

Does Chromium Have a Future in Dairy Cow Nutrition?

Dwain Bunting, Associate Professor, Department of Dairy Science

Introduction

Chromium (Cr) was recognized years ago as an essential trace element for man and some laboratory animals. However, because Cr was an ultra-trace mineral, required in parts per billion (ppb) concentrations, it was considered by most animal nutritionists to be an obscure trace mineral that was probably not important in normal diets. In the last five years, however, Cr has received a substantial amount of research and media coverage for its role in human nutrition. Chromium has been alleged to do everything from reducing blood cholesterol to decreasing fatness in couch potatoes. The only established metabolic role of Cr is its function in the glucose tolerance factor, which allows insulin to have its effects in the body. In both humans and animals, most of the positive biological responses to Cr supplementation are probably traceable to the known ability of Cr to improve insulin function.

Chromium's Effects in Livestock

Lee Southern's laboratory in the Department of Animal Science at LSU was among the first to show the potential benefits of Cr in livestock. When fed to swine, the compound Cr picolinate reduced fatness in swine. Chromium picolinate is now recognized for this effect in swine and is approved by the FDA for usage in swine diets. Although the actual data are somewhat less than convincing, Cr picolinate is marketed for humans for its ability to increase muscle mass in weight training adults.

Among the most promising effects of supplemental Cr has been improved resistance to or recovery from stress, and increased immune function. In Canadian research, increased feed intake and weight gain were observed during the first few weeks after arrival of shipping stressed feeder calves. Improved health and growth performance were invariably associated with improvements in stress and (or) immune criteria. In contrast, as observed in our own laboratory as well as others, when physiologically adapted feeder calves were fed over longer feeding periods, growth performance was not affected by Cr supplementation.

Chromium Analysis and Levels in Feedstuffs

Analysis for Cr in animal feeds is technically difficult, requiring highly sensitive instruments and specially equipped labs. Because Cr is a component of steel, exposure of feeds to metal surfaces in feed processing increases Cr contamination. Because of these problems, the information available on basal levels of Cr in animal feeds is scant and variable. The basal Cr concentrations reported for experimental diets for ruminants (range: 300 to 1,600 ppb) is usually higher than the supplemental Cr added to these diets (250 to 500 ppb). There is little information on the biological activity/availability of Cr in feedstuffs for livestock. However, with the exception of unique biological products, such as brewer's yeast, the Cr in most ruminant feedstuffs should probably be considered to be poorly available.

Effect of Chromium on Health and Milk Production

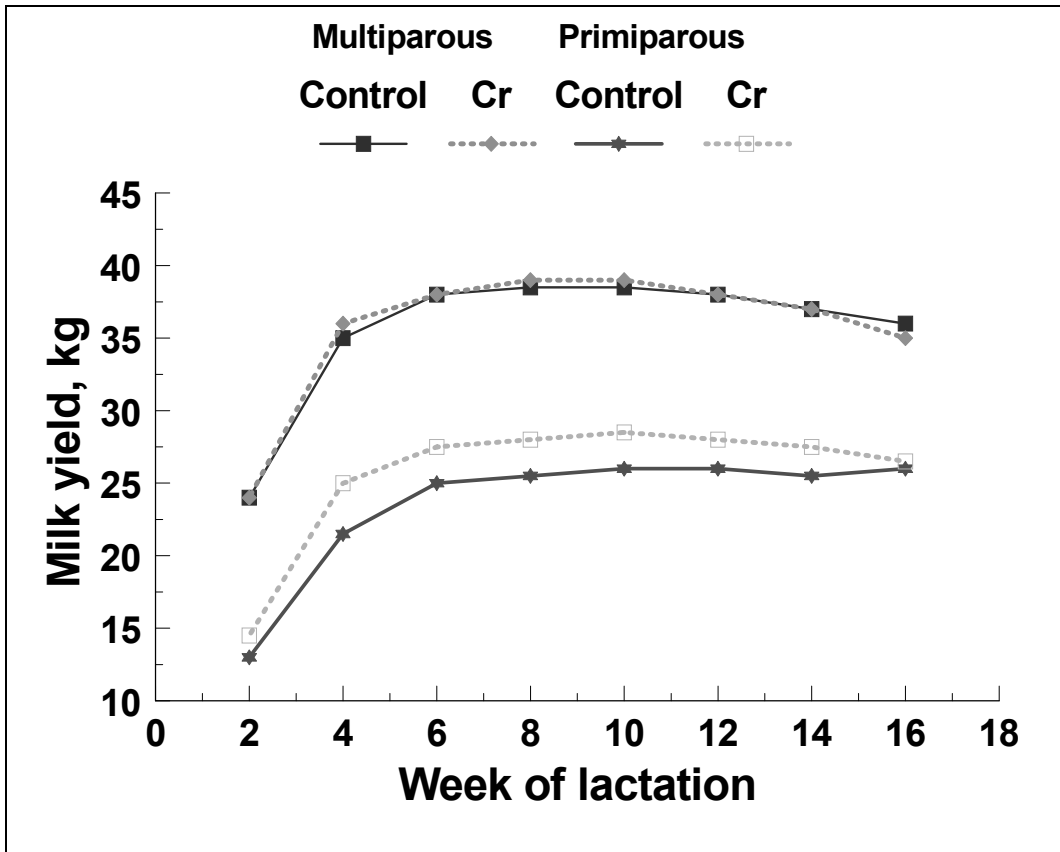
In early lactation, increased insulin effectiveness may have significant health and performance implications. When cows are in severe negative energy balance or are over-conditioned, excessive mobilization of fat tissue may lead to accumulation of fat in the liver and reduced liver function. In addition, there is generally a strong relationship between fatty liver disease and the development of ketosis. Insulin generally reduces breakdown of fat stores, decreases hepatic ketogenesis, and increases body utilization of ketones. Supplemental Cr has been shown to reduce fat concentrations in the livers of obese mice.

