interferon has become available. A company in California has recombinant, genetically engineered bovine gamma interferon, and they are doing a lot of research on it. If it is effective it will probably be on the market in the next few years for use. They can produce it very cheaply. We looked at gamma interferon *in vitro* and we see that several of the effects of averdine are mimicked by the gamma interferon. This is *in vitro,* we haven't given it *in vivo* yet. So we think there is some potential for the gamma interferon to be an immunomodulator. I should mention that some of you probably know there is a product called agritheron that is coming on the market in Texas very soon which is an alpha interferon. It's a human alpha interferon. This is bovine gamma. Human alpha interferon has antiviral activity in cattle, but it may not have these immunomodulating activities that we see with gamma. I don't think it will have the immunomodulating activity. The gamma interferon should be treated as a totally separate sort of substance than the human alpha. The human alpha is not working too well, we shouldn't give up interferon totally.

That was a fly through our last seven years' research. It is kind of sad when you can summarize seven years research in fifteen minutes!

Potassium & Sodium for Dairy Cattle

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Stress may be defined as a condition adverse to the well-being of an animal. It can originate from the climatic environment (i.e. heat or cold stress), from the physical environment (i.e. shipping stress or limitations of confinement), from nutritional deficiencies or toxicities or from social interactions. An animal's environment is the aggregate of all external and internal conditions and influences. Environmental stressors, to name a few, may include altitude, wind, disease organisms, ectoparasites, endoparasites, soil pH and fertility, rainfall and humidity, temperature, light and radiation.

Lactation is also a stress placed on a producing cow. If lactational stress is associated with heat stress, the potassium requirement for the cow appears to increase. This is due to decreased feed intake and also increased loss of endogenous potassium through sweating.

In general potassium is important for the following functions:

1. Osmotic balance between cells and extracellular fluids;
2. Acid-base regulation;
3. Ionic balance controlling cellular excitability and activity;
4. Water balance;
5. Activation of several enzyme systems;
6. Oxygen and carbon dioxide transport in blood.

Also, potassium is the mineral element present in highest concentration in milk. Milk contains 0.15% potassium as compared to only 0.11% calcium and 0.08% phosphorus. A high producing dairy cow secretes 25 to 40% of daily potassium intake in milk, depending on level of feed intake and milk yield. In higher producing cows, potassium may become the limiting dietary factor for milk production. Since the cow has little storage capacity for potassium (such as bones for calcium and phosphorus), she must consume adequate amounts to supply maintenance and production requirements on a daily basis.

Research interest in potassium nutrition has been intensified during the past several years for several reasons. The trend in recent years toward the use of complete blended rations has reduced the feeding of roughages which contain high levels of potassium. There is also more feeding of by-product feeds, corn silage and cereal grains, all low in potassium content.

Dr. David Beede, a University of Florida nutritionist, has conducted several studies in which he investigated the relationship of potassium and sodium to milk production and heat related stress.

In the first experiment conducted by Dr. Beede, he placed one group of cattle on a potassium adequate diet (0.96% K) and a second group on a potassium deficient diet (0.11% K). Based on earlier research reports, it was expected that 3-4 weeks would be required to see signs of potassium deficiency. However, the response to the potassium deficient diet was much more dramatic than expected. Within 3-5 days of the start of the experiment:

1) Dietary potassium deficiency resulted in precipitous declines in feed and water consumption, milk production and blood plasma potassium concentration;
2) The death of three cows occurred and others suffered from nearly complete inanition and pica;
3) Cows could detect absence or presence of potassium (as potassium chloride) in the basal diet. They would consume feed containing potassium, refuse feed with no potassium;

4) Potassium therapy quickly reversed deficiency signs and;

5) Higher producing cows appeared to be most acutely affected by dietary potassium restriction.

In one experiment, the objective was to assess production responses of early to mid-lactational cows to varying potassium percentages (0.66, 1.08 and 1.64% of diet dry matter) while maintained in a no shade or shade management system from mid-May through mid-September.

Total daily feed intake was greater in the shade than no shade environment (21.3 vs. 18.7 kg). Daytime feed intake was depressed 56% in the no shade area (4.0 vs. 9.2 kg). No shade cows consumed increasing amounts of feed as potassium content increased, suggesting that higher potassium enhanced dry matter intake (3.7, 4.0 and 4.7 kg at 0.66, 1.08 and 1.64% potassium). At night, feed intake was 19.5% greater in no shade cows than those with shade provided (14.7 vs. 12.3 kg) suggesting an attempt to compensate for reduced daytime intake.

