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Trace Minerals and Stress in Dairy Cows

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The lactating dairy cow is the most productive of all farm animals with many cows giving over 100 lbs of milk per day during peak lactation. In order for cows to achieve their genetic potential for milk production they must be fed well balanced diets before they calve. The transition period, beginning about three weeks prior to calving and continuing for three weeks post-calving, is one of the most stressful periods in the life of a dairy cow. Recent research has shown that adequate trace mineral and vitamin nutrition during this transition period is critical to avoiding many of the most common diseases occurring at or shortly after calving. The purpose of this paper is to review the relevant research showing that proper nutrition is essential in helping the dairy cow cope with the stress of early lactation.

Transition Period:

During the transition period, the dairy cows go through dramatic physiological changes to prepare them for the onset of lactation and the climb to peak milk production. Because of these endocrine changes immunosuppression is common resulting in increased susceptibility to disease. Immunosuppression is most often expressed as reduced

neutrophil function, lymphocyte responsiveness to mitogen stimulation, antibody response and cytokine production (Mallard et al., 1998; Kehrli et al., 2006). Mastitis, metritis and retained placentas are three common diseases linked to a compromised immune system.

Oxidative stress during this period is also believed to contribute to the increased disease risk. Changes in the metabolic profiles associated with moving from the dry period to calving to early lactation may increase the production of reactive oxygen radicals causing oxidative stress. Oxidative stress occurs when the reactive oxygen radicals overwhelm the antioxidant defense mechanisms. Immune cells are extremely sensitive to oxidative stress because their cell membranes contain polyunsaturated fatty acids which are oxidized by the reactive oxygen radicals resulting in more reactive oxygen radicals. Several trace minerals and vitamins are essential for an effective antioxidant defense system (Spears and Weiss, 2007).

Selenium and Vitamin E:

Selenium and vitamin E are complementary in allowing the cow to handle immune system-challenges. Both selenium and vitamin E are required to optimize the effectiveness of neutrophils when attacking and destroying invading bacteria (Spears and Weiss, 2007). Chemotatic migration of neutrophils towards invading organisms was reduced by a selenium deficiency in goats (Aziz et al., 1984). Likewise, peripheral blood lymphocytes isolated from selenium deficient cows exhibited a reduce response to mitogen stimulation (Cao et al., 1992). Whole blood selenium concentrations were negatively correlated with

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mammary infections in a study involving 32 Pennsylvania dairy herds.

The complementary nature of selenium and vitamin E in reducing the incidence and severity of mastitis was clearly shown by Smith et al., (1984). Giving 0.1 mg selenium/kg body weight 21 days before calving reduced the duration of clinical mastitis by 46%, but did not reduce the incidence. Oral administration of 740 IU vitamin E/ day in combination with selenium reduced the incidence of mastitis by 37% and the duration by 62%.

Several trials have shown that selenium supplementation of selenium deficient diets reduced the incidence of retained placentas in dairy cows (Allison and Laven, 2000). Often, if dairymen suspect a deficiency, they wonder whether selenium should be given by injection rather than feeding due to variation in feed intake by individual cows. Julien et al (1976) showed that oral supplementation was as effective as intramuscular injection of selenium and vitamin E in preventing retain placenta in cows fed selenium deficient diets.

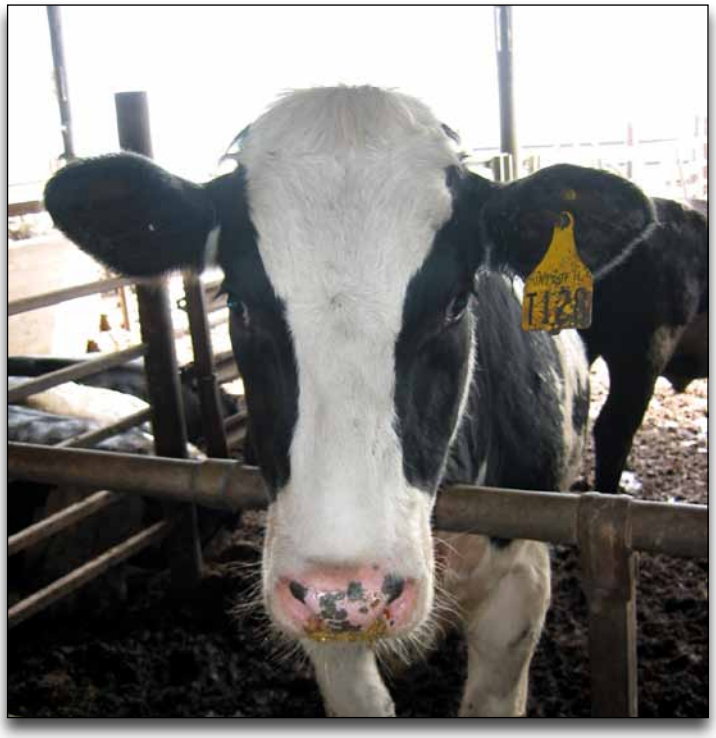
Copper:

Copper is important to the antioxidant system because it is part of the copper-zinc superoxide dismutase enzyme. This enzyme helps convert superoxide radicals to hydrogen peroxide in the cell. Copper deficiency can occur in diets normally considered adequate because of high levels of antagonists such as sulfur, iron, and molybdenum which reduce bioavailability.

