



The effect of terramycin on the utilization of dehydrated and ammoniated dehydrated alfalfa silage pellets and urea in rations fed to cattle and sheep
by Donald R Gill

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Animal Industry
Montana State University
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Abstract:

Steer calves were used to determine the value of ammoniated and dehydrated alfalfa silage. Three trials were conducted to test the products. Sun-cured alfalfa pellets were used as the control ration in two of the tests. In the first trial, steer calves were wintered for 77 days using the pellets, a grain ration, and grass hay. Sixteen steer calves were used in the study with eight head in each lot. The animals were individually fed, and all animals received the same amount of feed. The control lot gained 2.08 pounds daily. The lot which received the dehydrated alfalfa silage pellets gained 1.56 pounds daily. The poor gains made by the lot that was fed silage was attributed to the poor palatability of the silage pellets.

The same steers were fattened for 156 days after the wintering period. The grain ration was increased during the fattening period, but gains were still poor. The steers which received the silage pellets refused to consume on a high level of feed. The palatability problem was again noted.

Dehydrated alfalfa silage pellets and dehydrated ammoniated alfalfa silage pellets were tested using steer calves. The dehydrated ammoniated silage pellets contained 2.8 percent non-protein nitrogen. The steers were fed barley pellets and grass hay in conjunction with the silage tested. Sixteen steer calves were divided into two lots to test the two silage pellets. Four steers in each lot received 75 milligrams of terramycin daily in the barley pellets. No difference was noted in daily gains as affected by the two types of silage pellets. The lots which received terramycin had increased feed efficiency and increased gains compared to the lots which received no terramycin. The calves which received terramycin refused less feed than did the lots which did not receive terramycin.

The effect of terramycin and urea on the digestibility of sun-cured alfalfa pellets was studied using sheep. Urea increased the digestibility of the pellets. The digestibility of protein, fat, crude fiber, and nitrogen free extract was also increased. Terramycin was added to the pellet-urea ration at the rate of 10 milligrams per pound of feed. The digestibility of protein and nitrogen free extract was reduced. Crude fiber and fat digestibilities were unaffected.

Blood-urea nitrogen levels were determined from blood samples taken in conjunction with the digestibility work with sheep. The data may indicate that terramycin caused a delay in the hydrolysis of urea to ammonia in the rumen.

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by

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14

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TABLE OF CONTENTS

INDEX TO TABLES	5
INDEX TO FIGURES	6
ABSTRACT	7
INTRODUCTION	8
REVIEW OF LITERATURE	11
Ruminant Digestion	11
The Concept of Non-Protein Nitrogen Feeding in Ruminant Nutrition	13
The Relationship of Blood-Urea Values to Protein Utilization	15
The Effect of Non-Protein Nitrogen on the Utilization of Nitrogen	16
The Effect of Urea on Digestibility of Lignin and Cellulose	17
The Effect of Alfalfa on Urea Utilization	18
The Effect of Antibiotics on High Roughage Rations for Cattle and Sheep	19
PROCEDURES	22
Wintering Calves with Dehydrated Alfalfa Silage	22
Fattening Calves with Dehydrated Alfalfa Silage	23
The Use of Dehydrated Alfalfa Silage Pellets and Dehydrated Ammoniated Alfalfa Silage With and Without Terramycin in Wintering Steer Calves	24
Digestion Studies to Determine the Effect of Urea and Urea and Terramycin on the Apparent Digestibility of Sun-Cured Alfalfa Pellets	27
Blood-Urea Studies	30
RESULTS AND DISCUSSION	31
Wintering Calves with Dehydrated Silage	31
Fattening Steers Using Dehydrated Silage	31

TABLE OF CONTENTS (Continued)

Feeding Dehydrated Alfalfa Silage Pellets and Dehydrated Ammoniated Alfalfa Silage Pellets With and Without Terramycin	34
The Apparent Digestibility of Ammoniated Dehydrated Alfalfa Silage Pellets	37
The Effect of Terramycin on Gains and Feed Efficiency	38
The Apparent Digestibility of Sun-Cured Alfalfa Pellets	41
The Apparent Digestibility of Sun-Cured Alfalfa Pellets as Affected by the Addition of Urea	44
Additional Observations Made When Urea Was Added to the Ration	47
The Apparent Digestibility of Sun-Cured Alfalfa Pellets as Affected by the Addition of Urea and Terramycin	48
Factors Which Affect Digestibility Procedures	52
Losses Associated with Storage of Feces for Drying and Chemical Analysis	53
The Effect of Urea and Terramycin on Blood-Urea Nitrogen	53
Blood-Urea Nitrogen Values as Affected by Dehydrated Sun-Cured Alfalfa Pellets	54
The Effect of Feeding Urea on Blood-Urea Nitrogen Values	54
The Effect of Terramycin and Urea on Blood-Urea Nitrogen Values	61
SUMMARY	63
LITERATURE CITED	65

INDEX TO TABLES

I.	THE EXPERIMENTAL DESIGN OF THE 1958 WINTERING TRIAL.	23
II.	PROXIMATE CHEMICAL ANALYSIS OF DEHYDRATED SUN-CURED ALFALFA AND DEHYDRATED ALFALFA SILAGE PELLETS	24
III.	EXPERIMENTAL DESIGN OF 1959 STEER FEEDING TRIAL AT FORT ELLIS.	25
IV.	PROXIMATE CHEMICAL ANALYSIS OF THE FEEDS USED DURING THE 1959 TRIAL	26
V.	THE RESULTS OF WINTERING CALVES FOR 77 DAYS TESTING DEHYDRATED ALFALFA SILAGE AND SUN-CURED ALFALFA PELLETS	32
VI.	THE RESULTS OF FATTENING CATTLE 156 DAYS USING DEHYDRATED ALFALFA SILAGE AND SUN-CURED ALFALFA PELLETS	33
VII.	WEIGHT GAINS MADE BY STEERS DURING THE 110-DAY FEEDING PERIOD.	35
VIII.	THE APPARENT DIGESTIBILITY OF AMMONIATED DEHYDRATED ALFALFA SILAGE PELLETS ON A DRY-MATTER BASIS	37
IX.	WEIGHT GAINS OF INDIVIDUAL STEERS	39
X.	FEED CONSUMPTION OF INDIVIDUAL STEERS	40
XI.	PROXIMATE CHEMICAL COMPOSITION OF DEHYDRATED SUN-CURED ALFALFA PELLETS ON A DRY-MATTER BASIS	41
XII.	THE APPARENT DIGESTIBILITY OF SUN-CURED ALFALFA PELLETS AVERAGE FROM FOUR SHEEP. DATA IS GIVEN ON A DRY-MATTER BASIS	42
XIII.	PROXIMATE CHEMICAL COMPOSITION ON A DRY-MATTER BASIS OF INDIVIDUAL SHEEP FECES DURING THE CONTROL PERIOD. COEFFI- CIENTS OF DIGESTIBILITY ARE ALSO GIVEN	43
XIV.	THE APPARENT DIGESTIBILITY OF SUN-CURED ALFALFA PELLETS PLUS 1% UREA USING AVERAGE DATA FROM FOUR SHEEP IN THE STUDY . . .	45
XV.	PROXIMATE CHEMICAL COMPOSITION ON A DRY-MATTER BASIS OF INDIVIDUAL SHEEP FECES AS INFLUENCED BY THE ADDITION OF 1% UREA TO THE RATION. COEFFICIENT OF DIGESTIBILITY IS GIVEN FOR EACH NUTRIENT	46
XVI.	THE APPARENT DIGESTIBILITY OF SUN-CURED ALFALFA PELLETS PLUS UREA AS AFFECTED BY TERRAMYCIN	49

XVII.	COMPARISON OF THE COEFFICIENTS OF DIGESTIBILITY DURING THE THREE COLLECTION PERIODS (AVERAGE OF FOUR SHEEP).	49
XVIII.	PROXIMATE CHEMICAL COMPOSITION ON A DRY-MATTER BASIS OF INDIVIDUAL SHEEP FECES AS INFLUENCED BY THE ADDITION OF UREA AND TERRAMYCIN TO THE RATION. COEFFICIENT OF DIGESTIBILITY IS GIVEN FOR EACH NUTRIENT	50
XIX.	BLOOD-UREA VALUES FOR SHEEP NO. 8004X AT VARIOUS TIME PERIODS ON THE CONTROL RATION, CONTROL PLUS UREA AND THE CONTROL PLUS UREA AND TERRAMYCIN	55
XX.	BLOOD-UREA VALUES FOR SHEEP NO. 8002X AT VARIOUS TIME PERIODS ON THE CONTROL RATION, CONTROL PLUS UREA AND THE CONTROL PLUS UREA AND TERRAMYCIN	56
XXI.	BLOOD-UREA VALUES FOR SHEEP NO. 8093X AT VARIOUS TIME PERIODS ON THE CONTROL RATION, CONTROL PLUS UREA AND THE CONTROL PLUS UREA AND TERRAMYCIN	57
XXII.	BLOOD-UREA VALUES FOR SHEEP NO. 8705V AT VARIOUS TIME PERIODS ON THE CONTROL RATION, CONTROL PLUS UREA AND THE CONTROL PLUS UREA AND TERRAMYCIN	58
XXIII.	AVERAGE BLOOD-UREA VALUES FOR THE CONTROL, CONTROL PLUS UREA, AND UREA PLUS TERRAMYCIN	59

INDEX TO FIGURES

Figure 1.	Average blood urea values at various time intervals for the control period, control plus urea and urea plus terramycin	60
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ABSTRACT

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Dehydrated alfalfa silage pellets and dehydrated ammoniated alfalfa silage pellets were tested using steer calves. The dehydrated ammoniated silage pellets contained 2.8 percent non-protein nitrogen. The steers were fed barley pellets and grass hay in conjunction with the silage tested. Sixteen steer calves were divided into two lots to test the two silage pellets. Four steers in each lot received 75 milligrams of terramycin daily in the barley pellets. No difference was noted in daily gains as affected by the two types of silage pellets. The lots which received terramycin had increased feed efficiency and increased gains compared to the lots which received no terramycin. The calves which received terramycin refused less feed than did the lots which did not receive terramycin.

The effect of terramycin and urea on the digestibility of sun-cured alfalfa pellets was studied using sheep. Urea increased the digestibility of the pellets. The digestibility of protein, fat, crude fiber, and nitrogen free extract was also increased. Terramycin was added to the pellet-urea ration at the rate of 10 milligrams per pound of feed. The digestibility of protein and nitrogen free extract was reduced. Crude fiber and fat digestibilities were unaffected.