Morning milk yield was 23% greater in the shaded group (9.6 vs. 7.8 kg). Evening yield was 27% higher in shaded cows (8.1 vs. 6.4 kg). A curvilinear effect of potassium on total daily milk yield was noted with 15.2, 16.6 and 16.1 kg/d with .66, 1.08 and 1.64% potassium. Milk yield improved as potassium content increased from .66 to 1.08%. Considered with the environment, milk yield response to added potassium from .66 to 1.08% was greater in no shade cows (12% increase) than those with shade (6% increase). However, increasing dietary potassium content to 1.64% reduced milk yield by 7% as compared to 1.08% potassium. It was suspected that dietary sodium, relative to potassium, was not adequate in the highest potassium treatment. Sodium content of the basal diet was 0.15% close to the 1978 N.R.C. recommendation of 0.18%. However, a deficit of sodium (relative to potassium) was implicated in a previous experiment.

A second experiment was conducted to evaluate effects of dietary source and quantities of sodium and total dietary potassium on feed intake and milk yield. The basal diet was formulated to contain 0.18% sodium and 1.0% potassium. Sodium sources were added to the basal diet as sodium bicarbonate (0 or 1%) or sodium chloride (0 or 0.73%); added potassium was from potassium chloride (0.6 or 1.6%).

Total daily dry matter intake was higher in the shaded group of cows than the no shade. Results pooled for both environments showed dry matter intake increased 5.1% with higher total dietary potassium (17.7 vs. 18.6 kg/d), 1.8% with added $NaHCO_3$ (18.0 vs. 18.3 kg/d), and 2.8% with added NaCl (17.9 vs. 18.4 kg/d).

Total daily milk yield was not affected in this experiment by the environment. However, milk yield was increased 3.6% with higher dietary potassium (19.2 vs. 19.9 kg/d), 5.2% with added $NaHCO_3$ (19.1 vs. 20.1 kg/d), and 4.7% with added NaCl (19.1 vs 20.0 kg/d). Added Na HCO_3 increased milk fat percent (3.6 vs 3.4%) while dietary potassium and NaCl did not. Four percent fat-corrected milk yield was 8.2% greater with $NaHCO_3$. This compared to 5.2% increase in actual milk yield with $NaHCO_3$. Higher dietary potassium and added NaCl increased 4% fat-corrected milk yield the same relative magnitude as was observed for actual milk yield.

From research he has conducted, Dr. Beede has arrived at the following conclusions.

1. Dietary potassium deprivation caused acute reductions in feed consumption and milk yield; the essentiality of a daily supply of dietary potassium for the lactating cow was demonstrated.
2. Supplementation of dietary potassium and sodium at levels above the present N.R.C. recommendations of 0.8% potassium and 0.18% sodium will result in significantly higher milk yields.
3. Beneficial responses to supplementation of these minerals was observed in both early lactation cows during the winter and heat-stressed cows at all stages of lactation.
4. Response to higher levels of potassium (greater than 1% of the diet dry matter) was most efficacious if included with higher levels of sodium (.4-.6%).
5. Gross efficiency of milk production (pounds of milk per pound of dry matter consumed) was improved by providing higher levels of sodium and potassium; or, at equal dry matter intake, cows receiving higher sodium and potassium gave significantly more milk.
6. Sodium bicarbonate or sodium chloride can be used to provide supplemental sodium. Including either sodium source at about 1.0% of the diet dry matter increased milk yield 3 to 8% even if the N.R.C. (1978) sodium recommendation already was supplied in the ration. With sodium chloride, the response in milk yield (3 to 5%) seems to be due specifically to the additional sodium.
7. Cost-benefit analysis indicate that adding **potassium at 1.5 to 1.8%** and **sodium at 0.4 to 0.6%** of the ration dry matter from either sodium chloride or sodium bicarbonate can increase net profit per cow per day compared to formulating rations nearer to N.R.C. recommendations.
8. Sizeable variation in potassium content of forage and concentrate feeds has been observed and emphasizes the need to obtain laboratory analysis on individual feeds to "fine-tune" nutrition programs.
9. If sodium bicarbonate is included in the ration, enough sodium chloride should be removed to maintain a final sodium content in the diet of 0.4 to 0.6%. Potential for chloride deficiency by replacing sodium chloride with sodium bicarbonate appears very remote. Based on all available data, milk yield response to sodium bicarbonate may be greater in diets containing silage than complete mixed rations containing dry roughages.
10. At higher levels of potassium and sodium supplementation, magnesium should be increased in the

diet dry matter from 0.2% (N.R.C.) to 0.3% or 0.35%. Other work suggests that changing the relative proportion of potassium and sodium in the diet may enhance magnesium absorption from the gut and therefore could possibly increase milk production.

