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CHROMIUM IN ANIMAL NUTRITION

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Introduction

In the late 1950's Schwartz and Mertz (1959) found that chromium was an essential component of a factor in brewers yeast that corrected impaired glucose metabolism in rats fed certain diets. Subsequent research demonstrated that chromium functioned by enhancing insulin action. Insulin is an important hormone that triggers glucose uptake by muscle, adipose tissue, and liver following a meal. A lack of chromium in the body results in tissues becoming less responsive or resistant to insulin. Chromium deficiency is believed to be one factor associated with the development of type 2 or adult onset diabetes in humans (Anderson, 1992).

Chromium absorption has not been studied in livestock but in humans only 0.5 to 2.0 % of chromium in foods is absorbed (Anderson and Kozlovsky, 1985). Inorganic sources of chromium, such as chromium chloride, are also considered to be poorly absorbed. Most research suggests that organic forms of chromium are more bioavailable than inorganic chromium sources.

Traditionally, it has been assumed that practical diets fed to livestock and poultry provide sufficient chromium to meet animal requirements. This assumption has changed in the past 10 to 15 years as a number of studies have indicated that chromium supplementation of animal diets can affect animal metabolism and production criteria. In swine (Amoikon et al., 1995) and cattle (Stahlhut et al., 2006a) chromium supplementation has enhanced insulin sensitivity. This paper will update regulations regarding chromium supplementation of animal diets, and discuss responses to chromium supplementation that have been observed in cattle and swine.

Chromium Forms and Levels Permitted in Animal Diets

Chromium supplements have been available across the counter for human use for a number of years. It has only been recently that certain forms of chromium have been permitted as supplemental sources of chromium in swine and cattle diets. In the United States research with chromium sources must be evaluated for safety by the Food and Drug Administration (FDA) prior to their use in animal diets. This evaluation includes not only animal safety but also human safety, as meat and milk from animal supplemented with chromium will enter the human food chain.

Two organic forms of chromium (chromium picolinate and chromium propionate) are currently permitted for addition to swine diets at levels not to exceed 0.2 mg of supplemental chromium per kg of diet. The FDA issued a regulatory discretion letter in July, 2009 which permitted the use of chromium propionate in cattle diets. Chromium propionate is the only chromium source currently permitted for supplementation to cattle diets in the United States. It can be added at levels up to 0.5 mg of supplemental chromium per kg of diet dry matter (DM). Currently, chromium supplementation is not permitted in poultry, equine, sheep, goat, and companion animal diets. In countries outside the United States, regulations regarding chromium supplementation to animal diets vary greatly from one country to another.

Swine

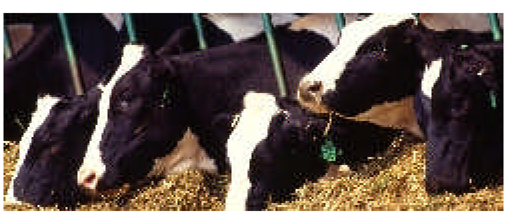
Growth and feed efficiency responses to chromium supplementation in swine have been highly variable. Page et al. (1993) found that supplementing 0.2 mg chromium/kg diet, as chromium picolinate, increased gain in one of three experiments with growing and finishing pigs. In a more recent study, chromium propionate supplementation did not affect weight gain of growing and finishing pigs (Jackson et al., 2009). Supplementation of chromium to pig diets has improved carcass quality in a number of studies. Reduced backfat and increased percentage of muscle has been reported in growing and finishing pigs supplemented with chromium picolinate (Page et al., 1993) and chromium propionate (Jackson et al., 2009).

Addition of chromium to sow diets has improved reproductive performance. Lindemann et al. (2004) reported that supplementing 0.2 mg chromium (chromium picolinate)/kg diet increased the number of pigs born alive by 0.33/litter. This study involved a total of 245 sows and was conducted at three different Universities. In a study conducted at a commercial swine operation in Kansas, chromium picolinate addition to sow diets increased first service farrowing rate from 82.9 to 95.5 % in the first parity (Real et al., 2008).