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INTRODUCTION

In many parts of the world, the fattening of livestock cannot be practiced because the feeds that are required by animals would have to come from food supplies needed by the human population. When the human population in an area increases, feeds that are associated with animal feeding are taken over by the human population.

The livestock industry is continually forced toward using what are considered now as low-quality feeds. These low-quality feeds must be improved so that livestock production can be increased.

This thesis deals with the effect of non-protein nitrogen compounds and terramycin in ruminant nutrition. Urea is the non-protein nitrogen compound that has received the most use in feeding cattle and sheep. It was first used in Germany during World War I. Urea feeding was developed out of necessity when the war effort took the normal supplies of protein supplements used in animal feeding for human and industrial needs. Urea is a partial protein replacer in ruminant nutrition. Ruminants are able to use this nitrogen containing compound to replace part of their protein requirement if urea is used properly.

Each year, feed manufacturers are using more urea in formulating feeds. In 1945 less than 500 thousand tons of urea were used in livestock feeding, however, by 1956 the use had grown to over 4,500 thousand tons of urea annually.

Antibiotics were first used in swine fattening rations in 1949. Since that time, it has been almost standard procedure to include antibiotics in formulated feeds for fattening and growing pigs and chickens.

The use of antibiotics in cattle rations has not met with the wide acceptance that it has in other classes of animals. The first work in feeding antibiotics to cattle did not show any advantage. It is now recognized that the levels used were much too high. These high levels caused the cattle to scour.

More recently, the use of low levels of antibiotics in cattle nutrition has been more successful. Antibiotics may increase the utilization of non-protein nitrogen in rations for cattle and sheep.

Work at Montana State College by Thomas and Bellows (1957) indicated a slower release of ammonia from urea in the rumen when terramycin was added to the ration. This work led to further interest in studying the effect of antibiotics on non-protein nitrogen utilization.

The dehydration of silage is a new procedure in the livestock feeding industry. If silage can be successfully dehydrated, it will reduce many of the problems of incorporating silage into formulated feeds. Silage is a product which in its natural state is too bulky to be used in many livestock rations. The addition of ammonia to silage offers possibilities in ruminant feeding. The ammoniated silage can also be dehydrated and pelleted giving the product an advantage as to the handling of it.

The value of non-protein nitrogen in ruminant nutrition has been established. The ammoniation of silage affords a low cost means of supplying non-protein nitrogen in cattle and sheep rations.

Dehydrated alfalfa silage pellets were tested in 1958. The first phase of this thesis describes the procedure and results of this trial.

In 1959, ammoniated dehydrated alfalfa silage pellets were tested

along with a dehydrated silage pellet. In this trial, terramycin was fed to part of the steers receiving these two pellets.

The effect of the antibiotic terramycin was studied in conjunction with a digestibility trial. In this trial the digestibility of a sun-cured alfalfa pellet with and without urea was determined. Terramycin was fed in conjunction with urea to note its effect on non-protein nitrogen utilization. Blood-urea nitrogen determinations were made in conjunction with the digestibility work. The data of Lewis (1957) and others indicates that blood-urea values are useful in determining the fate of ammonia originating in the rumen. The results of these tests are discussed in this thesis.

REVIEW OF LITERATURE

Ruminant Digestion

The digestive tract of a ruminant differs from other classes of animals since a highly symbiotic relationship exists between the host animal and microorganisms which are found in the digestive tract. The distinguishing feature of the alimentary tract of a ruminant is the large rumen or paunch located in the anterior portion of the digestive tract. The capacity of the rumen varies with the size and nutritional state of the animal, but in medium-sized cattle the rumen will hold approximately 25 to 40 gallons. Large herbivorous ruminants have a rumen capacity of about 60 gallons. The rumen is the first of four compartments. It is followed in order by the reticulum, omasum and the abomasum. The abomasum is similar to the stomach of monogastric animals, and is frequently referred to as the true stomach.

The rumen and the reticulum are actually not separate organs but together make up a fermentation unit whose contents can approximate 20 to 25 percent of the gross weight of the animal.

Feeds such as coarse grass, hay, silage and grain are swallowed after partial mastication and enter the rumen and reticulum. The feed is then triturerated with water consumed, along with large amounts of amylase free saliva. The saliva is highly buffered at a pH of about 8.2. A 1000-pound ruminant will secrete about 45 liters of saliva daily. The large amounts of bicarbonate in ruminant saliva serves to neutralize the acidic end-products of fermentation in the rumen. After the food is churned about in the rumen, the coarse material is returned to the mouth in the form of

a bolus. The bolus is chewed again and reswallowed. This continues until the physical character of the rumen contents is such that re-cycle is no longer possible. The usual retention time in the paunch is about 24 hours.

Fermentation, chewing and the mechanical action reduce the feed in the rumen to a semi-liquid, rich in microorganisms, fatty acids and other metabolic intermediates. A portion of the soluble nutrients and fermentation end products are absorbed through the rumen wall. Most of the short chain fatty acids are absorbed through the walls of the rumen and reticulum. Further absorption of nutrients takes place in the omasum. The remainder of the rumen contents makes its way to the abomasum for further digestion by the host animal.

The rumen and the reticulum are the sites of a symbiotic relationship between the host animal and numerous microorganisms. The microbes found in the rumen and reticulum include bacteria, protozoa, actinomycetis and yeasts. Gall et al (1947) noted that the bacterial concentration of rumen contents was approximately $10-150 \times 10^9$ bacteria per gram. Protozoa are the next most numerous organism in the rumen followed by actinomycetes and yeasts.

The microbes found in the rumen make it possible for ruminants to use low-quality roughages and synthetic chemical compounds such as urea. The organisms found in the rumen help break down cellulose and related compounds to usable nutrients. Under ideal conditions, probably all the essential vitamins that these animals require except Vitamins A and D are synthesized in the rumen and reticulum.

Some classes of bacteria are able to meet part of all of their protein

requirements, through the ammonia gas and probably other forms of nitrogen. Protein synthesis by the microorganisms found in the rumens of cattle and sheep make it possible for these animals to utilize proteins of low biological value and non-protein nitrogen.

The Concept of Non-Protein Nitrogen Feeding in Ruminant Nutrition

Zuntz (1891) suggested that the rumen microflora play a role, not only in cellulose digestion, but also in the utilization of non-protein nitrogen by ruminants. Morgan and associates (1907, 1911, 1910, 1921, 1922, 1924) contributed much in their urea feeding studies with sheep and dairy animals. They reported satisfactory replacement of 30 to 40 percent of the protein in sheep rations.

Voltz and associates (1920, 1922, 1924) were the first to investigate the hypothesis that protein in useful amounts could be synthesized from non-protein nitrogen sources through microbial action in the presence of suitable carbohydrates. They reported growth of lambs on a very low protein diet, which consisted of urea, starch, alkali-washed rye straw and inorganic salts. The scarcity of nitrogenous concentrates in Germany during World War I, and the development of the processes for nitrogen fixation gave great emphasis to these early investigations. German workers remained active in their research on the use of urea and other non-protein nitrogen compounds as protein substitutes in ruminant feeds.

Workers at the University of Illinois in cooperation with the DuPont Company did early work with urea in this country. Harris and Mitchell (1941) demonstrated by paired feeding that urea supplementation of a semi-purified sheep ration of low protein content resulted in nitrogen equili-

brium and improved digestibility of dry matter and cellulose.

The ruminant animal has apparently made use of urea for nutritional purposes ever since its appearance on earth. The ruminant has had an exogenous as well as an endogenous source of non-protein nitrogen down through the ages. The data of Perkins et al (1952) clearly demonstrates that standard feed ingredients such as alfalfa, oats, protein meals, and wheat mill products contain non-protein nitrogen.

McDonald (1952) observed that the saliva of sheep will supply approximately one gram of natural urea to the rumen each day. In larger animals such as the cow, approximately ten grams of urea will be supplied in saliva each day.

It has been suggested that urea may be secreted from the rumen wall in periods of nutritional stress. Houpt (1958) noted that up to 15 grams of urea were secreted from the rumen walls of a sheep each day. It was also noted that camels, during periods of nutritional stress, excrete only 1 to 2 percent of the urea in the glomeruli. When adequate protein is present, camels usually excrete about 40 percent of the urea which reaches the glomeruli. It was stated that the variations in urea clearance appear to be independent of plasma urea concentration and the glomerular filtration rate. Urea clearance seems to be related to nitrogen intake and growth.

It appears that the ruminant has a mechanism whereby it can conserve nitrogen by recycling it back into the rumen. The data of Belasco (1954) indicates that rumen microflora can utilize creatine, creatinine, purines, and pyrimidines as nitrogen sources raises the question of whether other

nitrogen excretory products are similarly conserved.

The Relationship of Blood Urea Values to Protein Utilization

It was shown by McDonald (1952) that ammonia liberated in the rumen is absorbed into the ruminal veins and carried along the portal veins to the liver. Because ammonia is not normally found in the peripheral blood, it has been presumed that all the ammonia absorbed from the rumen is converted to urea in the liver. It is probable that the urea so formed is partially returned to the rumen in the saliva.

It has been observed by Lewis (1957) that the efficiency of utilization of protein consumed by the ruminant is influenced by the quantity of ammonia produced in the rumen. Preliminary observations indicated that the level of blood-urea in sheep is relatively constant and dependent upon protein level in the diet. Changes in diet lead to different levels of blood urea concentrations which can be correlated with different rumen-ammonia concentrations. Blood-urea values follow increases or decreases in rumen ammonia after a delay period of four to eight hours. Fluctuations in blood-urea concentration in the sheep are not primarily due to changes in overall nitrogen intake.

One of the most common methods of blood urea nitrogen determination is the aeration method of Van Slyke and Cullen, (1914). Repp et al (1955) ran 350 blood urea determinations to determine toxicity of various non-protein nitrogen compounds using the aeration method. Lambs weighing less than 100 pounds were used in the study. Urea toxicity was noted when 30 grams of urea were fed daily. Death usually resulted when 40 grams of urea were given. Blood urea levels ran from a normal 10-20 milligrams per-

cent to around 100 where death usually followed. It was noted that death probably resulted due to toxic product formation in the rumen rather than due to high blood urea values.

