KRMIVA

EFFECT OF TRACE MINERAL LEVEL AND SOURCE ON PERFORMANCE OF DAIRY CATTLE

DJELOVANJE RAZINE I IZVORA MINERALA U TRAGOVIMA NA REZULTATE MLIJEČNOG GOVEDA

M. Socha, C. Rapp, J. P. van der Meer

Professional paper – Stručni članak
UDC: 636.2.:636.087.72
Received – Primljeno: 20 may – svibanj 2003.

SUMMARY

The role of trace minerals in the dairy production cycle is increasing in importance. Nutritionists and veterinarians need to understand the function and interrelationships of each of these trace minerals. In addition, they need to understand the role of the various levels and forms of trace minerals to fully evaluate the need in today's dairy rations.

INTRODUCTION

Dairy producers today utilize a vast array of feedstuffs as dietary components for their rations. Concerns over protein, energy, fiber and mineral content are justified and need to be individually addressed and reviewed as to how they interact. Among these, trace minerals become readily important based upon metabolic needs and possible dietary interactions.

The overall objective of this paper is to discuss the role of trace minerals in the dairy production. In addition, it will address the differences in mineral sources, the role of organic trace minerals in dairy production and finally how other dairy producers around the world are meeting the trace mineral needs of their dairy cattle. The objective of this paper is to introduce these issues and review the function of trace minerals in metabolism.

TRACE MINERALS - FUNCTIONS

IODINE: The primary physiological requirement for iodine is the synthesis of hormones by the thyroid gland that regulate the cow's rate of energy metabolism (NRC, 1989).- In addition, some producers feed iodine compounds in excess of the nutritional requirement to cattle for the prevention of footrot (Miller and Tillapaugh, 1967).

IRON: The primary physiological requirement for iron is in oxygen transport during respiration, in enzymes used in energy metabolism and by the immune system. The majority of iron in the body is found in the red blood cell as a component of hemoglobin.

SELENIUM: The primary physiological requirement for selenium is as a component of glutathione peroxidase. This enzyme is involved in the immune system in protecting cells from intermediate metabolites the body produces to protect itself in the fight against harmful invasions. It is also used by the thyroid gland as an enzyme component involved in energy metabolism.

ZINC: The primary physiological role of zinc is as a component of numerous enzyme systems. The metabolic action of these systems includes carbohydrate and energy metabolism, protein synthesis and nucleic acid metabolism, epithelial

Mike Socha, Ph. D., Christof Rapp, Ph. D., Ing. J. P. van der Meer, Zinpro Animal Nutrition, Boxmeer, Netherlands.

tissue integrity, cell repair and division, vitamin E absorption, vitamin A transport and utilization, and beta-carotene conversion, transport and utilization. In addition, it plays a major role in the immune system and certain reproductive hormones.

The recommended dietary zinc content lactating dairy cattle is 40 ppm (NRC, 1989). Many nutritionists and veterinarians recommend feeding at least twice this level.

COPPER: The primary physiological role of copper is in its function as an enzyme activator and enzyme constituent (Maynard and Loosli, 1969). It also has a basic function in iron metabolism and red blood cell maturation, in addition to being a key component of the immune system.

Copper deficiency symptoms include poor performance, loss of hair color and reduced fertility. Copper deficiency interferes with the synthesis of keratin resulting in increased lameness and increased cases of mastitis.

Excess molybdenum in the feed of dairy cattle reacts in the rumen with sulfur and forms compounds that interfere with copper absorption and metabolism.

MANGANESE: The primary physiological role of manganese is as an activator of a number of enzyme systems. In addition, it plays a role in reproduction (NRC, 1989). A deficiency of manganese results in suppression of estrus, reduced conception rate, poor skeletal growth and weak, poor condition of legs, feet and joints (Mertz, 1987). Manganese deficient animals are found to exhibit skeletal abnormalities in a number of animal species.

COBALT: The primary physiological role of cobalt is as a constituent in vitamin B_{12} (cyanocobalamin). Dietary sources of vitamin B_{12} are not used efficiently by ruminants because of inactivation by ruminal microbes (Miller, 1988). When sufficient dietary cobalt is fed, synthesis of adequate amounts of vitamin B_{12} takes place in the rumen. Vitamin B_{12} is needed for adequate metabolism of propionate, one of the ruminal volatile fatty acids.