Harmon (1998) reported that fed heifers diets that were marginally copper deficient (6-7 mg Cu/kg diet) had 60% infected mammary glands at calving compared to 36% in heifers fed copper adequate diets (20 mg Cu/kg diet). In a similar study, heifers fed 20 mg Cu/kg diet and challenged with E. Coli had lower clinical mastitis scores, lower somatic cell counts, and lower peak rectal temperatures then heifers fed 6.5 mg Cu/kg diet (Scaletti et al., 2003).

Zinc:

Zinc is essential as a cofactor for over 80 enzymes, many of which are needed for the synthesis of DNA or RNA. Thus zinc may impact immune function because of its essential role in cell replication and proliferation. Zinc is also required for the synthesis of metallothionein, a metal binding protein that may scavenge hydroxide radicals (Prasad et al., 2004). Severe zinc deficiency in calves has been shown to impair immunity (Droke and Spears, 1993). Plasma zinc concentrations normally decrease in dairy cows at calving, but usually return to normal within 3 days (Goff and Stable, 1990). The exact role this has in the increased incidence of disease post-calving has not been investigated.



Chromium:

The most recent Dairy NRC (2001) does not give a requirement for chromium in the lactating cows. However, Spears (2000) reported that chromium supplementation may improve health and immune function in stressed calves. Chromium supplementation of cows' diets prior to calving has improved immune response. Lymphocytes from cow supplemented with 0.5 mg chromium-amino acid chelate/kg diet had an increased blastogenic response and an improved antibody response to ovalbumin administration over unsupplemented cows (Burton et al., 1993). Cows receiving 3.5 mg chromium from chromium picolinate the last 9 weeks of pregnancy reduced the incidence of retained placentas to 16% compared with 56% in unsupplemented cows (Villalobos et al. 1997).

Economics:

Long term cost-benefit ratio studies are very costly when evaluating the merits of trace mineral supplementation for lactating cows. Depending on the level of trace mineral fortification, 10 to 15 cents per cow per day is probably on the high side of expected cost. This would equal approximately $36 to $50 per year per cow. A dairy industry average is $100 to $150 of cost per case of clinical mastitis.

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For every incidence of mastitis that is prevented, you could feed that cow trace minerals for 2 to 4 years. When the benefits from reduced retained placenta and metritis are added on top of that, the return on investment is very positive.

SUMMARY:

Trace minerals and vitamin E are essential to having a healthy immune system in lactating cows. Dairy cows undergo a period of immunosuppression just before and after calving. Proper supplementation of selenium, vitamin E, copper, zinc and chromium has shown benefits in maximizing the immune response. Proper trace mineral supplementation of dairy cow diets is essential to maintaining the health of cows and the economic competitiveness of the dairyman.

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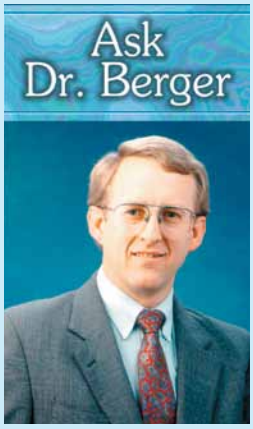
Question and Answers



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Q **Should I give my hunting dog additional salt to prevent fatigue before I take him hunting this fall?**

A Although fatigue and exhaustion are common symptoms of a sodium deficiency, most dog diets contain adequate sodium that salt supplementation is not needed.

Q **Is iodine supplementation necessary for sheep?**

A Yes, definitely; I am familiar with a sheep producer who lost most of this year's lamb crop due to feeding non-iodized salt. Most lambs were born with very little wool and had goiter.

Q **If my cows have been without salt for several days or weeks, should I be concerned about feeding loose salt ad libitum.**

A Cattle can develop a strong craving for salt after as little as 7 days without salt. I would recommend spreading a limited amount (1-2 ounces/head) of loose salt in many locations for a few days before giving them ad libitum access. Free-choice feeding of salt is very safe, but salt toxicity can occur if the cattle have been without salt for an extended period.

Q **Should I be concerned that the salt-trace mineral supplement being fed to my 4-H pig does not contain cobalt?**

A Pigs and poultry do not require supplemental cobalt. Vitamin B12 is added to monogastric animal diets, while ruminants can synthesize B12 in the rumen if adequate cobalt is present.

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