The Effect of Non-Protein Nitrogen on the Utilization of Nitrogen

Nitrogen balance studies were made by Harris and Mitchell (1941) using eight Rambouillet sheep; the sheep weighed 27 to 40 kilograms. Nitrogen balance was maintained on a high roughage ration when 161 milligrams of casein nitrogen or 202 milligrams of urea-nitrogen was supplied per kilogram of body weight daily. The ration consisted of the following percentage composition--25 wheat straw, 10.5 wood pulp, 28.42 corn starch, 25 brown sugar, 4.5 corn oil, 2 salt mixture and 0.58 citric acid. At equilibrium, the biological value of urea nitrogen was 62 and casein nitrogen was 79. Considerable variability was noted in individual animals' ability to convert urea. Low levels of urea were more effective than higher levels.

Wegner et al (1941) made observations on the chemical changes of rumen ingesta with and without urea. A fistulated heifer was fed a high roughage ration consisting of timothy hay, corn, oats, and corn silage. The crude protein of the ration was 8.45 percent. In the rumen, the protein level increased to 11.8 percent at five hours after feeding. Non-protein nitrogen in this control ration was 0.17 percent. At the end of one hour after feeding, it was 0.25 percent in the rumen contents, and decreased to a value around 0.09 percent.

Urea was added to the ration at the rate of one percent on a dry matter basis giving a crude protein level of 11.3 percent to 12.1 percent in the rumen. The non-protein nitrogen in the rumen started at 0.98 percent

and dropped in one hour to 0.34 percent. In five hours, it had dropped to around 0.1 percent. The data showed that urea was hydrolyzed within one hour, and that the liberated ammonia had disappeared from the rumen in four to six hours. It was noted by Wegner et al (1941) that in rations high in roughage, that the utilization of urea-nitrogen decreased when the protein level of the rumen contents reached 12 percent.

Urea has been fed in combination with succulent corn silage. Van Arsdell et al (1953) noted that corn urea protein supplement fed to fattening steers gave a greater feed efficiency and improved carcass quality over similar levels of soybean oil meal, and corn and soybean oil meal. Purdue supplement A was used as the control.

Chicken litter has been used as a source of non-protein nitrogen for fattening steers. Noland (1955) reported that ground chicken litter was a better protein supplement than soybean oil meal in fattening beef steers. Chicken litter was far superior as a protein supplement than was ammoniated molasses. In this case, as in many others, the feeding of ammoniated molasses caused a condition where cattle seemed to go beserk. Non-protein nitrogen found in chicken litter is mostly in the form of uric acid.

The Effect of Urea on Digestibility of Lignin and Cellulose

Urea has the effect of increasing the digestibility of the cellulose in the ration. Harris and Mitchell (1941) noted that when urea was fed in combination with a high roughage ration, cellulose digestibility was increased. The study, using eight Rambouillet sheep which weighed from 27 to 40 kilograms, showed that the digestibility of lignin was unaffected. The digestibility of dry matter was increased in the trial.

The bovine ruminant possesses no salivary enzyme for the degradation of cellulose; nor is there any such enzyme secreted into the rumen. The breakdown of cellulose in the ruminant is performed by the flora found in the rumen. (Doetsch and Robinson 1953).

Burroughs et al (1953) showed that many feeds influence rumen micro-organisms in cellulose digestion. Dried distillers solubles, soybean oil meal, and linseed oil meal seemed to be the most helpful. Adequate nitrogen must be present in the ration to support good cellulose decomposition.

Byers (1957) reported that when urea was added to an all corn ration, the digestibility of all nutrients except fat was increased. Digestion coefficients for the corn and corn plus urea rations were, protein 52.48, 68.81; fiber 48.10, 51.35; fat, 71.22, 71.01; NFE, 69.36, 74.95.

The Effect of Alfalfa on Urea Utilization

Bentley and Moxon (1952) reported that in a feeding trial with 39 percent of the protein in the ration coming from urea, that alfalfa ash (copper, cobalt, manganese, zinc, and iron) improved daily gains 43 percent. The alfalfa ash increased daily gains from 1.34 pounds to 1.92 pounds. Feed consumption per 100 pounds of gain was cut 77 pounds.

Alfalfa is high in iron. Burroughs (1951) reported that iron stimulated urea utilization in the artificial rumen. It was also noted in this trial that phosphorus had no effect on urea utilization.

Pelleting of a feed affects the digestibility of the product. Meyer et al (1959) reported increased feed efficiency due to the pelleting of sun-cured alfalfa.

The Effect of Antibiotics on High Roughage Rations for Cattle and Sheep

One of the first trials in which antibiotics were fed to ruminants was at Oklahoma. Bell et al (1950) fed aureomycin to steers in balance trials. Urea was fed in combination with one of the rations tested. Aureomycin was first fed at a level of 0.6 grams daily. These rations produced marked anorexia and diarrhea within 48 to 72 hours after the aureomycin was given. In a second trial, the level of aureomycin was cut to 0.2 grams daily, but the same symptoms were demonstrated as with the high level. Digestibility of dry matter and crude fiber was decreased 15 and 50 percent respectively.

Aureomycin was fed to lambs by Colby et al (1950). The antibiotic was added to the ration at the level of 100 milligrams daily. Animals which received aureomycin went off feed and gained considerably less than did the control lambs.

Bridges et al (1953) fed various levels of aureomycin to determine the effect of high and low levels of this antibiotic. Aureomycin as a feeding supplement was fed to lambs at levels of 1.1 to 15.0 milligrams per pound of feed. The rations were composed of milo and alfalfa hay; and milo, cottonseed meal and alfalfa hay. Increases in rate of gain resulting from feeding the aureomycin were relatively small and were not significant statistically. An apparent improvement in feed efficiency was evident when aureomycin was fed at levels of 2.2 to 5.0 milligrams per pound of feed.

The National Research Council's Nutrient Requirements of Domestic Animals No. V Nutrient Requirements of Sheep recommended a level of five

to ten milligrams of antibiotics per pound of feed in 1957. The greatest response to antibiotics seems to have occurred under conditions of stress.

Chlortetracycline (Aureomycin) and oxytetracycline (terramycin) have been used most frequently in lamb rations, reports the National Research Council.

In many cases, the inclusion of antibiotics at low levels have increased feed efficiency in high roughage rations.

The effect of aureomycin rumen contents of cattle has been studied by Hungate et al (1955). Rumen samples were studied in vitro to study the effects of inhibition on rumen contents. It was noted that when the antibiotic concentration reached over six micrograms per liter of rumen contents, that inhibition was exhibited. Inhibition was demonstrated by reduction in gas production from the rumen sample. Rumen organisms were able to develop a resistance to the effect of the antibiotics if it had been given for a long time. It took higher levels of streptomycin to cause inhibition using the same technique.

Aureomycin, when used in combination with urea, promoted growth rate in dairy calves, reports Lassiter et al (1955). Aureomycin had no effect on blood urea levels in the calves receiving both urea and the antibiotics.

Little information is available on the effect of antibiotics on the utilization of non-protein nitrogen. Antibiotics have been used in combination with urea in many rations, but the effects have not been studied. Thomas and Bellows (1957) studied the blood urea nitrogen values after a urea and terramycin capsule was given to a steer. It was noted that terramycin brought about a slower increase in blood urea nitrogen. They theo-

rized that the antibiotic had prolonged the hydrolysis of urea to ammonia, and might possibly result in an increased utilization of urea.

It has been reported by Leffel et al (1957) that aureomycin has had an effect of lowering the digestibility of the various feed nutrients. Fatty acid production was measured using radio active techniques and no difference was noted due to aureomycin on an alfalfa hay, barley ration.

Not all workers agree with Leffel et al (1957). Lambert and Jacobson (1957) reported that aureomycin feeding increased cellulose decomposition in the rumen. Nylon bags containing cellulose (solka floc) were introduced into the rumens of fistulated steers. Cellulose digestion was estimated by the disappearance of cellulose from the bags in 48 hours.

PROCEDURE

Wintering Calves with Dehydrated Alfalfa Silage

Sixteen Hereford steer calves, obtained from the Montana Agricultural Experiment Station Red Bluff herd, January 21, 1958, were randomly divided into two lots of eight animals each. The cattle were fed at the Fort Ellis steer barns. The feed lots consisted of a shed and outside exercise lots. Individual feeding stalls were used, and animals were held in the stalls for about four hours after feeding. Just before the animals were released, any feed not eaten was weighed back and removed. A common water tank was located inside the shed. Mineral boxes were located in the two lots. One box contained iodized salt and the other steamed bone meal.

The cattle were held off feed and water for 20 hours before they were weighed on and off the trial. During the trial, the cattle were weighed at 28-day intervals. The cattle were weighed on the trial February 25, 1958, and they averaged 473 pounds in weight at that time. The cattle were numbered with a black dye at the beginning of the trial to enable the feeder to identify the animals for individual feeding. The cattle were fed a grain ration which consisted of 75 percent barley, 10 percent oats and 15 percent wheat mixed feed. Grass hay was fed to both lots. One lot received dehydrated sun-cured alfalfa pellets. The other lot received dehydrated alfalfa silage pellets. The experimental design is shown in Table I.

The animals were individually fed and both lots received the same amount of feed. The animals were started out on two pounds of the grain ration and 0.5 pounds of each type of alfalfa pellets. The intake of hay

TABLE I. THE EXPERIMENTAL DESIGN OF THE 1958 STEER WINTERING TRIAL

Lot Number	1	2
Number of Head	8	8
Treatment		
Grain ration ^{1/}	X	X
Grass hay	X	X
Dehydrated sun-cured alfalfa pellets	X	0
Dehydrated alfalfa silage pellets	0	X

^{1/} The grain ration consisted of 75 percent barley, 10 percent oats and 15 percent wheat mixed feed.

was limited to five pounds daily throughout the trial. The level of pellets fed during the trial was increased as rapidly as the animals would clean them up in the four hours they were held in the stalls. Every attempt was made to obtain maximum consumption of the pellets. The cattle were fed this wintering ration for 77 days.

Fattening Calves With Dehydrated Alfalfa Silage

After the wintering period, the cattle were continued on a fattening study using the same rations. The level of the grain ration was increased to get the cattle on full feed. Two pounds of sun-cured alfalfa pellets were added to the dehydrated silage pellets that each animal received daily to increase total feed consumption. The cattle were fattened for 156 days after the wintering period. The cattle in lot 1 averaged 625 pounds in weight and the cattle in lot 2 averaged 593 pounds in weight at the start of the fattening period. One steer was removed from lot 1 during the trial

when it was suspected it had hardware disease. When slaughtered, it was noted that the trouble was a liver abcess. Two steers were removed from lot 2 during the trial. One steer died and the other was taken for a rumen fistula operation for another trial. The cause of death of the steer that died was undetermined.

