The effect of magnesium oxide supplementation on the fertility of dairy cows grazing fertilized pastures

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The Cedara dairy herd of 100 lactating Friesian cows was randomly subdivided into three treatments. A mineral supplement comprising a standard salt + dicalcium phoshate mixture (Treatment 1), the standard + 5% of a commercial trace-mineral premix (Treatment 2) and the standard mix + 10% MgO (Treatment 3) was fed at 130g/cow/day. Inter-calving periods were significantly ($P<0,05$) reduced from 394 days in Treatment 1 to 373 in Treatment 3 while the services to conception were reduced from 1,94 to 1,54 by magnesium supplementation.

Die Cedara suiwelkudde van 100 lakterende Frieskoeie is ewekansig in drie behandelings ingedeel. 'n Standaard sout en dikalsiumfosfaatmengsel (Behandeling 1), die standaard mengsel + 5% van 'n kommersiële spoorelement voormengsel (Behandeling 2) en die standaard mengsel + 10% MgO (Behandeling 3) is teen 130g/koei/dag gevoer. Die tussenkalfperiode was betekenisvol ($P<0.05$) verminder van 394 dae in Behandeling 1 tot 373 dae in Behandeling 3 en die aantal dekkings per konsepsie is verminder vanaf 1,94 tot 1,54 met magnesium byvoeding (teenoor die standaard mengsel).

Keywords: Dairy cattle, fertility, ionic balance, magnesium

Magnesium plays a key role in the enzyme systems for energy transfer and utilization, smooth muscle contraction and the nervous system (Miller, 1979; Holmes & Wilson, 1984). Magnesium deficiencies are typically associated with grass tetany (hypomagnesaemia), especially on well-fertilized pastures (Miller, 1979; Little, 1982). Low magnesium levels may be associated with sub-clinical hypomagnesaemia and a subsequent reduction in milk yields (Holmes & Wilson, 1984). Infertility has apparently been relieved by magnesium supplementation (Pickard, 1986).

In sharp contrast to other elements, the magnesium in lush green grass is not readily available to the animal. High potassium and nitrogen levels in the soil adversly affect magnesium uptake by plants. In the plant the magnesium becomes bound to long chain fatty acids leading to the possible formation of insoluble magnesium-soaps (Miller, 1979; Little, 1982). Magnesium has also been shown to be strongly bound to bacterial cell walls in the rumen, also reducing the amount of magnesium available to the animal. It has been postulated that the deleterious effect of potassium on magnesium utilization, may operate in part via stimulated microbial activity in the rumen providing increased potential for the binding of magnesium to bacterial cell walls (Little, 1982). It has been suggested that the ratio of Na:K in the rumen influences the rate of absorption of magnesium from the anterior digestive tract, as its absorption is a sodium-dependent process. It was suggested that a dietary sodium concentration, less

than 0,2% reduced the absorption of magnesium (Allen & Sanson, 1980). In contrast to green herbage, magnesium in hay is more freely available to the animal (Miller, 1979; Little, 1982).

An ionic balance exists between potassium, sodium, calcium and magnesium in the animal body (McDowell, Conrad, Ellis & Loosli, 1983). Kikuyu (*Pennisetum clandestinum*) herbage, the predominant grazing for dairy cattle in Natal, has an imbalanced Ca: P ratio (<1) and high levels of potassium in the herbage. Italian ryegrass (*Lolium multiflorum*), an important winter grazing species, also contains high potassium levels in the herbage and both ryegrass and kikuyu have an imbalanced cation ratio (K/Ca + Mg > 2,2). The supplementation of calcium has been found to improve the fertility of dairy cattle on Cedara, but sufficient calcium cannot be supplemented to balance the K/Ca + Mg ratios without impairing rumen function. Therefore preliminary trials were conducted on Friesian dairy heifers, where 0,5% magnesium sulphate was included in the mineral lick in an attempt to balance the K/Ca + Mg ratio. The fertility of these heifers improved dramatically, from over four inseminations per conception to less than two. It was then decided to extend this study to lactating dairy cows.