Researchers at the University of Kentucky (Besong and others, 1996) observed reduced blood ketones and liver fat levels in Holstein cows fed Cr picolinate beginning 30 days before calving. Canadian scientists (Yang and others, 1996) also observed trends for reduced blood ketones in early lactation cows.

At first glance, there would seem to be little reason to think that supplemental Cr would increase milk production in ruminants. Glucose uptake by the mammary gland does not require insulin. In addition, blood insulin concentrations are generally higher in low-yielding compared with high-yielding dairy cows. However, emerging data from lactation studies suggest that supplemental Cr may increase milk yield under certain metabolic circumstances. In the previously mentioned Canadian study, two experiments were

reported in which supplemental Cr increased early lactation milk production in primiparous (first calf) but not in multiparous cows (Figure 1). Although they did not report differences between primiparous and multiparous cows, the Kentucky scientists also observed increased milk yield in the first 60 days of lactation in cows supplemented with Cr. Unfortunately, there are no published reports of the effects of Cr on performance for an entire lactation.

It is not yet clear how supplemental Cr may increase milk yield in early lactation. A slight reduction in the rate of mobilization of body fat may simply help stabilize fat metabolism in the liver, reduce hepatic ketogenesis, and perhaps allow feed intake to increase more rapidly after calving. Chromium may also improve the action of growth hormone by improving the sensitivity of the insulin-like growth factors that are synthesized in response to the action of growth hormone.



Organic Cr seems to have proven efficacy for increasing reproductive performance in swine (Trout, 1995). Increasing the level or effectiveness of insulin has generally positive effects upon the reproductive axis and it is possible that dairy cow fertility may also be positively influenced by improved insulin action. The only available report regarding Cr and bovine fertility (Yang and others, 1996) suggests that supplementation with organic Cr may reduce days open in Holstein cows. However, the number of cattle in that study limits the conclusions that may be drawn.

Future of Chromium in Dairy Nutrition

Because Cr is essential for the normal functioning of insulin, all physiological functions in which insulin plays a critical role have the potential to be influenced by a deficiency of Cr. Consequently, it is probably valid to consider Cr an essential nutrient, at least for high-producing ruminants. Although the data are somewhat limited, the performance and multiple health-related benefits of organic Cr for the early lactation cow are compelling and physiologically reasonable. Currently, Cr is only approved for use in swine diets and, then, only Cr picolinate can be used. However, it seems likely that Cr could be an important component of future lactation rations.

Further Reading:

Anderson, R. A. 1987. Chromium. In: W. Mertz (Ed.) Trace Elements in Human and Animal Nutrition (5th Ed.). p 225. Academic Press, San Diego, CA.

Besong, S., J. Jackson, S. Trammell, and D. Amaral-Phillips. 1996. Effect of supplemental chromium picolinate on liver triglycerides, blood metabolites, milk yield and milk composition in early lactation cows. *J. Dairy* 79(Suppl. 1):196 (Abstr.).

Bunting, L. D., J. M. Fernandez, D. L. Thompson, Jr., and L. L. Southern. 1994. Influence of chromium picolinate on glucose usage and metabolic criteria in growing Holstein calves. *J. Anim. Sci.* 72:1591.

DePew, C. L., L. D. Bunting, and J. M. Fernandez. 1995. Blood metabolite responses in preweaning Holstein calves given chromium picolinate. *J. Anim. Sci.* 73 (Suppl. 1):276 (Abstr.).

Mertz, W. 1993. Chromium in human nutrition: A review. *J. Nutr.* 123:626.

Trout, W. E. 1995. Hypothesis provides explanation as to chromium's effect on reproductive efficiency in swine. *Feedstuffs*, Dec. 25.

Yang, W.Z., D. N. Mowat, A. Subiyatno, and R. M. Liptrap. 1996. Effects of chromium supplementation on early lactation performance of Holstein cows. *Can J. Anim. Sci.* 76:221.