Both pellets fed were one-fourth inch in diameter. The silage in the dehydrated silage pellets was ensiled in a trench. The pellets were a dark burnt brown color and had a very offensive odor. The predominant odor was that of butyric acid. Proximate chemical analysis of the pellets used in the trial was determined by the Chemistry Department at Montana State College. Table II shows the proximate analysis data obtained.

TABLE II. PROXIMATE CHEMICAL ANALYSIS OF DEHYDRATED SUN-CURED ALFALFA AND DEHYDRATED ALFALFA SILAGE PELLETS.

	H ₂ O ^{1/}	Protein	E.E. ^{2/}	C.F. ^{3/}	Ash
	%	%	%	%	%
Dehydrated alfalfa silage pellet	8.4	12.9	2.6	16.1	12.1
Dehydrated sun-cured alfalfa pellet	10.7	12.5	1.7	34.9	7.1

- ^{1/} Moisture
^{2/} Ether extract
^{3/} Crude fiber

The Use of Dehydrated Alfalfa Silage Pellets and Dehydrated Ammoniated Alfalfa Silage With and Without Terramycin in Wintering Steer Calves

Fourteen Hereford steer calves from Montana State College Red Bluff herd and two calves purchased from the Climbing Arrow Ranch were put on test January 15, 1959. The calves averaged 560 pounds in weight at the time the trial began. The cattle had been fed as much grass hay as they would clean up for six weeks preceding the trial. The calves were fed at

the Fort Ellis steer sheds located East of Bozeman. The experimental conditions were similar to those described in the previous trial. A high phosphorus supplement was used in place of steamed bone meal in this trial. All of the cattle were fed barley pellets. Terramycin was added to the barley pellets that four head in each lot received so that each steer received 75 milligrams daily. Five pounds of grass hay were fed daily throughout the trial. Lot 6 received dehydrated ammoniated alfalfa silage and lot 7 received dehydrated alfalfa silage pellets. The experimental design is shown in Table III.

TABLE III. EXPERIMENTAL DESIGN OF 1959 STEER FEEDING TRIAL AT FORT ELLIS.

Lot Number	6A	6B	7A	7B
Number of Head	4	4	4	4
Treatment				
Ammoniated dehydrated alfalfa silage pellets	X	X	0	0
Dehydrated alfalfa silage pellets	0	0	X	X
Barley pellets	X	0	X	0
Barley pellets and terramycin <u>1</u> /	0	X	0	X
Grass hay	X	X	X	X

1/ Two pounds of these pellets supplied 75 milligrams of terramycin daily. Barley pellets without terramycin made up the remainder of the barley fed after the initial two pounds.

The steers were started on feed, and the level of feed was raised as rapidly as possible until full feed was reached. The level of feed was raised when all of the calves were cleaning up their feed. The level of

feed was kept the same for all the animals; thus, the good eaters were held back by those which were reluctant to go on feed. Initially, the steers were fed one pound of silage and one pound of barley pellets. It was intended that the level of the silage pellets and the barley be kept the same, and that the hay intake be limited to five pounds daily after the calves were on feed. It soon became apparent that the silage was unpalatable. The level of barley pellets was increased and the silage pellets were increased whenever possible.

The ammoniated dehydrated alfalfa pellets were produced by stacking green alfalfa and covering with an air-tight plastic cover. Ammonia gas was pumped in after the cover was placed on the stack. The silage was later dehydrated and pelleted through a one-fourth inch dye. Proximate chemical analysis are given in Table IV. Digestibility studies were run

TABLE IV. PROXIMATE CHEMICAL ANALYSIS OF THE FEEDS USED DURING THE 1959 TRIAL.

	Ammoniated Dehydrated Alfalfa Silage Pellets	Dehydrated Alfalfa Silage Pellets	Barley Pellets	Barley Pellets and Terramycin
Moisture %	7.7	5.2	6.6	8.1
Crude Protein %	16.3 ^{1/}	13.2	12.2	12.2
Ether Extract %	2.6	1.6	2.5	2.1
Crude Fiber %	36.2	38.3	6.0	4.6
Ash %	19.6	18.5	2.7	2.4

^{1/} Contains 2.8 percent non-protein nitrogen.

on this product using three sheep of Targhee breeding. Digestibility was determined by difference. A level of 400 grams of the silage pellets were

fed in combination with 900 grams of sun-cured alfalfa pellets daily.

The dehydrated alfalfa silage pellets were made from silage produced in a trench silo. The alfalfa silage used in these pellets was not the same quality of alfalfa used in the ammoniated product. The silage was purchased from a ranch near Townsend, Montana, by the Belgrade Alfalfa Mill.

No attempt was made to evaluate the quality of this product. Briggs (1959) stated that there is no accurate way to assess a sample of silage other than an actual feeding trial. The dehydrated alfalfa silage pellets were pelleted through a one-fourth inch die. Proximate chemical analysis are shown in Table IV.

Digestion Studies to Determine the Effect of Urea and Urea and Terramycin on the Apparent Digestibility of Sun-Cured Alfalfa Pellets.

The growth rates of steer calves were used as a means of judging the performance of the dehydrated alfalfa and ammoniated alfalfa silage pellets in the first part of this trial. It was felt that digestion studies would be a more direct method of measuring the response of the animals to urea and terramycin.

Sheep were selected for conducting digestion trials. Three yearling, wether lambs of Targhee breeding and one lamb of Columbia breeding were used. The eartag numbers and weights in pounds of these lambs at the beginning of the trial were as follows: 8002X, 124; 8004X, 118; 8093X, 108; and 8705V, 94.

Digestion stalls were of the design described by McCall, (1943). Collection bags were made of canvas and were similar to those described

by Forbes, (1937).

The sheep used in the trial had previously been used in digestion trials. These trials had been about two months long. The sheep were allowed a week in a dry lot at the sheep barn between trials. During this time, they were fed the same ration as the one which was used in the digestibility studies. The animals were well accustomed to the digestion stalls when they were put in. The sheep were tended twice a day at nine in the morning and again at five in the afternoon. At these times, the animals were fed, watered, and the collection bags emptied.

In studying the effect of urea and urea and terramycin in combination, on the apparent digestibility, the dehydrated, sun-cured alfalfa pellets were chosen to serve as the ration. A mixture of one-third bone meal and two-thirds salt was supplied to the sheep ad libitum. The sun-cured alfalfa pellets were one-quarter inch in diameter.

The sheep received 1,300 grams of alfalfa pellets daily. They were fed 650 grams at each feeding. The level of feed intake was calculated to be at the maintenance level or just above using the National Research Council standards (1957).

Feces were weighed immediately after they were collected, and ten percent of the feces were dried over a steam radiator for chemical analysis. The feces were dried for one week after the last sample was taken, and then weighed to determine moisture loss. The samples were then ground in a Wiley Mill through a one millimeter screen and set aside for chemical analysis. Preliminary periods and collection periods were seven days in length.

In the first digestion period, the digestibility of the alfalfa pellet was determined. During the second period, the digestibility of the alfalfa pellet plus thirteen grams of feed grade urea was determined. In the third period, the digestibility of the alfalfa pellet plus urea and terramycin was determined.

Urea was added to the ration during the second digestion period. One percent or 13 grams of 42 percent nitrogen feed grade urea were added to the daily ration. Six and one-half grams of urea were mixed with about ten grams of ground alfalfa pellets and put in the feed can; alfalfa pellets were added to give 656.5 grams for each feeding. The animals cleaned up all the feed and the additives in a very few minutes after feeding.

Terramycin (TM-10) was added to the alfalfa pellets and urea at the rate of 1.3 grams of (TM-10) daily. The level selected is the level recommended by the National Research Council Nutrient Requirements of sheep. This corresponds to the level of ten milligrams of terramycin per pound of feed. The terramycin was added to the urea in the amount of 0.65 grams, and was mixed with about ten grams of ground alfalfa pellets just prior to each feeding.

Chemical analyses of the feeds and feces were done at the Animal Nutrition Laboratory at Montana State College by the author. The AOAC procedures were used.

All samples were run in duplicate and any determinations that did not agree were conducted again. All digestion coefficients were calculated on a dry matter basis.

Blood Urea Studies

Blood-urea nitrogen values were determined on the same sheep used in the digestibility studies.

Blood samples were taken from the jugular vein of the sheep following each collection period. When blood samples were to be taken the sheep were fed and tended at the usual time. The first blood sample was taken 15 minutes after the sheep were fed. This allowed adequate time for the sheep to clean up all the feed. In most cases, the sheep had cleaned up their feed in less than five minutes. Sheep number 8004X was omitted from the blood work as he was a slow eater and would not have given values corresponding to the other sheep. The blood samples were run for urea nitrogen at the Animal Nutrition Laboratory at Montana State College. Blood-urea was determined by the aeration method (Van Slyke and Cullen, 1914).

RESULTS AND DISCUSSION

Wintering Calves With Dehydrated Silage

The primary objective of the steer wintering trial was to test the value of dehydrated alfalfa silage pellets. It was therefore desirable to feed the maximum amount of pellets. It became apparent at the start of the trial that the pellets were not palatable. The levels of the grain ration and hay were held to a minimum to obtain maximum consumption of the silage pellets. The control lot, fed the sun-cured alfalfa pellets, cleaned up all of their feed in a short time. It appeared that these cattle would have gone on a higher level of feed. Table V shows the results of the 77-day wintering trial.

The gains and feed efficiency of the lot which received the dehydrated silage pellets were less than the control lot, the average weight gains being 120 and 160 pounds respectively. The palatability of the silage pellet seemed the limiting factor as to the utilization of this feed. The animals appeared to be healthy and the only difficulty observed was the loss of appetite. Noland (1955) reported that some cattle have gone beserk on ammoniated feeds. This condition was not noted during the trial.

Fattening steers Using Dehydrated Silage

The evaluation of a product such as dehydrated alfalfa silage, can best be determined by feeding the maximum amount of the product to test animals. During the wintering period discussed previously, the calves were fed as much silage as they would consume.

The primary objective of the fattening trial was to determine the value of dehydrated alfalfa silage in fattening rations. The level of

TABLE V. THE RESULTS OF WINTERING CALVES FOR 77 DAYS TESTING DEHYDRATED ALFALFA SILAGE AND SUN-CURED ALFALFA PELLETS.

Lot Number	1	2
Treatment		
Dehydrated sun-cured alfalfa pellets	X	
Dehydrated alfalfa silage pellets		X
Number of Head	8	8
Average weights, pounds		
Initial	474	462
Final	634	592
Gain	160	120
Daily gain	2.08	1.56
Feed per cwt. gain		
Grain ration	188	251
Pellets	156	208
Hay	241	321
Total	585	780

grain fed was increased and the silage pellets were fed in an amount as not to lower the total feed consumption of the lot. Two pounds of dehydrated sun-cured alfalfa pellets were added to the silage pellets that each steer received daily. This had the effect of increasing the total feed intake. The results of the trial are shown in Table VI.

