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Feeding Urea to Cattle and Sheep

Livestockmen often have to choose between feeds which contain urea and those which do not. A general understanding of the value and limitation of urea is necessary to make a sound choice. The important considerations in this regard are discussed in this fact sheet.

WHAT UREA IS

Ruminant animals such as cattle and sheep are unique in that they can utilize some simple compounds which contain nitrogen to meet their requirements for protein. These are referred to as nonprotein nitrogen compounds. The chief one used in cattle and sheep feeding is urea.

Urea is not a foreign substance to animals. Considerable quantities are formed in the body in the metabolism of proteins. Some of this urea is returned to the rumen along with saliva. Ruminants secrete large quantities of saliva, and it has been reported that as much as one-third ounce of urea may be returned to the rumen by cattle daily in this way. Livestock also receive some urea through many common feedstuffs. Alfalfa hay and oats may contain 35 to 45% of their total nitrogen as urea.

The urea used in livestock feeds is produced commercially on a large scale. It has an appearance similar to finely granulated salt and has a bitter taste. It is a concentrated source of nitrogen—the feeding grades have a protein equivalent of 262%. This amount of protein makes 1 pound of urea equal to about 6 pounds of soybean meal in its potential protein value.

HOW UREA IS UTILIZED BY CATTLE AND SHEEP

There are numerous microorganisms present in the rumen of cattle and sheep which require protein for their proper growth and multiplication. They can synthesize the needed protein from the nitrogen contained in urea when they have an adequate supply of readily available carbohydrates. Urea does not furnish any carbohydrates. It, therefore, should be mixed with high-energy feeds such as grain, molasses, and conventional high-protein ingredients which furnish readily available carbohydrates.

The microorganisms in the rumen, which use the nitrogen in urea and build it into their own body proteins during their multiplication, pass through the digestive tract along with the feed material as it is being digested. They are subjected to digestion the same as the feed particles and thus supply protein needed by the host animal.

It has been shown that the microorganisms of the rumen contain large amounts of protein on a dry matter basis and that the protein is of high quality for ruminants. A large portion of the protein available to cattle and sheep is this "microbial protein" regardless of the source of protein in the ration. For this reason, a simple nonprotein nitrogen compound such as urea becomes a satisfactory replacement for protein in the ration for cattle and sheep when fed under proper conditions.

WHY FEED UREA

Urea should not be considered something necessary to have in the ration. Rather it is one source of an essential nutrient—protein, or more specifically as a replacement for protein in the ration for cattle, sheep, and other ruminants. When considered in this manner, the value of urea in the ration is essentially a matter of obtaining a lower cost feed. The livestock feeder should expect to buy a protein supplement which contains urea cheaper than one of similar content and ingredient composition but without urea. This should be true whether the supplement be the usual meals and pellets or a liquid protein concentrate (LPC) containing principally molasses and urea.

One can expect an increase in the use of urea in manufactured feeds when there is a short supply of conventional high-protein ingredients such as soybean meal, linseed meal, and cottonseed meal and...
when they are high in price in relation to grain. The use of urea mixed with grain (often some molasses also) as a replacement for high-protein ingredients is often necessary so that the total supply of high-protein feeds will be adequate to meet the total feeding needs. Since urea is unsatisfactory as a source of protein for swine and poultry, its use as a protein supplement must be limited to the feeding of ruminants.

**SOME FACTORS THAT AFFECT UTILIZATION OF UREA**

There are some important factors which affect the utilization of urea by the rumen microorganisms. It is important that the person feeding urea understand these, since it will not be utilized efficiently and may even be toxic when fed improperly in large amounts.

**Level of Protein in the Ration.** Urea serves no useful purpose when included in a ration already adequate in protein. The primary purpose of feeding urea is to supply nitrogen for the needs of the rumen microorganisms in the synthesis of protein. Rate of conversion of urea nitrogen to protein decreases when the protein content of the ration becomes greater than 12%. Up to this level of protein in the ration, urea appears to be utilized about as efficiently as the common high-protein ingredients.

This fact is not a criticism of urea. Rations with as much as 12% protein appear adequate for beef cattle and sheep under most conditions and, therefore, would not need a protein supplement from any source.

**Level of Urea.** The level of urea in the protein supplement or total ration is an important factor affecting its utilization. Research has shown that urea is utilized efficiently when it furnishes up to one-third of the protein in the ration. When fed in larger amounts than this, efficiency of utilization may be reduced.

