Understanding The Metabolism Of Nitrogen Means Profit For Your Clients

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What is over Nitrification? How does it affect animals? Where is it most likely to occur? What can be done to prevent problems connected with nitrates?

The nitrate problem has been with us a long time. The first reference I have found in the literature is in Second Kings Chapter 2, verse 19. This was about 840 B.C. "The men of the town said to Elisha, the town is pleasant to live in as you can see, but the water is foul, and the people suffer from miscarriages."

Dr. Wm. Albrecht of the Dept of Agronomy at the University of Mo. gave me the best advice of anyone about 1965 when he told me to study nature as well as books.

The first illustration I'll ask you to use is to have you go with me in your mind's eye to a cow pasture. I want you to remember the beautiful lush green ring of grass which grows up around a cow platter. Almost everyone of us have seen this highly fertilized growth of grass which results from the natural process of too much fertilizer. The grass is taller, greener and more luxurious than the surrounding grass. It also has a higher NPN or non protein nitrogen and an imbalanced cation ratio and under normal grazing conditions the cows won't eat it.

Now compare what we are doing with our corn crops. We fertilize with every imaginable type of Nitrogen until we have the tallest, most lush growth possible and we harvest prior to natural maturity. Then we force the cow to eat this feed with the most sophisticated of automatic machinery. Then we stand in amazement and watch them get sick even after we increase their protein and supply them with more of the same poison thru a lick tank filled with urea.

When we are in the business of making meat or milk we have only 5 basic materials to compose the diet. They are: Water, Energy Feeds, Protein, Vitamins and Minerals.

The most important ingredient in any diet is water. If you don't remember anything else that you hear from me today the emphasis on pure, wholesome and plenty of water is by far the most important thing about balancing any ration. It is also the best treatment that can be applied to correcting a nutritional problem.

The real difference in the chemical composition of the energy and protein portions of the diet is the inclusion of the elements nitrogen and maybe phosphorus and sulfur in the molecule. Nitrogen is the key element in the structure of all protein. The cow with her wonderful rumen is able to make meat or milk from the most amazing array of junk foods. The cow is able to make use of the production of millions of acres of this planet which are of no use to man's diet because she can take NPN and cellulose both of which we cannot digest and make some of the best food we can eat.

The cow performs best in this synthesis if the diet contains the proper ratio of energy to protein and if the minerals are in the proper relationship. If the NPN or NO^3 is in excess in the diet we see the following 4 major problems. Remember that the symptoms are going to vary with the degree of insult and will all be superimposed one on the other so that all your God-given talent must be utilized to the highest degree to interpret what you are seeing. You may see a variation in symptoms ranging from sudden death to only a mild lowering of production but the problem will be exhibited with some or all of the following conditions.

1. Lowered Production
2. Anoxia
3. Vitamin Interference
4. Antibody impairment

1. **Lowered Production.** I'm sure most of you have seen the dramatic drop in milk production which can occur from changing feeds. One day you will read the dipstick on the tank and read it again in dismay when you realize that overnight your production has plummeted. If a feed is introduced with a higher NPN or too much nitrate some of the energy has simply been used to make the conversion of NPN to protein and the energy spent on this process is not then available for production. It does not matter whether the conversion of nitrate to protein happens in the plant growing in the field or in the rumen of the cow, the chemistry is the same.

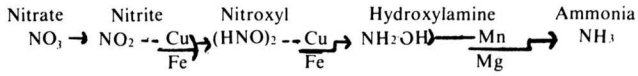
The simplest way to illustrate the chemical equation is:

NO_3 + Energy + H + proper catalysts and enzymes = Amino groups NH_2

The energy used in the field to produce protein comes from the sun. There is no sunlight in the rumen and any energy consumed to make the change from NPN to protein must come from energy in the diet. You cannot spend your paycheck on two things at once and the cow cannot use her energy for nitrate reduction and production. It must be

either reduction or production.

The second insult of NO^3 to the system is anoxia. Anoxia results from the formation of methemoglobin. We need to go back to the formula of NO^3 reduction to illustrate:



All of us know that NO^2 or nitrite is not a stable molecule and will combine with something very quickly. When nitrite combines with hemoglobin the result is a stable compound. The red blood cell which has combined with nitrite is no longer capable of transfering oxygen to the tissues. This gives us the pneumonia symptoms in the weaner calf. We may diagnose the symptoms as shipping fever. It will starve a fetus for oxygen and the cow will abort, and we will vaccinate for all manner of abortion related disease and watch in dismay and frustration when our treatments are applied with no benefit and cows continue to abort.

Anoxia can be exhibited in many different sets of symptoms but the underlying cause may be hidden because we do not study nature.