TABLE VI. THE RESULTS OF FATTENING CATTLE 156 DAYS USING DEHYDRATED ALFALFA SILAGE AND SUN-CURED ALFALFA PELLETS.

Lot Number	1	2
Treatment		
Dehydrated sun-cured alfalfa pellets	X	
Dehydrated alfalfa silage pellets <u>1/</u>		X
Number of Head	7	6
Average weight, pounds		
Initial	625	593
Final	936	901
Gain	311	308
Daily gain	1.93	1.90
Feed per cwt. gain		
Grain ration	393	393
Pellets	265	249 <u>2/</u>
Hay	251	251

1/ Two pounds of sun-cured alfalfa pellets were added to the silage pellets that the animal received daily.

2/ The total average amount fed each animal consisted of 457 pounds of the silage pellet and 312 pounds of the sun-cured alfalfa pellet.

At the conclusion of the trial the cattle were taken to Spokane and slaughtered. The cattle all graded U. S. good with one steer grading standard. The weight gains of steers fed during both the wintering and fattening periods were retarded by the low level of feed intake of the lot

that received the silage pellet. Just before the cattle were sold, they were eating 11 pounds of the grain ration and four pounds of the pellets daily. Steers of these weights on full feed should have been eating about 20 pounds of grain daily. The palatability problem of the dehydrated silage pellet was probably responsible for the poor feed intake and subsequent poor gains. The lot that received the sun-cured alfalfa pellet would have undoubtedly consumed a much higher level of feed.

Feeding Dehydrated Alfalfa Silage Pellets and Dehydrated Ammoniated Alfalfa Silage Pellets With and Without Terramycin.

It was intended that the steers be fattened when this project was initiated. The level of feed was increased as rapidly as possible without throwing the cattle off feed. Within a few weeks after the cattle were started, it became quite apparent that there was a definite palatability problem with both the ammoniated and dehydrated alfalfa silage pellets. The cattle would not clean up any great amount of feed as long as these pellets were present. It was then decided to feed the cattle at the same level. Thus, the feed fed would have the effect of only being a wintering ration.

The average daily ration after 28 days on feed was four pounds of barley pellets, (treatments B had terramycin added to two pounds of these pellets to provide 75 milligrams per day), three pounds of the ammoniated or dehydrated alfalfa silage pellets, and five pounds of grass hay. Later, the hay was decreased to four pounds daily in an effort to obtain greater consumption of silage and barley. Table VII shows the average weights and gains made by the steers throughout the 110-day period.

TABLE VII. WEIGHT GAINS MADE BY STEERS DURING THE 110-DAY FEEDING PERIOD.

Lot Number	6A	6B	7A	7B
Treatment	No OTC <u>1/</u>	OTC	No OTC	OTC
Ammoniated dehydrated alfalfa silage pellets	X	X		
Dehydrated alfalfa silage pellets			X	X
Number of Head	4	4	4	4
Average weights, pounds				
Initial	444	465	469	466
Final	556	594	579	601
Gain	112	129	110	135
Daily gain	1.02	1.17	1.00	1.23
Feed per cwt. gain				
Barley pellets	297	277	322	280
Silage pellets	235	219	248	218
Hay	489	427	500	407

1/ OTC Oxytetracycline (terramycin)

The data shown in the table indicates that there was not much difference in gains as affected by the silage treatments. All of the steers that received the dehydrated alfalfa silage pellet had an average daily gain of 1.11 pounds daily. The steers that received the ammoniated silage pellet had an average daily gain of 1.10 pounds.

No real differences were obtained from this trial as to the feeding advantages of the two pellets. It should be added here that even though

it is hard to tell the quality of a silage sample, that the plain silage was probably a higher quality product as it was removed from the silo than the ammoniated silage. Both silage pellets, when inspected, usually were a dark burnt brown color. Both pellets had somewhat of an offensive odor. (Butyric acid). Briggs (1959) stated that a butyric acid fermentation in a silo is undesirable. Butyric acid is formed in the presence of aerobic conditions and in general indicates a low quality silage.

Before dehydrated silage can be adequately tested, the palatability problem of this product must be solved. The results of this trial indicate that dehydrated silage had apparently lost a good portion of its value during the ensiling dehydration or pelleting process. It is felt that a major problem in the dehydration of silage is the loss of the volatile fatty acids. The process of fermentation in a silo reduces many of the readily available carbohydrates to fatty acids. When the silage is fed in the succulent form, these fatty acids are available to the animal. This may, in part, explain the excellent results which have been obtained through feeding silage. Many vitamins are synthesized during the fermentation process in a silo. It is quite probable that these vitamins and other factors are destroyed during the heat of dehydration. The temperatures used in commercial dehydrators often reach in excess of 1000 degrees Fahrenheit.

The process of pelleting involves temperatures in excess of 200 degrees Fahrenheit. A major, unsolved problem in relation to dehydration of silage is to determine the actual loss of nutrients. The proximate chemical analysis of the silage indicated an ash content of 21.4 percent on a dry-matter basis. Chemical analysis data taken from Morrison (1956)

indicates that regular alfalfa silage has an ash content of 10.7 percent on a dry matter basis. This difference is probably an indication of loss of digestible nutrients in the dehydrated silage.

During the period that the cattle were fed the dehydrated silage, the cattle developed no visible symptoms of any disease. This is in contrast to some trials where difficulty was encountered when cattle were fed ammoniated products.

Weight gains made by the cattle fed the two silage products were very poor. The most apparent reason was the poor palatability. It appears that further work is necessary to improve the product.

The Apparent Digestibility of Ammoniated Dehydrated Alfalfa Silage Pellets

The apparent digestibility of ammoniated dehydrated alfalfa silage pellets was determined by difference, using three sheep of Targhee breeding. The apparent digestibility is indicated in Table VIII.

An attempt was made to determine the digestibility of the silage pellet directly, but the sheep developed scours and had to be taken off this feed.

TABLE VIII. THE APPARENT DIGESTIBILITY OF AMMONIATED DEHYDRATED ALFALFA SILAGE PELLETS ON A DRY MATTER BASIS.

	Protein	E.E. 1/	C.F. 2/	NFE 3/	TDN 4/
	%	%	%	%	%
Ammoniated Dehydrated alfalfa silage pellets	11.21	1.69	27.84	16.34	59.78

1/ Ether extract.

2/ Crude fiber.

3/ Nitrogen-free extract.

4/ Total digestible nutrients.

The Effect of Terramycin on Gains and Feed Efficiency

The effect of terramycin on rations fed to steers at Montana State College in 1959 is shown in Table VII, Page 35. Half of the steers in each of the two lots (ammoniated dehydrated alfalfa silage and dehydrated alfalfa silage pellet fed lots) received 75 milligrams of terramycin daily. The steers that received terramycin gained at a more rapid rate than the animals which did not receive terramycin. The gains may not be as real as they appear in Table VII. In looking at the individual gains of the animals, Table IX, it is noted that there is much individual variability within the lots. The gains were not statistically significant.

Steer number 402 was treated for liver abcess March 13, 1959. In reviewing individual gains, it is quite apparent that had this steer not been sick his gains may have had considerable effect on the gains as affected by terramycin in lot 6. It is also possible that had this steer been receiving terramycin that it might not have been troubled with the liver abcess. While the gains as affected by terramycin were too variable to be statistically significant, terramycin did increase the average rate of gain.

Terramycin increased feed consumption and feed efficiency in both lots. The effect of terramycin on feed efficiency is shown in Table VII. The average and individual feed consumption of the steers is given in Table X. The table shows that the steers which received terramycin refused less feed. All individual steers that received terramycin had a feed consumption in excess of the average of the steers without terramycin. The advantage of feeding terramycin was apparent in relation to increasing the appetite of the steers in this trial.

TABLE IX. WEIGHT GAINS OF INDIVIDUAL STEERS (1959)

Lot 6A. Ammoniated dehydrated alfalfa silage pellets
plus barley pellets and grass hay

<u>Animal</u>	<u>Initial Weight</u>	<u>Final Weight</u>	<u>Gain</u>	<u>Average Daily Gain</u>
812	460	595	135	1.23
815	440	545	105	.95
817	425	535	110	1.00
402 ^{1/}	450	550	100	.91

Lot 6B. 75 milligrams terramycin added daily to two
pounds of the barley pellets

803	520	670	150	1.36
820	450	575	125	1.14
805	430	575	145	1.32
844	460	555	95	.86

Lot 7A. Dehydrated alfalfa silage pellets plus barley
pellets and grass hay

823	490	610	120	1.09
814	500	610	110	1.00
816	465	585	120	1.09
418	420	510	90	.82

Lot 7B. 75 milligrams terramycin added daily to two
pounds of the barley pellets

809	475	565	90	.80
822	465	635	170	1.55
890	475	580	105	.95
807	450	625	175	1.59

^{1/} Steer No. 402 treated for liver abscess, April 1, 1959. The March 13th weight on this steer was 525 pounds, on April 13th, this steer weighed 510 pounds.

TABLE X. FEED CONSUMPTION OF INDIVIDUAL STEERS

Lot 6A. Ammoniated dehydrated alfalfa silage pellets
plus barley pellets and grass hay

<u>Steer No.</u>	<u>Barley Pellets</u>	<u>Silage Pellets</u>	<u>Grass Hay</u>
61	373.5	296.5	550.0
62	331.0	256.5	550.0
63	324.5	260.5	550.0
64	308.0	243.0	550.0
Average	334.2	264.1	550.0

Lot 6B. 75 milligrams terramycin added daily to two
pounds of the barley pellets fed in lot 6A

65	373.5	295.5	550.0
66	361.0	282.5	550.0
67	344.0	269.0	550.0
68	350.5	282.5	550.0
Average	357.2	282.4	550.0

Lot 7A. Dehydrated alfalfa silage pellets plus
barley pellets and grass hay

71	346.5	268.0	550.0
72	358.5	279.0	550.0
73	358.0	278.0	550.0
74	356.0	264.5	550.0
Average	354.8	272.4	550.0

Lot 7B. 75 milligrams of terramycin added to two
pounds of the barley pellets fed in lot 7A

75	369.0	290.0	550.0
76	374.5	297.5	550.0
77	367.5	291.5	550.0
78	374.5	297.5	550.0
Average	378.1	294.1	550.0

The Apparent Digestibility of Sun-Cured Alfalfa Pellets

The procedures involved in determining the digestibility of a feed measures only one loss of energy from the animal. The loss of nutrients in the feces is not the only source of energy loss from the animal body but it is the largest and the most variable. Nutrients are also lost from the animal in the urine and in the combustible gases. Although they do not account for all the losses of nutrients, digestibility studies are the most economical method of evaluating a feed. The study made it possible to study the effect on digestibility of urea and of terramycin and urea in combination.