11. Dry cow and heifer rations should contain near the N.R.C. recommendations of 0.8% potassium and 0.1 to 0.2% sodium. Higher levels suggested here for lactation rations could cause udder edema if fed to nonlactating animals about to refreshen.

Question: Are there any upper limits for potassium supplementation to receive a negative effect?

Answer: When we first started doing this work the higher levels of potassium got up around about 1.6, he started seeing a negative effect from it. The curve started coming back down. But that was with lower sodium levels, when the sodium was around .2, a little less than .2. When he raised his sodium up to .4 or .6 then I don't think he has reached an upper limit. He hasn't gone above a 1.6 or very close to that in his potassium.

Question: Did the chloride content of these diets remain constant?

Answer: Dr. Beede didn't figure the chloride content of the diet at all.

Question: What about the palatability of the higher levels of potassium?

Answer: At these levels it had no effect on feed intake at all, so I assume the palatability was acceptable.

Question: How do you tell how much potassium is available in dry feed such as alfalfa? It is high in potassium but it is not available to the cow.

Answer: They really don't have any really good way of measuring potassium availability in feeds at this time. Now we have some very specific methods for measuring calcium availability in feedstuffs and phosphorus availability in feedstuffs. Most people assume that since potassium is a water soluble ion, if it is in the feed it is available. Most nutritionists at this time are figuring that even with alfalfa, as far as I know, the quantity there is available to the cow, and they plug it into their formulas at 100%.

Campylobacter Fetus Bacterin

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CAMPLYLOBACTERIOSIS (Vibriosis) is a venereal disease of cattle caused by *Campylobacter* (Vibrio) *fetus* subsp. *fetus*. The infection, isolated to the genital tract, results in infertility and early embryonic death. Abortion occurs in a small percentage of cattle. The disease is transmitted by coitus under natural conditions and may also be spread by the use of contaminated semen in artificial insemination and by contaminated instruments.

The best method to bring the disease under control is to use artificical insemination. Semen for this purpose should either be from known uninfected bulls or treated with antibiotics.[1] When natural service is employed, as in large beef herds, vaccination is recommended.

Studies conducted at Beecham Laboratories and by others have demonstrated that vaccination can significantly increase pregnancy rates in the face of exposure to infection.[2,3,4]

Two factors influence the successful use of bacterins: 1) the potency of the bacterins; 2) proper administration of the product. All USDA licensed *Campylobacter fetus* bacterins must be demonstrated as safe, pure, potent and effective. However, these products vary in formulation. Three characteristics can affect the potency or effectiveness of Campylobacter bacterins. These are: 1) the quantity of the antigen they contain; 2) the quality of that antigen; and 3) the use of adjuvants.

There are many methods to quantitate the amount of antigen used in preparing a bacterin. The method of choice would be to measure the antigen which stimulates the productions of protective antibodies. With some organisms for which the pathogenicity is well defined, this is relatively easy. In Colibacillosis for example, antibodies against the *Escherichia coli* pili are protective, and tests have been developed to quantitate pili levels. It has been suggested that heat-labile gylcoproteins surface antigens (K antigens) are the protective antigens in bovine campylobacteriosis.[5,6] However, no test to quantitate these antigens has been published. A second method to measure antigen levels is measurement of total bacterial mass. Quantity of bacterial cells can be measured by one of several methods such as optical density, cell counts, protein nitrogen and dry or wet weight.

There are three major antigen groups associated with *Campylobacter fetus* subsp. *fetus*. The O or somatic heat stable antigens, the H or flaggelar antigens, and the K or heat labile surface antigens. As mentioned earlier, only the K antigens have been implicated in protection. Bacterins containing just the O or the O and H antigens were not protective, while bacterins containing O, H and K antigens were.[5]

At least 7 heat labile K antigens have been identified. Types 2 and 3 are most commonly associated with venereal disease.[7] More than one surface antigen may be associated with a particular *Campylobacter* strain. Antigenic shifts in vivo have been reported.[6] An efficacious Campylobacter bacterin should incorporate a range of the most common K antigens and be produced by a method which reduces the chances of antigenic shifting.

In addition to the appropriate concentration of the correct antigens, an efficacious bacterin needs to be adjuvanted. Two