients of apparent digestibility of the nutrients in sagebrush, digestion trials were conducted with two wild antelope fawns and 4 sheep. The antelope consumed an average of 11,381 grams of chopped sagebrush during the 12-day fecal collection period, as compared to an average of 7,708 grams consumed by the sheep in the collection period. The antelope averaged 57.90 pounds in weight, while the sheep averaged 81.8 pounds. The sheep were taken from dry-lot feeding, and did not take readily to a sagebrush diet. Range sheep accustomed to sagebrush probably would have consumed it more readily.

The coefficients of apparent digestibility of the constituents of sagebrush cut in December and January are presented for antelope and sheep. The only significant difference found in the digestibilities between the two Genera was for dry matter; the antelope having the higher coefficient which was 34.06 per cent as compared to 24.03 per cent for the sheep. The average coefficients of apparent digestibility for antelope were: crude protein, 62.18 per cent; ether extract, 49.56 per cent; all carbohydrates (crude fiber and nitrogen-free extract), 32.12 per cent; and ash, 30.41 per cent. The sheep had slightly lower average coefficients except for ether extract. They were: crude protein, 57.60 per cent; ether extract, 52.14 per cent; all carbohydrates (crude fiber and nitrogen-free extract), 23.45 per cent; and ash, 19.58 per cent.

The antelope consumed an average of 4.50 pounds per hundredweight daily of chopped sagebrush and 2.86 quarts per hundredweight daily of water.

The young wild antelope died shortly after being changed from a sagebrush ration to a sagebrush and prairie hay mixed ration. The amount of sagebrush fed was reduced to a minimum in an attempt to induce the animals to eat the hay, and apparently this caused them to weaken and die.

It is the opinion of the author that the liveability of antelope used in digestion studies would be increased if older and stronger animals were used. An outdoor exercise pen with a solid fence at least seven feet high would be desirable for antelope. Conducting studies in a temperate season of the year would minimize the susceptibility to respiratory infections and would be conducive to the general health of the animals used in a digestion study.

This study indicates that antelope and sheep digest the constituents of sagebrush with much the same order of efficiency.

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