The digestion coefficients were all computed on a dry-matter basis. During each of the three collection periods, 9,100 grams of alfalfa pellets or 8,385.65 grams of dry matter were fed. The proximate chemical analysis of the alfalfa pellets fed is shown in Table XI. The table indicates all nutrients on a dry-matter basis.

TABLE XI. PROXIMATE CHEMICAL COMPOSITION OF DEHYDRATED SUN-CURED ALFALFA PELLETS ON A DRY MATTER BASIS.

Protein	Ether Extract	Crude Fiber	NFE	Ash
%	%	%	%	%
16.57	1.72	36.12	37.23	8.36

The total grams of fecal dry matter collected during the control period follows for the individual sheep: 8002X, 3828.14; 8004X, 3898.32; 8093X, 4138.08; and 8705V, 4188.94.

The apparent digestibility of dehydrated sun-cured alfalfa is shown in Table XII. The data is compiled using the average of four sheep.

TABLE XII. THE APPARENT DIGESTIBILITY OF SUN-CURED ALFALFA PELLETS
AVERAGE FROM FOUR SHEEP. (DRY-MATTER BASIS)

	Protein	Fat	Crude Fiber	N--Free Extract
Nutrients consumed, grams	1384.5	144.2	3028.4	3122.0
Nutrients excreted in feces, grams	451.0	140.8	1991.9	1033.4
Digested nutrients, grams	938.5	3.4	1037.0	2088.6
Coefficient of digesti- bility, %	67.75	3.76	34.24	66.90
Composition of ration, %	16.57	1.72	36.12	37.23
Digestible nutrients, %	11.23	.06	12.37	24.91

The TDN as computed from the data in Table XII was 48.65 percent on a dry matter basis. The digestion coefficients and chemical composition of fecal material for individual sheep are shown in Table XIII.

TABLE XIII. PROXIMATE CHEMICAL COMPOSITION ON A DRY MATTER BASIS OF INDIVIDUAL SHEEP FECES DURING THE CONTROL PERIOD. COEFFICIENTS OF DIGESTIBILITY ARE ALSO GIVEN.

	Protein	Ether Extract	Crude Fiber	NFE	Ash	Dry Matter
	%	%	%	%	%	%
Sheep No. 8002X.						
Composition of Feces	10.25	4.64	50.39	24.62	10.79	
Coefficient of Digestibility	71.76	-18.80	36.31	69.81		54.35
Sheep No. 8004X.						
Composition of Feces	11.60	2.92	48.31	28.01	9.17	
Coefficient of Digestibility	67.46	21.08	37.82	65.02		53.51
Sheep No. 8093X						
Composition of Feces	10.88	2.68	49.71	26.33	10.41	
Coefficient of Digestibility	67.60	23.11	32.09	65.10		50.65
Sheep No. 8705V						
Composition of Feces	12.16	3.84	50.09	24.10	9.81	
Coefficient of Digestibility	63.34	-10.34	30.71	67.66		50.05

The Apparent Digestibility of Sun-cured Alfalfa Pellets as Affected by the Addition of Urea

During the second collection period, the effect of urea on the digestibility of the sun-cured alfalfa pellet was determined. The effect of the addition of one percent urea to the basal ration can be seen in Table XIV. During the collection period, 9,100 grams of alfalfa pellets supplied 8,385.65 grams of total dry matter. Ninety-one grams of 42 percent nitrogen urea was also fed during the collection period. Total nitrogen for protein digestibility was determined by adding the 91 grams of urea to the protein in the alfalfa pellet. Because feed-grade urea contains very small amounts of other nutrients, the addition of the urea was not considered in calculating the coefficients of digestibility of the other nutrients except total dry matter digestibility.

The total grams of fecal dry matter collected during the second collection period were as follows: 8002X, 3695.79; 8004X, 3655.00; 8093X, 3669.15; and 8705V, 3856.66. A breakdown of the data on the apparent digestibility of sun-cured alfalfa as affected by the addition of one percent urea is shown in Table XIV.

The total digestible nutrients as computed from the data in Table XIV is 52.97 percent. The digestion coefficients and chemical composition of fecal material for individual sheep is shown in Table XV.

The addition of one percent urea to the basal ration increased the digestibility of all nutrients. The digestibility of total nitrogen in the ration was increased 10.59 percent. The total nitrogen in the ration consisted of 222 grams from the alfalfa pellet and 38.22 grams from the urea. Urea, thus, supplied 14.69 percent of the total nitrogen.

TABLE XIV. THE APPARENT DIGESTIBILITY OF SUN-CURED ALFALFA PELLETS PLUS 1% UREA USING AVERAGE DATA FROM FOUR SHEEP IN THE STUDY.

	Protein	Fat	Crude Fiber	N--Free Extract
Nutrients consumed, grams	1627.9	144.2	3028.4	3122.0
Nutrients excreted in feces, grams	389.1	96.7	1863.6	1010.4
Digested nutrients, grams	1238.8	47.5	1165.3	2111.6
Coefficient of digesti- bility, %	76.10	33.0	38.3	67.6
Composition of ration, %	16.6	1.7	36.1	37.2
Digestible nutrients, %	12.61	.57	13.91	25.17

Harris and Mitchell (1941), Wegner et al (1941), Burroughs et al (1950), and others have reported a decrease in digestibility of total nitrogen when urea was added to a ration. However, most workers have reported using higher levels of urea. Rations generally were higher in digestible protein than was the dehydrated, sun-cured alfalfa pellet used in this trial.

Byers (1957) reported a similar increase in digestibility of protein when urea was added to an all corn ration. The ration was mostly corn, silage, and ground shelled corn.

The standard procedure used in digestibility studies are subject to error in the case of non-protein nitrogen. The possibility remains that some or all of the urea nitrogen entered the blood stream and was excreted in the urine.

The apparent digestibility of ether extract was increased 88.59 per-

TABLE XV. PROXIMATE CHEMICAL COMPOSITION OF INDIVIDUAL SHEEP FECES AS INFLUENCED BY THE ADDITION OF 1% UREA TO THE RATION. COEFFICIENT OF DIGESTIBILITY IS GIVEN FOR EACH NUTRIENT (DRY MATTER BASIS)

	Protein	Ether	Crude	NFE	Ash	Dry
	%	Extract	Fiber	%	%	Matter
		%	%			%
Sheep No. 8002X						
Composition of Feces	10.02	2.58	49.72	28.12	9.56	
Coefficient of Digestibility	77.25	33.86	39.33	66.71		56.40
Sheep No. 8004X						
Composition of Feces	10.53	2.55	50.45	26.74	9.74	
Coefficient of Digestibility	76.36	35.38	39.12	68.69		56.88
Sheep No. 8093X						
Composition of Feces	10.43	2.69	50.16	28.15	8.57	
Coefficient of Digestibility	76.49	31.57	39.24	66.92		56.71
Sheep No. 8705V						
Composition of Feces	10.85	2.58	50.11	25.72	10.72	
Coefficient of Digestibility	74.30	31.01	36.20	68.23		54.50

cent. However, rations of this class have large proportions of substances having no relation to fats and of little nutritive value. Metabolic products found in the feces may account for a much greater protein of the total ether soluble material.

Considering the small amounts of fats found in the ration and the fecal metabolic products which enter into the calculation of the digestion coefficients, the chance for error in calculating the coefficient for this nutrient is great. The apparent increase in digestibility of ether extract with the addition of urea is probably not of much significance. If the increases are as real as they appear, urea would have beneficial effect as far as this nutrient is concerned.

The effect of urea on crude fiber digestibility is probably the most significant finding in trials where urea has been fed. The literature reveals many trials where urea has increased the digestibility of this nutrient. Probably the biggest benefit derived from feeding low levels of urea is in the increased utilization of crude fiber. The addition of one percent urea increased the digestibility of this nutrient 11.00 percent in this trial. The high roughage ration used contained 36.12 percent crude fiber, so the increase in digestibility of this nutrient would be more important than in the case of ether extract or protein.

The digestibility of nitrogen free extract was increased 1.09 percent when urea was added to the ration. Dry matter digestibility was increased 7.09 percent due to the addition of one percent urea to the ration.

Additional Observations Made When Urea was Added to the Ration

When 13 grams of urea were added to the daily ration, it was noted

that water consumption and urine output by the sheep nearly doubled.

Animals, in general, require more water on high protein diets. This is probably due to the animals increased needs for water for clearance of nitrogenous waste products.

During the urea feeding period, sheep number 8004X seemed to lose some of his appetite. This sheep cleaned up all of its feed in about 30 minutes. The other sheep cleaned up their feed in less than ten minutes.

The water that the sheep received was Bozeman City water which contained both chlorine and flourine. These substances may or may not have affected the results of the trial.

Mineral and salt consumption by the animals was high with each animal consuming about a pound of the salt bone meal mix each week.

The Apparent Digestibility of Sun-Cured Alfalfa Pellets as Affected by the Addition of Urea and Terramycin

During the third collection period, the effect of urea and terramycin on the digestibility of sun-cured alfalfa pellets was determined. During the collection period, 9,100 grams of alfalfa pellets and 91 grams of feed grade urea were fed. The ration contained 1.3 grams of TM-10 daily. The nutritive composition of the TM-10 was unknown. Because the terramycin carrier supplied a very small amount of nutrients, it was not included in figuring the coefficients of digestibility. The addition of urea to the ration was discussed in the previous discussion. The same procedures were used in determining the digestion coefficients.

The total grams of fecal dry matter collected during the period were as follows: 8002X, 3930.80; 8004X, 3930.80; 8093X, 3911.92; 8705V,

3959.22. Table XVI shows the apparent digestibility of the ration.

TABLE XVI. THE APPARENT DIGESTIBILITY OF SUN-CURED ALFALFA PELLETS PLUS UREA AS AFFECTED BY TERRAMYCIN.