Protein supplements with 4 to 5% urea and about 40% total protein have been shown to be equal to protein supplements of equal protein content but without urea when used to supplement rations composed primarily of roughages and protein supplement. With rations composed of a large amount of grain, protein supplements with as much as 10 to 12% urea have been satisfactory.

Recently there has been some interest in formulating protein supplements with around 60 to 65% total protein by the use of high levels of urea. Results with these supplements have been variable. In some experiments, 1 pound of such high-protein supplement has given about the same results as 2 pounds of a supplement with only one-half as much protein. In other experiments, gains were not as good when feeding the high-protein supplement.

Two factors which may have affected the results obtained with these high-protein supplements are the amount of grain being consumed and the level of urea in the supplement. The amount of readily available carbohydrates furnished by grain in the ration has been shown to affect the amount of urea that can be fed satisfactorily.

The total amount of urea fed is also important. A protein supplement with about 65% protein can be made with a mixture of 90% soybean meal and 10% urea. Some of these high-protein supplements have been formulated with as much as 15 to 18% urea by using some low-protein ingredients in the mixture. Results with such wide differences in the amount of urea are likely to be different even though the total protein content is similar in two supplements. More research is needed with protein supplements containing high levels (15-18%) of urea before general recommendations can be made for their use.

**Amount and Kind of Carbohydrates.** An adequate source of readily available carbohydrates is necessary for synthesis of the urea nitrogen into protein. Starch and sugars in grain and sugars in molasses furnish the needed carbohydrates. Cellulose in roughages as a source of carbohydrates is broken down too slowly for efficient utilization of urea. Therefore, the amount of urea needs to be limited more when fed with roughages in the absence of grain or molasses.

Several experiments have shown that urea is utilized more efficiently with starch or grains rich in starch than with sugar or feeds rich in sugar, such as molasses, as the source of carbohydrates. This results from the fact that sugars and molasses pass out of the rumen too rapidly for the greatest value as sources of energy in the synthesis of protein from urea. One should not expect protein supplements containing urea and high levels of molasses to have any greater feeding value than those with similar levels of protein but containing high-quality grain and low levels of molasses. Molasses appears to have some advantage over starch from grain in reducing the danger of urea toxicity and, therefore, permits feeding larger quantities of urea. The level of urea, however, should not be increased over recommended amounts when feeding large quantities of molasses because efficiency of utilization of the urea is likely to be lowered.

**Vitamin and Mineral Content of the Ration.** The vitamin content of the ration is not known to affect the utilization of urea except as it might affect the bacterial activity of the rumen and the general well-being of the animal. Therefore, the vitamin content of the ration should be about the same whether or not urea is fed.

High-protein ingredients such as soybean, lin-
seed, and cottonseed meals are better sources of calcium, phosphorus, and trace minerals than are most grains. When urea is included in the ration, smaller amounts of these high-protein ingredients are needed. This reduces the mineral content of the ration, but free choice mineral supplementation, including trace mineral salt, will likely take care of the mineral needs.

**UREA TOXICITY**

Urea toxicity under proper feeding conditions appears rather unlikely. However, toxicity can result when urea is not thoroughly mixed with other feed ingredients or when high levels are fed improperly. Most cases of urea toxicity described by research workers are cases that have been produced experimentally.

The amount of urea that can be consumed by cattle and sheep without harmful effects varies considerably and is influenced by several factors. Cattle and sheep are most susceptible to urea toxicity when consuming limited quantities of low-quality nonlegume roughages without concentrates or when they have not had access to feed for several hours.

Considerably higher levels of urea can be fed safely with rations containing grain or molasses. Animals fed alfalfa hay are more resistant than those fed low-protein nonlegume hay. Animals accustomed to urea-containing feeds can consume higher levels without toxic effects. Levels of urea commonly used are not likely to result in any problem from toxicity when included in the rations of healthy animals fed adequate amounts of feed.

**PRACTICAL CONSIDERATIONS**

The important consideration when feeding urea is to obtain a ration equally as good as one without urea but at a lower cost. To do this, limit urea so it furnishes only about one-third of the protein in the ration or not over 1% by weight of the total ration. Toxicity should not be a problem when fed at these levels.

