Use of organic trace elements in nutrition

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Milk production has been characterised in recent years by a steady increase in individual cow milk yield. In order to meet the dietary requirements of high producing cows the importance of providing an adequate supply of nutrients, especially trace elements, is growing.

As the elements manganese and zinc are usually present at insufficient levels in ruminant rations, these elements are added to commercial rations via mineral supplements.

Zinc is a component of numerous enzymes, and therefore plays a key role in the metabolism of cows. It affects the metabolism of nucleic acids, carbohydrates, proteins and fats, the immune system and the formation of important hormones.

Zinc is also involved in a wide variety of body processes such as maintenance of skin function, spermiogenesis, formation and maintenance of claw keratin stability and in RNA and DNA synthesis.

Zinc is stored in all organs of the body, the highest concentrations being found in bones, liver, skin and hair. The zinc requirement of dairy cows is 50mg/kg dry matter.

Manganese plays an important role in the formation of connective tissue and cartilage. It is also needed to support a normal cholesterol and lipid metabolism.

The manganese requirement is 50mg/kg dry matter. Manganese deficiency has adverse effects mainly on reproduction and rearing results. This leads to poor fertility, manifested in cows by silent oestrus, reduced conception rates, increased abortion rates and a high incidence of vaginal and uterine inflammations.

Recent attention has focused on the use of organic trace element compounds. The main argument in support of this is that elements with these specific binding forms are believed to have higher bioavailability.

Table 1. Nutrient content of the ration.

Net energy lactation (MJ/kg DM)	6.95
Utilisable crude protein (g/kg DM)	174.0
Ruminal N balance (gN/kg DM)	1.0
Crude fibre (g/kg DM)	172.0
Manganese (mg/kg DM)	52.8
Zinc (mg/kg DM)	54.5

DM=dry matter

	Control group	Test group	p-values
Milk yield (kg/cow and day)	33.00 ± 0.33	33.84 ± 0.33	< 0.0001
Fat (%)	3.92 ± 0.030	3.92 ± 0.03	0.92
Protein (%)	3.47 ± 0.012	3.46 ± 0.01	0.40
Lactose (%)	4.90 ± 0.009	4.94 ± 0.01	0.02
Urea (mg/l)	267 ± 3.00	280 ± 3.00	< 0.0001
Cell count (1,000/ml)	201 ± 18.0	147 ± 18.0	0.02
Log. cell count	4.57 ± 0.06	4.40 ± 0.06	0.01

Table 2. Milk performance parameters.

They are claimed to provide additional benefits compared with inorganic compounds.

We conducted a study comparing the effects of organic amino acid-zinc chelates and amino acid-manganese chelates on health and performance of dairy cows on a dairy farm with conventional feeding.

Study design

The study was conducted under production conditions in an agricultural cooperative in the district of Wartburg, East Germany. Some 192 dairy cows were selected from the herd, averaging 430 Holstein-Friesian dairy cows and divided into two groups (control and test group) which were similar in milk yield and number of previous lactations.

During the course of the trial the control and the test group were continuously replenished with fresh calved cows so as to obtain a uniform milk yield between the two groups. The dairy cows were kept under standard conditions in a loose barn with slatted floor. They were milked three times a day. The cow:trough ratio was 1:1. The ration was dispensed by means of a mobile mixer-feeder.

All cows were fed the standard ration according to requirement (Total Mixed Ration) based on maize silage, wilted grass silage and concentrates. The ration was composed of 32% maize silage, 38% wilted grass silage, 3% hay and 27% concentrates. The mineral supplementation was achieved by adding 200g mineral feed to the total mixed ration.

The mineral feed of the control group contained 6,000mg of inorganically bound manganese and zinc per kg. In the test group inorganic zinc and manganese were replaced by organic amino acid-zinc chelates and amino acid-manganese chelates (BioKey, by Biochem, Lohne).

The zinc concentration of the ration was 54.5mg/kg DM and the manganese concentration 52.8mg/kg DM. This adequately covered the official intake levels of zinc and manganese recommended by the German Nutrition Society (GfE, 2001).

The nutrient analysis of the ration is shown in Table 1.

Investigations

All three milks from the test and control group were recorded daily over a seven month period in the herd management programme HERDE.

Official milk recording took place once a month, measuring milk yield, fat, protein and lactose content of the milk, somatic cell count and urea content of the milk. In addition, zinc and manganese concentrations in the milk of all cows were determined and metabolic tests performed. Crude nutrient analyses of the feedingstuffs used were performed once a fortnight for the forages and once a month for the concentrates.

Tests on milk, feedingstuffs and metabolic samples were conducted by standard methods. All reproductive and health data were recorded daily via the herd management programme HERDE. The data were evaluated by means of a mixed model using the SAS statistics software (Version 8.2; procedure mixed).

The calculated feed dry matter consumption of both groups was 23.6kg/day. The

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actual average dry matter intake per cow and day was 21.3kg in the test group and 20.8kg in the control group. These deviations were due to fluctuations in the amount loaded into the mixer and unconsumed feed.

Milk yield and composition

The mean milk yield of the cows was 33.0kg per cow and day in the control group and 33.84kg in the test group. The increased milk production in the test group by approximately 2.5% (+0.84kg) was statistically significant (Table 2). Fat and protein content of the milk did not differ between the two groups. The lactose content of the milk was slightly, but statistically significantly, higher in the test group than in the control group.

The cows receiving the organic zinc and manganese chelates had a distinctly lower somatic cell count in their milk ($p<0.02$).

Determination of the somatic cell count is an established diagnostic procedure for mastitis. A range of 20,000-50,000 cells per millilitre, with an upper limit of 100,000 cells per millilitre, is considered to be a normal, physiological cell count in milk from healthy quarters. The presence of somatic cells in the control group indicates an increased risk of mastitis. The trace elements are excreted in the milk produced.

	Control group	Test group
Number of samples	67	74
Manganese (mg/kg dry matter)	0.60 ± 0.47	0.51 ± 0.10
Zinc (mg/kg dry matter)	34.6 ± 7.8	33.3 ± 9.4

Table 3. Zinc and manganese content of the milk.

A clear relationship exists between the zinc and manganese content of the milk and their intake with the diet. But supplementation of organically bound zinc and manganese did not alter the content of manganese and zinc in the milk compared with the control group (Table 3).

Health

The number of sick cows was 58% higher in the control group than in the test group. The most important disease condition was mastitis. The incidence of mastitis in the group supplied with organic zinc and manganese was only about one quarter of that in the control group. Diseases of the locomotor system did not present a uniform picture. The proportion of cows with ovarian cysts did not differ between the control and the test group (Table 4).

Summary

A feeding trial was conducted under commercial production conditions to study the effect of replacing inorganic manganese and zinc compounds with organic binding forms.

It was observed that under the conditions prevailing in the trial the milk yield of the test group was 0.8kg/cow and day higher than in the control group. Supplementation of the test group with organic zinc and manganese compounds led to a reduction in the somatic milk cell count.

The study showed a distinct trend towards positive effects on the incidence of mastitis cases in the test group compared with the control group.

Overall, the results demonstrate clearly that the organic amino acid-zinc and amino acid-manganese complexes tested in this study can have a beneficial effect on milk yield and health of cows compared with conventional inorganic compounds. n

Table 4. Incidence of diagnosed diseases.

Diagnosis	Control group	Test group
Mastitis	81	22
Ovarian cysts	5	6
Corns	9	15
Laminitis	2	0
Sole ulcer	13	8