	Protein	Fat	Crude Fiber	N--Free Extract
Nutrients consumed, grams	1627.9	144.2	3028.9	3122.0
Nutrients excreted in feces, grams	398.5	95.0	1863.1	1139.7
Digested nutrients, grams	1229.5	49.2	1165.8	1982.3
Coefficient of digesti- bility, %	75.5	34.1	38.5	63.5
Composition of ration, %	16.6	1.7	36.1	37.2
Digestible nutrients,	12.5	.6	13.9	23.6

The total digestible nutrients as computed from the data in Table XVII is 51.38. The digestion coefficients and the chemical composition of fecal material for the individual sheep are shown in Table XVIII. The average coefficients of digestibility for each nutrient during the three collection periods are shown in Table XVII.

TABLE XVII. COMPARISON OF THE COEFFICIENTS OF DIGESTIBILITY DURING THE THREE COLLECTION PERIODS (AVERAGE OF FOUR SHEEP)

	Dry Matter %	Protein %	Fat %	Crude Fiber %	N--Free Extract %
Control	52.14	68.04	3.76	34.24	66.90
Urea	56.12	76.10	32.96	38.47	67.60
Urea and terramycin	53.60	75.52	34.15	38.49	62.50

Terramycin appears to have decreased the digestibility of protein and nitrogen free extract in the ration. The findings of the trial in respect

TABLE XVIII. PROXIMATE CHEMICAL COMPOSITION OF INDIVIDUAL SHEEP FECES AS INFLUENCED BY THE ADDITION OF UREA AND TERRAMYCIN TO THE RATION. (DRY MATTER BASIS)

	Protein	Ether	Crude			Dry
	%	Extract	Fiber	NFE	Ash	Matter
	%	%	%	%	%	%
Sheep No. 8002X						
Composition of Feces	9.98	2.52	48.03	27.80	11.62	
Coefficient of Digestibility	75.90	31.32	37.67	65.00		53.63
Sheep No. 8004X						
Composition of Feces	10.04	2.41	47.15	29.60	10.75	
Coefficient of Digestibility	75.64	34.32	38.81	62.73		53.63
Sheep No. 8093X						
Composition of Feces	9.96	2.41	46.61	29.10	11.92	
Coefficient of Digestibility	76.07	34.63	39.80	63.54		53.85
Sheep No. 8705V						
Composition of Feces	10.49	2.32	47.68	29.40	11.15	
Coefficient of Digestibility	74.49	36.31	37.67	62.72		53.29

to terramycin are subject to error. Protein utilization cannot be accurately determined in a digestion trial. A nitrogen balance study may have given entirely different results. Blood-urea nitrogen studies in relation to the digestion studies indicated a high blood-urea level over a longer period of time when terramycin was fed with urea as compared to urea without terramycin. Had this blood-urea nitrogen been excreted in the urine, the digestion coefficient should have been high for protein when terramycin was added to the ration. The possibility remains that the urea was being secreted back into the rumen which appears to be desirable. Steers that were fed terramycin in combination with ammoniated dehydrated alfalfa silage, which contained 2.8 percent non-protein nitrogen, gained more than did the control group without terramycin. There appears to be a slight indication that terramycin may affect the utilization of non-protein nitrogen but the techniques used in this trial were not adequate to obtain any accurate findings.

The errors inherent in digestibility procedures are discussed at the end of this section under the subheading "Factors Which Affect Digestibility Procedures."

Nitrogen-free extract digestibility appeared to be decreased when terramycin was added to the ration which contained urea. Mitchell's (1942) observations on the determination of nitrogen-free extract digestibility by conventional techniques raises some question to the findings in this trial.

Hungate et al (1955) demonstrated that antibiotics can cause a decrease in gas production by rumen microorganism in vitro. If terramycin

reduced gas loss from the rumen, the digestion coefficients for nitrogen-free extract and crude fiber may have been affected.

On the basis of the digestibility studies, terramycin probably had a slightly adverse effect on the digestibility of the urea containing rations. The digestion coefficients of the urea containing ration without terramycin were slightly higher. Total digestible nutrients were increased from 48.65 percent on a dry matter basis on the alfalfa pellets to 52.97 percent by the addition of one percent urea to the ration. Terramycin decreased the total digestible nutrients of the urea ration to 51.38 percent.

It should be noted that sheep number 8705V was treated for coccidiosis about eight weeks before the trial began. After the digestion trials were concluded, it was noted that the sheep had a low hematocrit value. A blood sample was taken and this sheep had a hematocrit value of 24 percent. The other sheep ranged from 45 to 54 percent. The sheep was definitely anemic and probably should have been removed from the trial. It is not known if this condition was present throughout the trial. In looking at the data for individual sheep, it is noted that sheep number 8705V was less efficient than the other sheep. Computed total digestible nutrients for the ration and treatments were probably slightly lower than they might have been had this sheep been replaced at the start of the trial.

Factors Which Affect Digestibility Procedures

Mitchell (1942) reports that when breaking down carbohydrates into crude fiber and nitrogen-free extract, the apparent digestibility is ficticiously high since the gaseous products of carbohydrate fermentation are included with the digestible products. The apparent digestibility of

ether extract is of little significance in rations containing high amounts of roughage, reports Mitchell (1942). Rations of this class have large proportions of substances having no relation to fats and of little nutritive value. Metabolic products found in the feces may account for a much greater portion of the total ether soluble material.

Todd (1951) noted that altitude has a significant effect on crude fiber determination. High altitude has the effect of reducing the boiling temperature of the acid and alkali used in the determination.

Losses Associated with Storage of Feces for Drying and Chemical Analysis

Fecal samples are subject to varying losses of nutrients during the processes of storage and handling. Colovas (1957) made observations on errors involved in drying feces for protein and energy determinations. Protein (Kjeldahl) and energy (determined in a bomb calorimeter) were run on fresh and dried fecal samples. Protein losses on the dried fecal samples ran from -2.5 to 34.2 percent, and energy losses ranged from 4.1 to 21.0 percent. Both protein and energy losses were significant at the one percent level. Procedures used in the collection and storage of fecal samples varies widely. McCall (1943) used one percent sulfuric acid in alcohol as a fecal preservative.

The Effect of Urea and Terramycin on Blood-Urea Nitrogen

Blood samples were taken from the jugular vein of the sheep used on the digestion studies at various time intervals and analyzed for blood-urea nitrogen. The data of Lewis (1957) indicates that blood-urea values are a good indication of ammonia release in the rumen.

Spector (1956) indicates that normal blood-urea nitrogen values for

cattle range from 6-27 milligrams of urea nitrogen per 100 milliliters of blood. The data of Repp et al (1955) indicates that normal blood-urea values for sheep are in the same range as cattle.

Blood-urea values are given for the individual sheep as they were affected by the control ration and the feed additives in Tables XIX, XX, XXI and XXII.

The average blood-urea nitrogen values at various time intervals during the three treatments are compiled in Table XXIII. A graph was made to help interpret the data. The graph is shown in Figure 1.

Blood-Urea Nitrogen Values as Affected by Dehydrated Sun-cured Alfalfa Pellets

Maximum blood-urea nitrogen was noted at 90 minutes post feeding when the control ration was fed. (Note graph in Figure 1). At 180 minutes after feeding, the blood-urea level had declined to near the pre-feeding level. Six hours after feeding blood-urea values had returned to the pre-feeding level. It should be noted that the curve rose slowly during the first 90 minutes compared to the curves when urea was fed.

The Effect of Feeding Urea on Blood-Urea Nitrogen Values

The graph indicates that blood-urea nitrogen reaches a peak 75 minutes after feeding when urea was added to the ration. Blood-urea nitrogen was 22.2 milligrams of urea nitrogen per 100 milliliters of blood at this time. For some reason blood-urea nitrogen during the urea feeding period dropped down to a value of 14.4 at 120 minutes post feeding. The blood-urea values again rose to 19.9 at 180 minutes after feeding and declined toward the pre-feeding level as time went on. The blood-urea

values during this period reached higher levels than they did during the control period. This supports the data of Lewis (1957) which noted that a higher protein level in the ration caused a correspondingly higher blood-urea value.

TABLE XIX. BLOOD-UREA VALUES FOR SHEEP NO. 8004X AT VARIOUS TIME PERIODS ON THE CONTROL RATION, CONTROL PLUS UREA AND THE CONTROL PLUS UREA AND TERRAMYCIN. 1/

<u>Time in minutes after feeding</u>	<u>Blood-urea (mg. urea N per 100 ml. blood)</u>		
	<u>Control</u>	<u>Urea</u>	<u>Urea + Terramycin</u>
0	7.5	----	----
15	8.8	----	----
30	8.8	----	----
45	9.6	----	----
60	9.6	----	----
75	10.5	----	----
90	10.2	----	----
120	7.9	----	----
150	---- <u>2/</u>	----	----
180	8.8	----	----
270	8.6	----	----
360	7.5	----	----

1/ This sheep was a poor eater, and would not clean up the feed additives if disturbed. Data for the urea and urea and terramycin periods are not available.

2/ Blood sample clotted.

TABLE XX. BLOOD-UREA VALUES FOR SHEEP NO. 8002X AT VARIOUS TIME PERIODS ON THE CONTROL RATION, CONTROL PLUS UREA AND CONTROL PLUS UREA AND TERRAMYCIN.

<u>Time in minutes after feeding</u>	<u>Blood-urea (mg. urea N per 100 ml. blood)</u>		
	<u>Control</u>	<u>Urea</u>	<u>Urea + Terramycin</u>
0	8.8	17.2	----
15	9.8	13.8	22.8
30	10.0	11.6	18.9
45	10.7	24.4	14.2
60	11.2	20.0	19.3
75	11.2	20.7	15.4
90	10.7	14.9	23.1
120	10.7	17.7	21.4
150	11.6	20.3	20.7
180	11.6	21.0	20.5
270	10.7	19.1	19.0
360	8.8	14.2	17.2

TABLE XXI. BLOOD-UREA VALUES FOR SHEEP NO. 8093X AT VARIOUS TIME PERIODS ON THE CONTROL RATION, CONTROL PLUS UREA AND CONTROL PLUS UREA AND TERRAMYCIN.

<u>Time in minutes after feeding</u>	<u>Blood-urea (mg. urea N per 100 ml. blood)</u>		
	<u>Control</u>	<u>Urea</u>	<u>Urea + Terramycin</u>
0	12.6	11.9	----
15	15.4	10.5	20.0
30	14.4	12.3	16.1
45	14.4	19.6	15.4
60	14.9	20.7	16.8
75	14.9	20.5	19.1
90	14.9	17.7	20.3
120	15.8	11.6	20.5
150	16.3	16.8	21.4
180	14.9	17.7	15.8
270	13.5	16.8	16.8
360	9.8	16.1	14.9

TABLE XXII. BLOOD-UREA VALUES FOR SHEEP NO. 8705V AT VARIOUS TIME PERIODS ON THE CONTROL RATION, CONTROL PLUS UREA AND CONTROL PLUS UREA AND TERRAMYCIN.