**Level of Urea in Supplements and Total Ration.**

In South Dakota the maximum level of urea permitted in feeds is set by the state feed regulations. These regulations state that the amount of urea shall be limited so as not to exceed one-third of the total protein in the ration, excluding pasture and roughages. This would mean that a 40% protein supplement to be fed as the only feed other than roughage and pasture would be limited to about 5.1% urea, a 30% protein supplement to about 3.8%. A protein supplement containing 10 to 12% urea would be satisfactory under these regulations when fed at a rate of 1 pound to about 10 pounds of grain.

The level of urea in a feed may be quoted in two ways. One is as the percent of urea in the feed. The other is the percent of the total protein furnished as urea.

When the percent of urea is given, one can calculate the amount of protein furnished by urea by multiplying the percent urea by 262 (the protein equivalent of urea). If a 40% protein supplement contains 5% urea, then 13.1% protein is furnished by urea (262 × 5/100 = 13.1%). To determine the percent of the total protein furnished by urea, divide the percent of protein as urea by the percent protein in the supplement (13.10 ÷ 40/4 = 32.75%). In this case, slightly less than one-third of the protein in the supplement is furnished by urea.

When the urea in the supplement is expressed in percent protein as urea, one can determine the amount of urea used by dividing this value by 262%. If a 36% protein supplement has 12% protein as urea, it contains 4.6% urea (12 ÷ 262/4 = 4.6%). One-third of the protein in the supplement is furnished by urea (12 ÷ 36/4 = 33.3%).

**Economy of Urea.** The savings in feed costs that can be made by feeding urea depend on the prices for urea, the high-protein ingredient it replaces, and the other ingredient(s) used to make up the difference between the amount of urea and the high-protein ingredient. One pound of urea and 6 pounds of corn grain are about equal to 7 pounds of soybean meal in protein and total digestible nutrients. This equation can be used to determine the economy of using urea and grain as a replacement for high-protein ingredients in the ration. When price relationships are favorable for this substitution, the savings will be greater for the higher levels of urea. The actual savings in terms of feed cost per unit of gain will likely be greatest when the urea is used at the proper levels as stated above. If used in greater amounts than this, reduced efficiency of utilization and lowered production will likely offset the savings in cost of the ration by using higher levels of urea.

**Use of Urea with Low-Protein Roughages.** Feeding low-protein ingredients requires a greater amount of protein supplementation. With a saving in feed cost from feeding urea, the advantage will be greater with low-protein rations requiring more protein supplementation than with rations requiring only a small amount of protein supplement. Urea is often used in such rations because of this fact. However, if the level of urea used is limited to furnish about one-third of the protein in the ration or 1% urea by weight, the total amount of urea that can be used is limited even with these low-protein ingredients; and they may not have any special advantage in utilizing larger quantities of urea.
At times there is an interest in using low-quality, low-protein roughages, such as oat hulls and corn cobs, as replacements for good quality roughages by properly supplementing with protein. A mixture composed of 1% urea, 10% cane molasses, 10% soybean meal, and 79% oat hulls would contain about 11% protein and about 40% total digestible nutrients. The cost of such a mixture would be about $22 per ton with the ingredients at the following prices per ton: urea, $100; molasses, $60; soybean meal, $75; and oat hulls, $10. The feeding value of such a mixture would be inferior to alfalfa hay and probably not quite as good as an average nonlegume hay such as prairie hay. It, therefore, would appear that such mixtures have little value in reducing feeding costs except when hay is in short supply and rather high in price.

Low-protein, low-quality ingredients such as corn cobs and oat hulls can be used to the greatest advantage in rations for wintering the cow herd or wintering young stock for limited gains. In these rations, 6 to 8 pounds of alfalfa hay will furnish an adequate amount of protein. The remainder of the ration can be composed of these low-protein roughages and furnish enough total digestible nutrients for limited production.

**GENERAL RECOMMENDATIONS**

1. The level of urea in protein supplements to be used as the only supplement to low-protein roughage or winter range should be limited to one-third of the protein in the supplement. This would be about 5.1% urea (13.3% protein equivalent) in a 40% protein supplement, 3.8% (10% protein equivalent) in a 30% protein supplement.

2. Protein supplements with 10 to 12% urea may be fed with fattening rations if fed at the rate of about 10 pounds grain to each 1 pound of protein supplement.

3. The same limitations should apply to liquid protein concentrates (LPC) containing high levels of molasses and to protein blocks.

4. When urea is mixed in a complete ration, the level should be limited to 1% or less of the total ration.

5. Urea should be mixed in protein supplements or complete rations only by persons having an understanding of its value and limitations and using equipment capable of uniformly distributing such small quantities thoroughly in the final mixture.