TRACE MINERAL SOURCES-INORGANIC VS. ORGANIC:

There is increasing interest in evaluating forms of trace minerals. Increasing bioavailability and subsequent metabolic activities are being studied to help evaluate the differences between sources.

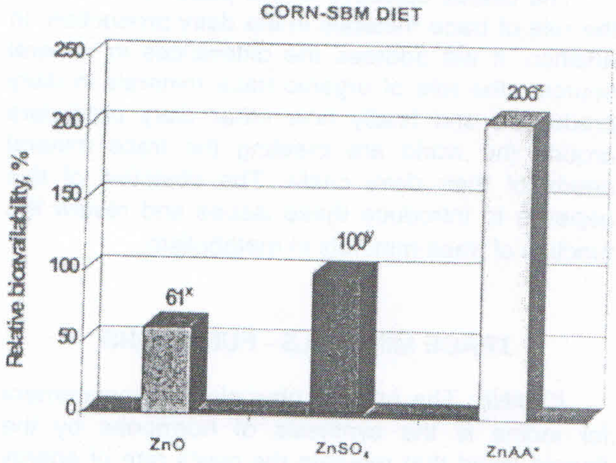
The inorganic forms most commonly used are the oxide and sulfate forms. Some minerals are provided in the carbonate form, but only those that are used in minute quantities.

It is routinely figured that the oxide form is about one-half as available as the sulfate form. This rule is normally accepted except in the case of copper oxide, which has virtually no bioavailability in the oxide form. AvailaMins®, Zinc Amino acid complex, 1:1 complexed trace minerals are given a value of twice as bioavailable as the sulfate form of the corresponding trace minerals.

Bioavailability of zinc from ZnAA has been shown to be 206% that of zinc from zinc sulfate in practical corn-soybean based growing diets (Figure 1). The researchers state that the greater bioefficacy of ZnAA relative to zinc sulfate in diets containing phytate and fiber suggests that metabolism of a ZnAA complex differs from inorganic zinc sources (Wedekind et al., 1992). Similar research has been conducted with manganese methionine yielding responses of similar magnitude (Fly et al., 1987, Henry et al., 1992).

Figure 1. Bioavailability of zinc oxide and zinc amino acid complex in relation to zinc sulfate in a corn-sbm diet (soybean meal)

Slika 1. Biodostupnost cinkovog oksida i cinkovog kompleksa aminokiselina u odnosu na cinkov sulfat u obroku kukuruz: sojina sačma



ZINC AMINO ACID COMPLEX* FOR LACTATING DAIRY CATTLE

Numerous studies have been conducted with dairy cattle evaluating the effects of ZnAA on lactation, somatic cell count and foot condition.

A summary of twelve trials is shown in Table 1. In these studies milk production was increased by an average of 4.26% and somatic cell count reduced by 33.3% (Andersson and Leon, 1998; Kellogg, 1990; Jones, 1995; Smith et al., 1999; TB-D-4002). A significant improvement in hoof texture, reduction in heel cracks and reduction in laminitis were noted with lactating cows fed ZnAA (Moore et al., 1989).

Effect of ZnAA on reproduction has also been studied. Research has shown that cows fed zinc amino acid complex have fewer spontaneous abortions along with trends for reduced SCC, mastitis, lameness, dead calves born, and premature removal from the herd because of poor performance (Graham, 1992). The researchers have pointed out that one important point to consider when evaluating efficacy of nutrient supplements on improvement of pregnancy outcome is whether supplementation precedes and overlaps periods of greatest risk.

Table 1. Summary of twelve trials evaluating the effect of feeding zinc amino acid complex[1] to lactating dairy cows (Andersson and Leon, 1998; Kellogg, 1990; Jones, 1995; Smith et al., 1999; Int TB-D-4009).