The Cedara dairy herd of 100 lactating Friesian dairy cows was randomly divided into three treatments and supplemented with either: Control mineral mix; Control mix + 5% of a commercial yeast extract/trace-mineral premix; Control mix + 10% maqnesium oxide. These mineral mixtures were fed individually at a rate of 130g/cow/day for a period of 3 years.

The Cedara dairy herd is on kikuyu grazing in summer and Italian ryegrass plus maize silage during the winter months. Concentrates are supplemented according to requirement, to a maximum of 2% of body mass.

The mineral contents of the mineral mixtures and those of the typical roughages fed are given in Table 1. The magnesium oxide contained less than one twentieth of the copper, zinc and manganese levels in the commercial premix. Unfortunately cobalt and selenium could not be measured locally, but these have been supplemented at Cedara previously without success. The Natal Midlands is deficient in iodine and it is therefore routinely supplemented. The control mineral mixture consisted of iodized salt (26%), dicalcium phosphate (72%) and molasses powder (2%) on predominantly ryegrass grazing. Cattle grazing kikuyu were fed a mineral mixture consisting of iodized salt (33%), dicalcium phosphate (48%), feedlime (17%) and molasses powder (2%) to balance the Ca: P ratio and allow for an increased salt requirement on kikuyu, it being a natrophobic plant.

Table 1 Mineral contents of the mineral supplements and those of typical roughages fed to the dairy herd

	Content (%)					
feed	DM	Ca	P	K	Mg	Na
Mineral mix a	98	17,30	12,90	0,09	0,09	10,23
Mineral mix b	98	17,65	13,29	0,10	0,91	9,74
Mineral mix c	98	15,70	11,70	0,10	5,98	9,30
Dairy meal	88	0,84	0,44	0,41	0,13	0,10
Ryegrass	100	0,44	0,23	3,87	0,23	0,15
Maize silage	100	0,25	0,14	0,73	0,26	0,04
Kikuyu	100	0,28	0,35	3,87	0,23	0,02

Table 2 The number of cows per treatment, milk production, number of services to conception and inter-calving period of the cows on the mineral treatments

	Treatment		
Item	A	B	C
n	69	56	64
Milk yield (kg/300 days)	6472	6546	6564
BF%	3,72	3,54	3,64
FCM yield (kg/300 days)	6200	6094	6210
Services per conception (transformed means)	$1,34^{a}$	$1,30^{ab}$	$1,18^{b}$
Services per conception	$1,94^{a}$	$1,79^{ab}$	$1,54^{b}$
Inter-calving period (days) (transformed means)	$5,97^{a}$	$5,94^{ab}$	$5,91^{b}$
Inter-calving period (days)	396^{a}	384^{ab}	373^{b}

^{a,b} denote significant differences ($P < 0,05$) within rows

The results of the mineral treatments are presented in Table 2. The inclusion of magnesium oxide significantly ($P<0,05$) improved the fertility of the cows over the control treatment. Treatment 2 (commercial premix) was not significantly different ($P<0,05$) from either Treatment 1 or 3. This could possibly be due to relatively high magnesium levels (12%) in the commercial premix. The services to conception data followed a Poisson distribution whilst the inter-calving period (ICP) data were lognormal. The data had to undergo a square-root transformation for services to conception and a log transformation for ICP to normalize the data and validate an analysis of variance. Month of calving was used as a co-variate in the analyses of variance, but proved to be non-significant indicating that the month of calving did not have an effect on fertility.

The use of both magnesium sulphate and magnesium oxide have been found to improve the fertility of livestock grazing well-fertilized pastures. Kitching (pers. comm.) of Allerton Veterinary Laboratories has similarly found magnesium oxide (industrial grade) from a different source to the authors to be effective in improving fertility in the field.

The significant improvement in fertility may be associated with improved cation ratios (K/Ca + Mg) resulting from calcium and magnesium supplementation, although high K/Ca + Mg ratios are usually associated with hypomagnesaemia (Kemp & t'Hart, 1957). Hypomagnesaemia has not proved to be a problem at Cedara in spite of the adverse cation ratio.

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