Mastitis is certainly a possible result of too much nitrogen somewhere in the system. When we make a corn field green by using nitrogen we do it by stimulating bacterial activity in the soil. If we stimulate bacteria in the udder which is starved for oxygen, has inadequate vitamin A and a lowered antibody response we can expect the result to be exhibited as mastitis. The proper treatment that is often neglected because we are too busy "bug hunting" culture and attempts to kill the bacteria. **We need instead to find out why the natural defense mechanisms in the cow are not functioning at the optimum level.**

3. **Vitamin interference** is the third aspect of the over nitrification. Vitamin A is that foreman in the factory of the body whose job is the manufacture of new cells in the lining structures of the body. The surface of the cornea in the eyeball is kept healthy due to the influence of Vitamin A. When Vitamin A is in short supply we see "pinkeye". The mechanism of vitamin interference is more complicated than can be covered in the time we have here today. This simple illustration will give you the idea. Carotene, the precursor of Vitamin A is a long skinny molecule. It might resemble a shoelace. In order for it to be absorbed into the system it must be attached to a protein complex which grasps the end of the molecule. The plastic end on your shoelace serves a similar function. When the plastic end is missing you cannot thread the shoelace into the eyelet on your shoe. When the protein complex which works with carotene is missing or not proper the system cannot effectively absorb carotene. The symptoms we see are a dull hair coat, sore eyes, lameness, diarrhea, and inappetence. These are nature's red flags to tell us that something is wrong with our vitamin delivery system.
4. **Impairment of the antibody system.** All antibodies are delicate protein. All of the antibodies contain nitrogen. No manufacturing process is efficient with an imbalance of supply of raw materials. When nitrogen is in such abundance as can happen in our animals diets it is little wonder that occassionally we don't have the natural immunity we could enjoy.

The times when we may see evidence of a diet imbalance and especially too much nitrogen are times of natural stress to the animal.

I would start with the dry cow late in gestation. Her oxygen demands are greater then than ever. Birth puts a stress on both the mother and infant. Weaning and changing the diet, especially removing the natural balanced minerals in the milk and subjecting the calf to stress of all sorts surely accentuates the imbalance in the diet.

Entry into a feedlot of the man who does not understand that urea is only a raw material of protein manufacture can be disaster. In a word *Stress* is a time in the life of the plant or animal when too much nitrogen can be the straw which literally breaks the animal and ruins its life.

We need to consider then what we can do to help remedy the situation. Prevention begins with understanding.

Water containing nitrate is beneficial to a degree in crop fertilization. It has no benefit to a living animal. Water supplies to animals should be regularly tested for nitrate content. Stagnant water whether in a pond, watercup or troughs which is liberally contaminated with feed can be the incubation area for bacteria. The waste products of this contamination can change the nitrate content. When you test the water, test it the way the animals get it and not just sample it at the end of the faucet. Dip it out of the watering device. I use the Brookside Laboratory in New Knoxville, Ohio for much of my testing.

Plants accumulate nitrates due to stress. If the cations in the soil are imbalanced the plant grows under stress and cannot effectively utilize the nitrogen it absorbs through the root system. This increases the NPN because the plant simply bites off more than it can chew. One illustration is an imbalance of magnesium and calcium in the soil. The soil should have about 4 times as much calcium as magnesium. Both of these elements contribute to the pH reading on the soil. If you are not aware of this relationship it will go undetected in routine soil analysis. If magnesium is too high in relation to calcium for some strange reason the plant will grow under stress and the plant will accumulate a greater amount of nitrogen which will be present either as nitrate or NPN. The other complication is that this plant will also often be deficient in magnesium. This combination in the diet can produce the symptoms of grass tetany, scours and other problems in the cow. All good balanced nutrition must come from a well balanced soil. We have been fertilizing with NPK for 40 years or more. The fertilizer companies label their products with three numbers which stand for nitrogen, phosphorous and potassium. No one disputes the necessity

for NPK but too few of us are concerned about calcium, magnesium and sodium which also have a great influence on the plant growth.

All that I know about soils I learned from the University of Mo. and the Brookside Laboratory in New Knoxville, Ohio. If the farmer has a consistent high accumulation of nitrate or too much NPN in his crop then a systematic soils study can often reveal the source of the problem.