Dairy Cattle

A number of recent studies have indicated that chromium supplementation of dairy cows can increase feed intake and milk production. Most of the chromium studies with dairy cows have involved supplementation during the transition period. It is well documented that the transition period from 21 days prepartum to approximately 21 days postpartum is a critical period in regard to health and subsequent milk production in high producing dairy cows. In studies conducted in Wisconsin (Hayirli et al., 2001) and New York (Smith et al., 2005) supplementing chromium methionine from 21 days prepartum until 28 days postpartum increased feed intake and milk production during the first 28 days in milk. Maximizing feed intake is important in early lactation because high producing dairy cows secrete more energy in milk than they consume. This results in considerable mobilization of body fat and protein, that can result in ketosis or fatty liver due to the large amounts of fatty acids released from adipose tissue to support milk production.

Supplementing with chromium during the transition period may increase feed intake and milk production later in lactation even if chromium supplementation is discontinued. McNamara and Valdez (2005) supplemented dairy cows with chromium propionate from 21 days prepartum until 35 days postpartum. After chromium propionate was removed from the diet on day 35, feed intake and milk production continued to be monitored through 90 days in milk. Chromium supplementation increased feed (DM) intake 3.7 lbs/day and milk production 1.8 lbs/day the first 35 days of lactation. However, from days 36 to 90 of lactation, cows that had previously received chromium supplementation consumed 9.5 lbs more DM/day and produced 8.4 lbs more milk/day than control cows.



Beef Cattle

Considerable research indicates that chromium can affect immune response and disease resistance in cattle (Spears, 2000). Several studies at the University of Guelph in Canada have evaluated chromium supplementation of calves that had been exposed to stresses associated with shipping. In some of these studies chromium supplementation has reduced morbidity from respiratory diseases (Moonsie-Shageer and Mowat, 1993; Mowat et al., 1993). Stress is known to reduce the immune response causing cattle to be more susceptible to disease. Furthermore, studies in humans have indicated that stress increases urinary excretion of chromium, and may increase chromium requirements. Chromium supplementation of stressed calves during the receiving period also has improved or at least tended to improve gain and feed efficiency (Moonsie-Shageer and Mowat, 1993; Mowat et al., 1993).

In beef cows, grazing pastures and being feed harvested forages in the winter, chromium supplementation has improved reproductive performance. In these studies chromium was provided in a free choice mineral where salt was used to regulate mineral consumption. Stahlhut et al. (2006b) reported that chromium picolinate supplementation increased pregnancy rate in beef cows 5 years of age or younger. Chromium did not affect pregnancy rate in cows 6 years of age or older. The improved pregnancy rate was associated with much lower plasma nonesterified fatty acid concentrations at approximately 21 and 79 days after calving in chromium-supplemented cows. Lower plasma nonesterified fatty acid concentrations would suggest that chromium-supplemented cows were mobilizing less body fat to support milk production. Consistent with the lower plasma nonesterified fatty acid levels, chromium supplementation reduced body weight loss in young cows (2 and 3-year olds) after calving. Improving pregnancy rate in young beef cows is important because pregnancy rate is lower in young cows compared to mature cows.

Supplementation of chromium, as chromium yeast, in a free choice mineral reduced the interval from calving to first estrus and tended to improve pregnancy rate in young Zebu cows in Brazil (Aragon et al., 2001). Body weight gain was also greater in cows supplemented with chromium from parturition until their calves were weaned. At the present time chromium is not permitted in free choice mineral supplements. In the future chromium may be cleared for use in trace mineral salt and other free choice mineral supplements.

Summary

Chromium functions to enhance the actions of insulin. Studies in cattle and swine have shown that chromium addition to certain practical diets can increase insulin sensitivity. Chromium supplementation is currently permitted only in swine and cattle diets. Chromium picolinate and chromium propionate can be added to swine diets at levels not to exceed 0.2 mg chromium/kg diet. Chromium propionate is permitted in cattle diets at levels up to 0.5 mg supplemental chromium/kg diet DM. In swine chromium supplementation has reduced backfat and increased percentage of muscle in growing and finishing pigs and improved reproduction in sows. Chromium has increased feed intake and milk production when supplemented during the transition period to high producing dairy cows. In beef cattle chromium supplementation has increased reproductive performance of cows and reduced the incidence of morbidity in stressed calves.

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