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Effects of an organic source of copper, manganese and zinc on dairy cattle productive performance, health status and fertility

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ABSTRACT

The objective was to determine effects of partially replacing Zn, Cu and Mn in sulphate form with organic trace minerals (OTM) during the dry period and lactation on dairy cow productive performance, fertility and health status, while supplying Zn and Cu to meet National Research Council (NRC; 2001) guidelines for lactating Holstein dairy cows in mid-lactation and Mn above NRC guidelines. At the beginning of the dry period, 296 pregnant Holstein cows were randomized to one of two experimental groups. During the dry phase, cows were fed a diet where Cu, Mn, and Zn were supplied as sulphates (control group) or a diet in which 500 g/kg of Cu, Mn, and Zn was supplied as sulphates and 500 g/kg as OTM (KeyShure™). During lactation, cows that had been previously assigned to the control group were fed, for 240 d, a diet where Cu, Mn, and Zn were supplied as sulphates (control group) while cows which had received OTM during the dry phase were fed a diet in which 250 g/kg of sulphates were replaced with similar amounts of organic Cu, Mn, and Zn (OTM). Cows were housed in a free stall barn with four pens (two pens per treatment). Colostrum from cows fed OTM contained more immunoglobulins (+19%; $P < 0.01$) whereas OTM supplementation had no effect on the concentration of trace minerals in colostrum. During the first 150 d, OTM increased milk fat content by 4.4% ($P < 0.05$) while milk yield, protein content and somatic cell count were not influenced by treatment. Because more cows from the OTM group became pregnant between 150 and 240 d, a higher number of services per conception (2.01 *versus* 2.61 for control and OTM, respectively; $P < 0.01$) occurred in cows fed OTM. Calf mortality at calving was lower in multiparous cows fed OTM (15.6 *versus* 5.6% for control and OTM, respectively; $P < 0.05$) whereas there were no differences in other pathologic events and claw disorders. This study produced evidence that partial substitution of Zn, Cu and Mn sulphates with OTM during the dry phase and lactation resulted in higher colostrum immunoglobulins and milk fat, as well as lower calf mortality at calving.

Abbreviations: aADF, acid detergent fiber; BCS, body condition score; DM, dry matter; NDF, neutral detergent fiber; OTM, organic trace minerals; SCC, somatic cell count; TMR, total mixed rations.

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1. Introduction

Providing adequate amounts of essential minerals is critical to maintain health and maximize productivity of dairy cows (NRC, 2001). Despite that minerals, both macro and trace, are usually fed as inorganic salts, several studies have investigated effects of organic sources of minerals in farm animals. Organic minerals can be described as nutritionally essential minerals attached to a carbon–hydrogen based molecule which acts as a ligand. Ligands that are used most frequently include amino acids, peptides and proteins. In particular, complexes where a mineral is bonded to amino acids with at least two bonds from each amino acid are referred to as chelated minerals or mineral chelates. Chelates are stable in the digestive tract and are usually characterized by higher bioavailability and retention by the animal (Henry et al., 1992; Wedekind et al., 1992; Formigoni et al., 1993; Predieri et al., 2005) than inorganic minerals.

Several beneficial effects were reported when organic trace minerals were fed to dairy cows, including improved fertility (Uchida et al., 2001), prevention of mastitis and foot lesions (Nocek et al., 2000; Siciliano-Jones et al., 2008), and improved productive performances (Nocek et al., 2006; Cope et al., 2009). However, in most of the cited studies, organic trace minerals were used at levels considerably higher than NRC (2001) guidelines.

Our objective was to determine effects of partially replacing Zn, Cu and Mn provided in sulphate form with organic trace minerals during the dry period and lactation on dairy cow productive performance, fertility and health status, while supplying Zn and Cu to meet NRC (2001) guidelines for lactating Holstein dairy cows in midlactation, and Mn above NRC (2001) guidelines.

2. Materials and methods

2.1. Animals and treatments

The experiment was conducted between May 2007 and February 2009 at a commercial farm near Verona (Italy). At the beginning of the planned dry period of 60 d, 296 pregnant Holstein cows, including 111 heifers, were randomized to one of two experimental groups with 147 and 149 in the control and organic trace minerals (OTM) groups based on homogeneity of milk yield (sire predicted transmitting ability was used for primiparous cows) and parity. During the dry period, cows were fed a diet (Table 1) where Cu, Mn and Zn were supplied as sulphates (control) or a diet in which 500 g/kg of Cu, Mn and Zn was supplied as sulphates and 500 g/kg as OTM (KeyShure™; Balchem, New Hampton, NY, USA). During lactation, cows were fed a diet for 240 d (Table 1) wherein Cu, Mn and Zn were supplied as sulphates (control) or a diet in which 750 g/kg of Cu, Mn, and Zn was supplied as sulphates and 250 g/kg as OTM (KeyShure™). KeyShure Cu, Mn and Zn are individual products that each contains 150 g/kg of the respective metal which is bound with amino acids and partially hydrolyzed protein to form a metal proteinate. The chemical composition of the supplements is in Table 2, and the chemical composition of the diets is in Table 3.

Lactating cows were housed in a free stall barn with four pens (two pens per treatment). Similarly, during the dry period, cows were housed in four separate pens (two pens per treatment) where each dry pen moved to the same lactation pen. Pregnant heifers entered the dry cow group 80 d before the estimated calving date. Cows from each experimental group were randomly allocated to one of the four dry pens, regardless of parity category, and stocking density was similar in all pens.

Beddings were rubber mattresses (Musicco, Brescia, Italy) and water and feeding spaces were the same in all pens. Each cow was fitted with a pedometer to measure daily activity in order to detect heat. Cows were milked twice a day at 03:00 and 15:00 h and the milking parlour was equipped with a device (Afimilk, S.A.E. AFIKIM, Kibbutz Afikim, Israel) that recorded individual cow milk yield.

Table 1
Ingredient composition (g/kg dry matter) of the experimental diets fed to the dry and lactating cows.[a]

	Dry cows	Lactating cows
Corn, silage	370	375
Triticale, silage	–	49
Alfalfa, hay	–	60
Wheat, straw	111	16
Grass, mixed hay	339	32
Corn, grain (ground)	–	239
Soybean, meal (500 g/kg crude protein, solvent)	45	60
Soybeans, extruded	45	100
Canola, meal (solvent)	75	47
Sodium bicarbonate	–	7
Mineral supplement[b]	15	15

[a] Diets were formulated using CPM-Dairy Version 3 software to meet the NRC (2001) guidelines for Holstein lactating dairy cows in midlactation; ingredient composition of the experimental diets remained the same throughout the trial.
[b] See Table 2.