Tablica 1. Sažetak 12 pokusa ocjenjivanja djelovanja hranjenja mliječnih krava u laktaciji cinkovim kompleksom amino kiselina

12 dairy lactation trials evaluating zinpro zinc methionine

Dvanestdnevni pokus laktacije proveden sa Zinpro cink metioninom

Measurement Mjerilo	n[a]	Control - Kontrola	ZINPRO[b]	p=[c]
Milk - Mlijeko, kg/d	10	30.5	31.8	0.0001
ECM[d], kg/d	10	30.4	31.7	0.003
3.5% FCM[a], kg/d	10	30.0	31.6	0.008
Fat - Mast, kg/d	10	1.06	1.10	0.03
Protein - Bjelančevine, kg/d	10	0.96	0.99	0.003
Fat - Mast, %	10	3.47	3.48	0.90
Protein - Bjelančevine, %	10	3.14	3.11	0.17
SCC - Somatske stanice (SCC), 1000s/mL	10	294	196	0.001

[a] Number of kind in which records were kept on the selected paramater. Averages are presented as least sequare means.

[b] Cows fed ZnPRO zinc methionine consumed 180 - 400 mg of Zn/hd/d - Krave hranjene sa cink metioninom dobivale su 180 do 400 mg/grlo/dan

[c] Model for stastistcal analysis included effect of trial (block) and treatment within trial (experimental unit)

[d] Energy-corrected milk, 3.5% fat and 3.2% protein - ECM = energetski korigirano mlijeko, 3,5 % masti i 3,2 % bjelančevina (energy corrected milk – ECM)

[e] Fat-corrected milk, 3.5% fat - FCM = korigirani sadržaj masti u mlijeku na 3,5 % masti (fat – corrected milk, 3,5 % fat)

MULTIPLE ORGANIC TRACE MINERAL PROGRAMMING FOR DAIRY CATTLE

Due to multiple trace mineral interactions as well as the role trace minerals such as zinc, copper, manganese and cobalt play in reproduction, claw integrity, mammary gland health and immune function, an increasing number of nutritionists, veterinarians and producers are interested in a combination of organic trace minerals.

In a summary of 11 trials, cows fed a combination of complexed zinc, manganese, copper and cobalt produced 2.8 % more milk and had 23 fewer days open (Table 2), (Bravo, 1997; Campbell et al., 1999; Kellogg, 1994; Kellogg, 1996; Kellogg, 1996; Nocek, 1994; Tomlinson and Snead, 2000; INT TB-D-4006). In addition to an improvement in lactation and reproductive performance, reductions in retained placentas, uterine infections and claw disorders have been observed in cows fed a combination of complexed trace minerals.

Table 2. Summary of trials evaluating the effect of feeding complexed zinc, copper, manganese and cobalt to lactating dairy cows (Bravo, 1997; Campbell et al., 1999; Kellogg, 1994; Kellogg, 1996; Kellogg, 1996; Nocek, 1994; Tomlinson and Snead, 2000; Int TB-D-4006).

Tablica 2. Sažetak pokusa ocjenjivanja djelovanja hranjenja mliječnih krava u laktaciji kompleksom cinka, bakra, mangana i kobalta

Measurement - Mjerilo	n[1]	Control - Kontrola	Complexes[2] Kompleks mikrominerala	P=3
Milk - Mlijeko, kg/d	11	35.2	36.2	0.0001
ECM[4], kg/d	9	36.3	37.3	0.0001
3.5% FCM[5], kg/d	9	36.2	37.3	0.0001
Fat - Mast, kg/d	9	1.29	1.34	0.001
Protein - Bjelančevine, kg/d	9	1.12	1.14	0.001
Fat - Mast, %	9	3.76	3.80	0.27
Protein - Bjelančevine, %	9	3.21	3.21	0.63
SCC - SCC, somatske stanice, 1000 s/ml	9	282	239	0.01
Days to first service - Dani prvog pripusta	6	82	75	0.001
Days open - Odnos vremena	6	138	115	0.01
Services/conception Pripust/bređost	4	2.3	2.0	0.05

SAŽETAK

Važnost uloge minerala u tragovima u ciklusu proizvodnje mlijeka sve je veća. Nutricionisti i veterinari moraju razumjeti funkciju i međusobnu povezanost svakog od minerala u tragovima. Osim toga, moraju razumjeti ulogu raznih razina i oblika minerala u tragovima da bi potpuno ocijenili potrebe u obrocima u mljekarstvu danas.