<u>Time in minutes after feeding</u>	<u>Blood-urea (mg. urea N per 100 ml. blood)</u>		
	<u>Control</u>	<u>Urea</u>	<u>Urea + Terramycin</u>
0	13.5	14.9	----
15	16.3	14.9	22.4
30	18.2	14.9	21.2
45	17.7	23.3	22.8
60	16.7	25.4	----
75	19.6	25.4	25.6
90	17.7	19.1	23.8
120	17.2	14.0	22.8
150	16.5	21.0	22.4
180	----	21.0	23.3
270	14.9	21.0	21.7
360	13.0	17.7	19.1

TABLE XXIII. AVERAGE BLOOD-UREA VALUES FOR THE CONTROL, CONTROL PLUS UREA AND UREA PLUS TERRAMYCIN.

<u>Time in minutes after feeding</u>	<u>Blood-urea (Mg. urea N per 100 ml. Blood)</u>		
	<u>Control</u>	<u>Urea <u>1</u>/</u>	<u>Urea + Terramycin <u>1</u>/</u>
0	10.6	14.7	----
15	12.6	13.1	21.7
30	12.8	12.9	18.7
45	13.1	19.1	17.5
60	13.1	22.0	18.0
75	14.0	22.2	20.0
90	13.3	17.2	22.4
120	12.9	14.4	21.6
150	14.8 <u>2</u> /	19.4	21.5
180	11.8	19.9	19.9
270	11.9	19.0	19.2
360	9.8	15.8	17.1

1/ Sheep No. 8004X was omitted from the average as he refused to clean up all of his feed in a reasonable time.

2/ Average of three sheep; the blood sample for sheep No. 8004X omitted when the blood sample coagulated before analysis.

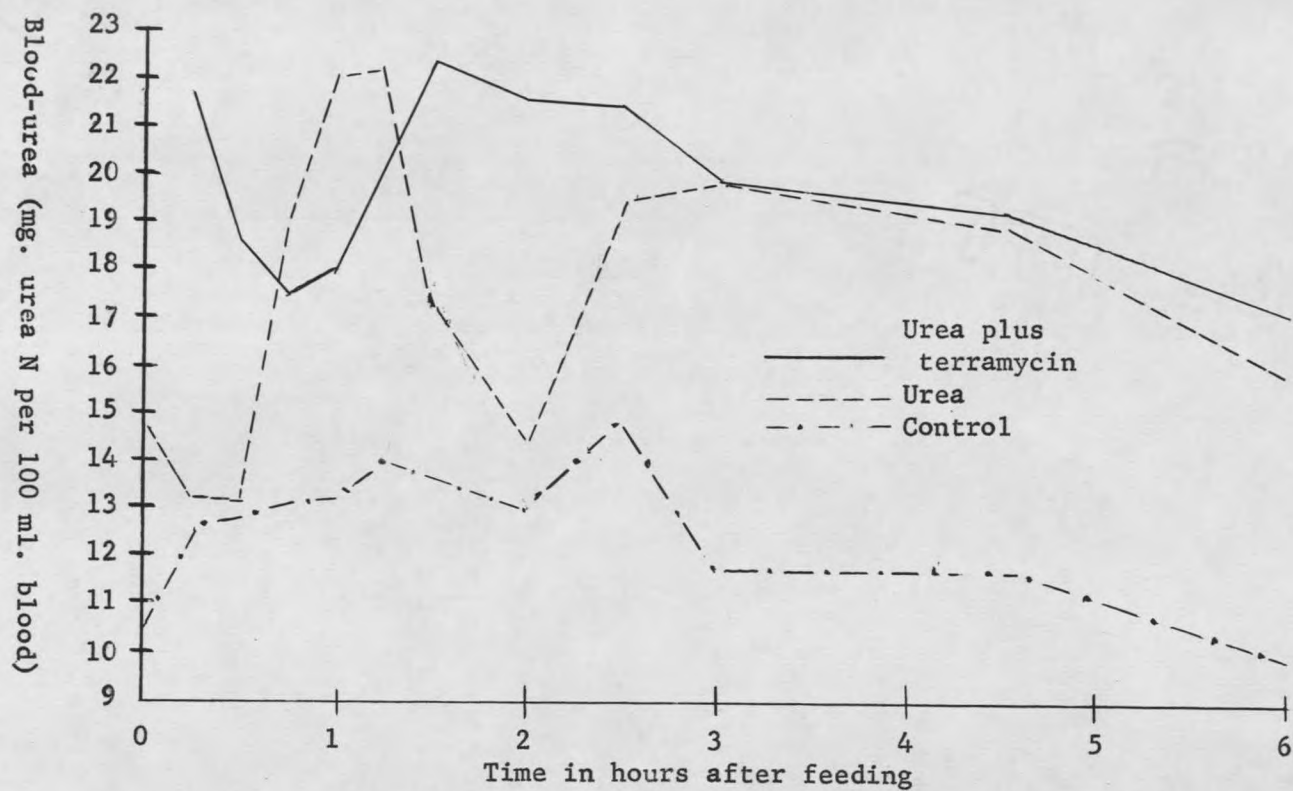


Figure 1. Average blood-urea values at various time intervals for the control period, control plus urea and urea plus terramycin.

The Effect of Terramycin and Urea on Blood-Urea Nitrogen Values

The addition of terramycin on the sun-cured alfalfa pellets and urea caused a change in the appearance of the blood-urea curve following feeding. For some reason, this treatment caused a much higher blood-urea level at 15 minutes after feeding. It was unfortunate that a blood sample was not taken just prior to feeding during this study. The data may indicate that terramycin brought about a slower release of ammonia in the rumen than when urea was added to the ration without terramycin. It is hard to draw any conclusions from the data, probably a portion in the variability in the curve is due to technique in the collection and analysis of the samples. The aeration technique was used in the laboratory determinations. Persons familiar with the technique will realize that in titrating the samples a slight error in judgment of the end point will have marked effect on the results obtained. Blood-urea determinations were run in a series of 12 at one time. Two blanks were run with each series. The greatest variability within the blanks was 0.2 milliliters of the base which was used in the titrations. The maximum variability in the analysis procedure as indicated by the slight variability in the blanks would have accounted for an error of 0.9 milligrams of urea nitrogen per 100 milliliters of blood.

The initial appearance of urea in the blood stream after terramycin was fed appeared to be slowed down. While this data is hard to interpret with any degree of accuracy, there are indications that terramycin may have inhibited some organisms in the rumen which were responsible for the initial hydrolysis of urea in the rumen. It is hard to draw a

correlation between the blood and digestibility work. Nitrogen-balance studies would have been valuable in conjunction with the blood-urea work.

The mechanisms which the animal uses in converting non-protein nitrogen to meat is not very well understood. Very little is known about urea break-down in the rumen. Much of the data in the literature assumes that the enzyme urease is present in the rumen. The presence of urease in the rumen is hard to demonstrate. Some workers in the field now seriously doubt the presence of this enzyme in an active state. This is in direct contrast to the assumption made by many workers in the past.

Much of the work done with non-protein nitrogen in ruminant nutrition has been done in vitro. The important role that the rumen wall and the entire body plays in the live process cannot be overlooked. Much of the data found in the literature must be evaluated cautiously.

In this trial, attempts were made to study blood-urea nitrogen levels. It was felt these values might indicate the fate of the urea in the rumen. This assumption was supported by Lewis (1957). The stress of collecting a blood sample from the animal every 15 minutes seemed quite apparent. It was impossible to tell what effect stress had on the blood-urea levels. The sheep were handled the same each time the blood samples were taken but a possibility of an interaction between the treatment and stress condition exists. It appears desirable that better techniques be developed for this type of study.

SUMMARY

Dehydrated silage pellets were tested using steer calves in three trials. During the trials, all steers were individually fed the same amount of feed.

The first trial consisted of a wintering period. Sixteen steer calves were divided into two lots. Both lots received a grain ration which consisted of barley 75 percent, oats 10 percent, and wheat mixed feed 15 percent. All animals received five pounds of grass hay daily. The control lot was fed dehydrated sun-cured alfalfa pellets and the other lot received dehydrated alfalfa silage. The gains made by both lots were poor. The average daily gains were 2.08 pounds and 1.56 pounds for the control and the silage lots, respectively. The lot that received the dehydrated silage pellets refused a considerable portion of their feed. The poor palatability of the silage pellet accounted for the low gains and feed efficiency in this lot.

In trial two, the same steers were continued on a fattening period of 156 days. In an effort to increase the consumption of the silage pellets, two pounds of sun-cured alfalfa pellets were fed daily with the silage pellets, and the grain portion of the ration was increased. The steers that received the silage pellets refused to go on a high level of feed. The control lot would have consumed a much higher level of feed had it been offered to them. The gains made by the steers were poor. The average daily gains were 1.93 pounds and 1.90 pounds for the control and silage lots, respectively.

Dehydrated alfalfa silage pellets and ammoniated dehydrated alfalfa

silage pellets were fed to steer calves in the third trial. Eight head of calves were fed in each lot and four calves in each lot received 75 milligrams of terramycin daily. Barley pellets and grass hay were fed in combination with the two silages. In both lots, the palatability problem of the silage pellets prevented the cattle from going on full feed. The average daily gains were 1.11 pounds for the silage lot and 1.10 pounds for the ammoniated silage lot. Terramycin increased feed consumption in both lots. Feed efficiency and daily gains were increased by the addition of terramycin in both lots.

Digestibility studies were conducted using sheep to study the effect of urea and urea and terramycin on the apparent digestibility of sun-cured alfalfa pellets. Urea increased the digestibility of all the nutrients in the trial. Terramycin in combination with urea appeared to decrease the digestibility of protein and nitrogen-free extract. Terramycin apparently did not affect the digestibility of ether extract or crude fiber.

Blood samples were taken for blood-urea analysis in conjunction with the digestion trials. Blood-urea studies indicated that the addition of urea to the ration caused a rise in blood-urea nitrogen following feeding. Terramycin appeared to slow the appearance of urea in the blood stream. A high level of blood-urea nitrogen was noted at a slightly longer period of time when terramycin was fed in combination with urea.

The effect of terramycin on the utilization of non-protein nitrogen was studied and over 148 blood-urea nitrogen determinations were made in conjunction with this study. The technique used in the study did not provide the means to find all the answers.

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