Not all problems in the soil are a matter of imbalance. Tillage practices on our farms need to be examined. When the moldboard plow turns up a slab of soil which is shiny and slick the part we never see down under the ground is also shiny and slick. One hundred years of plowing has produced an almost impervious layer which is easy to discover if you ever have to dig a post hole. That plow sole layer in the farm can be an effective barrier to the movement of soil moisture. When the root hairs penetrate to the depth of the plow sole they are often bathed in the excess fertilizer we have applied through ignorance of what the ability of that soil can safely hold. All too often the excess nitrogen applied winds up in our surface water. I had occassion to effectively treat calf scours with a D8 caterpillar and a subsoil ripper. The hay after this procedure was much more wholesome and the calf crop appreciated it. We can do little about the weather but we can realize that stricken forage usually has a higher NPN content. Feeds harvested early due to drought can be loaded with problems. Troubles have a way of compounding themselves. The oat hay crop harvested because of not enough water is stressed. Our earliest studies on oat hay poisioning or nitrate poisioning told us that oat hay can be toxic. Virtually any forage crop can be a nitrate accumulator under the proper conditions. The worst case I have ever seen was with bermuda grass hay in S. Carolina. This hay would kill a cow if she filled her rumen with nothing but this hay.

In general the forage sections of the plant are the areas where the nitrates and NPN are accumulated. The plant simply has not gotten around to finishing the job of conversion to protein of all the nitrogen it has absorbed. The lower portions of the cornstalk may be dangerously high in nitrate content while the stalk and leaf portions above the ear contains N which is already processed into wholesome protein.

The seed portions of plants contain little NPN or NO_3 because nature tends to make the finished product perfect. The simple answer then if you have a questionable forage is to blend out the nitrate with grain. Adding shelled corn to haylage is an excellent way to blend out nitrates and balance the diet.

No discussion of NPN can omit the concept of Urea Fermentation Potential. Urea is a simple chemical compound. It is formed by combining two ammonia and one carbon dioxide molecules. It can supply the amino group in the synthesis of amino acids for the manufacture of protein. Urea is one of the cheapest sources of protein available. Urea has some very definite limitations which are best understood using the concept of urea fermentation potential.

In order for urea to be processed into protein, energy is necessary. Different plants and portions of plants contain different ratios of energy to protein in their structure. A kernel of corn has much more starch than a kernel of wheat. Urea is a safe, reliable and economical protein supplement to shelled corn or ground ear corn but it simply will not do good things for a ration composed of wheat.

There are tables available which will tell you the UFP of feedstuff. Any feed or combination of feeds which have a positive UFP can benefit from the use of urea as a protein supplement. If the feed is alfalfa, for example, the UFP is negative. This tells us that you cannot effectively or safely add urea and expect benefits from that combination. Only about 20% of our feeds listed in the NRC tables have a positive UFP; 80% have a negative UFP.

Any plant grown or harvested under stress may contain NPN or nitrate above what is listed in the tables in the NRC for the analysis of that plant.

When Nitrate and NPN are high this lowers the UFP of that ration. UFP can be influenced by the balance of the major minerals available in the rumen. No energy exchange can be efficient with a deficiency of phosphorus. The Phosphorus fraction is the most expensive ingredient used in the manufacture of minerals which are made for sale to livestock owners. The price is the determining factor in the purchase of many feed supplements. I remember vividly when a semi-load of mineral was delivered to one of my clients. The mineral bags were excellent quality, the pictures were printed well and the mineral was palatable but it was little more than limestone, which is calcium. We were already feeding mostly alfalfa ration. The usual concentration of calcium in alfalfa is five times that of phosphorus so that if your diet is mostly alfalfa you have a built-in deficiency of phosphorus.

When we moved these mother cows to another pasture and watered them with a shallow well which was near the cornfield they did not perform well. They had plenty of feed, full bellies, and aborted calves. The owner wanted us to give them a shot to correct the problem. When the shots didn't help a feed salesman delivered the lick tanks with molasses and urea and that didn't work either.

The best answer for the dilemma of some of our owners is for them to find an honest veterinarian who can explain UFP in such a way as to logically help with the management decision.

The obvious answer to correcting nitrogen problems in a farm situation is observation, calculation and correction of inadequacies. Deficiencies are easier to correct than excesses.

When I find a nutritional problem my first recommendation is to remove the supplements with NPN. Increase the ratio of energy to protein and then begin a systematic analysis of the water first. Then analyze the forage and finally the grain portion of the ration.

By the time the veterinarian has been called our friend the farmer has already talked to the people he does not have to

pay so the feed and mineral salesmen have already been there and have had the chance to sell the protein and mineral mix. This calls for diplomacy. Sometimes if you are able to use what he has already purchased by proper proportion of what he has on hand you are able to make the client money and still retain the friendship and good will of the men who also work for the farmer.

I know of no way to tell if the soils or the forages are balanced without the services of a laboratory. Learn to work with, and interpret, the results of a laboratory you can trust. Learn to balance your rations and then maybe the client will stay in business and be able to pay his veterinarian bill!

Wet Clinic