Influence of higher fatty acids on the availability of magnesium in milking cows

A. KEMP [1], W. B. DEIJS [1] and E. KLUVERS [2]

[1] Institute for Biological and Chemical Research on Field Crops and Herbage (I.B.S.), Wageningen, The Netherlands

[2] Department of Animal Feeding of the Agricultural University, Wageningen, The Netherlands

Summary

In a digestion trial the influence was studied of adding various amounts of animal fat to winter rations of milking cows on the availability of the magnesium consumed. The results suggested that addition of animal fat increased the concentration of magnesium excreted with the faeces, thus decreasing the apparent availability. This confirmed earlier experience that milking cows receiving additional fat excreted more earth-alkali soaps in the faeces.

Higher crude protein contents in the herbage were associated with lower figures for availability of magnesium by the animal. An increase in the crude protein in the herbage was associated with higher contents of total higher fatty acids. Therefore, it seemed that the unfavourable influence of nitrogen fertilization on grassland on the magnesium supply to grazing cattle is completely or partly explained by changes of fat concentrations in the rations.

1. Introduction

The unfavourable effect of heavy nitrogen dressings on pastures on the magnesium concentration in the blood serum of milking cows and the incidence of hypomagnesaemic tetany has been established (BARTLETT et al., 1954; KEMP, 1958; SMYTH et al., 1958; HVIDSTEN et al., 1959). SJOLLEMA (1931) already emphasized the often high nitrogen contents in "tetany-prone" herbage. In grazing experiments one of the authors found a relation between the magnesium, potassium and crude protein contents in the grass and the magnesium contents in the blood serum of 822 milking cows (KEMP, 1960), suggesting that magnesium in grass should be higher to meet the animals' requirement if crude protein and potassium in the grass were higher.

More recent balance trials with milking cows showed that hypomagnesaemia in milking cows may arise from a shortage in the dietary supply of available magnesium (ROOK et al., 1958; KEMP et al., 1960), and that the low availability of dietary magnesium (averaging 17 %) and its large variations in availability (5–35 %) may become critical to the magnesium supply to the animal. These differences in availability are associated with the sometimes large between-animal differences, but apart from this the composition of the rations may also be of considerable influence. In a balance trial with milking cows fed on herbage in different stages of growth it was found that the "availability" of the magnesium ingested by the animals increased

Received for publication: 20th July, 1966.

considerably as the herbage matured (KEMP et al., 1961). The detailed results of this experiment are mentioned in Table 1.

Table 1. Influence of freshly cut herbage in different stages of growth on the magnesium utilization in milking cows

Cow	*Collection period*	*Crude protein (% d.m.)*	*Mg-intake (g/day)*	*Mg-faeces (g/day)*	*Mg-urine (g/day)*	*Mg-milk (g/day)*	*Mg-retention (g/day)*	*Mg-"availability" (%)*
1	A	25.9	14.04	12.71	0.48	1.91	—1.06	9
2	12.IV–22.IV		17.70	15.84	0.65	2.38	—1.17	11
1	B	17.8	13.29	11.53	0.40	1.86	—0.50	13
2	26.IV– 3.V		16.31	13.45	0.98	2.13	—0.25	18
1	C	14.0	12.29	10.00	0.69	1.71	—0.11	19
2	3.V –12.V		15.16	11.97	1.26	2.05	—0.12	21

In three subsequent periods two cows with milk yields of 14–22 litres per day were fed on grass from the same pasture but in different stages of growth. The growing stage was indicated as the crude protein contents in the grass in the periods A, B and C. Since the potassium contents did not differ much a possible influence thereof was negligible. The daily magnesium intake in period C was somewhat lower than in period A, resulting from a decrease in the magnesium content in the maturing grass. The magnesium excreted with the faeces decreased clearly, resulting in an appreciable increase in the figures for "availability" from about 10 % in period A to 16 % and 20 % in the periods B and C, respectively. This considerable rise in the "availability" was reflected by an increased magnesium excretion with the urine. The requirement of magnesium for secretion in the milk decreased only slightly in the three periods as a result of some decrease in milk production. These data stress the importance of an increasing availability for the magnesium supply to the animal. The negative retention of magnesium in period A increased to practically zero in period C. In addition it was natural to seek for other factors in maturing grass which influence the magnesium utilization by the animal.

From literature data and own observations WIND et al. (1966) suggest that higher fatty acids may interfere. Medical literature mentions e.g. that magnesium may form soaps insoluble in water which may influence the magnesium supply to man and animal. WIND et al. (1966) found that by increasing the fat content in the rations the soap content in the faeces increased, and, in some cases, the magnesium content in the blood serum decreased. For analysis for soaps in faeces see DEYS et al. (1963). Other observations also showed that fats may be important in the magnesium utilization by the animal (BROUWER et al., 1943). It seems reasonable to assume that a decrease in contents of total higher fatty acids in the rations could explain an increase in the "availability" of herbage magnesium in maturing grass, because in the grass there is a rather close relation between nitrogen and total higher fatty acids (BROUWER, 1944; IMMINK et al., 1965).

In this communication the effect of fat added to rations on the faecal excretion of magnesium by milking cows is discussed.

2. Experiments

In the winter of 1965–1966 a digestion trial with five milking cows on winter rations was carried out to get more information on the digestibility of fat, added in varying amounts to the rations. The fat supplied was animal fat, derived from succumbed animals. The milk yields of the five animals varied at the beginning of the experiment from 17 to 27 kg per day and the rations consisted of hay and concentrates. The experiment comprised two collection periods: A and B. Each of these periods was preceded by a preliminary period of 14 days. During the preliminary and collection period A no animal fat was supplied and the rations were computed according to feeding standards used in The Netherlands. In the preliminary and collection period B the same rations were used, adding, however, different amounts of animal fat (see Table 2). This fat, mixed through the concentrates, was readily consumed by the animals. To keep energy intake on the same level as in the preliminary and collection period A the concentrates were somewhat decreased. By changing the ratio of constituents in the concentrates total nitrogen intake was made about the same for periods A and B.
One week before the beginning of the collection periods the animals were equipped with a device for the separate collection of faeces and urine (VAN ES and VOGT, 1959). More details on the experimental routine and sampling have been recorded earlier (KEMP et al., 1961).

3. Results

Table 2 gives data on magnesium intake, excretion with the faeces and apparent availability of the magnesium consumed for the two periods. The magnesium intake during the collection period A varied only slightly. The excretion with the faeces

Table 2. Intake of magnesium and the excretion in the faeces in milking cows fed on winter rations with or without the addition of fat

Collection period	*Cow*	*Fat added (g/day)*	*Higher fatty acids in the rations (me./kg d.m.)*	*Mg-intake (g/day)* [1]	*Mg-faeces (g/day)*	*"Availability" (%)*
A [2]	Gerda	0	109	29.46	23.44	20
(without	Johanna	0	113	28.43	22.86	20
animal	Kl. Anke	0	114	28.13	20.14	28
fat)	Hendrina	0	110	29.43	21.07	28
	Trui	0	112	28.48	19.29	32
B [3]	Gerda	795	282	24.21	21.53	11
high fat	Johanna	795	297	23.38	22.12	5
B medium fat	Kl. Anke	543	248	24.41	19.64	20
B	Hendrina	281	168	26.43	20.43	23
low fat	Trui	281	175	25.62	16.01	38

[1] Magnesium of drinking water included.
[2] Collection period A from 7 Feb. to 15 Feb.
[3] Collection period B from 3 March to 11 March.

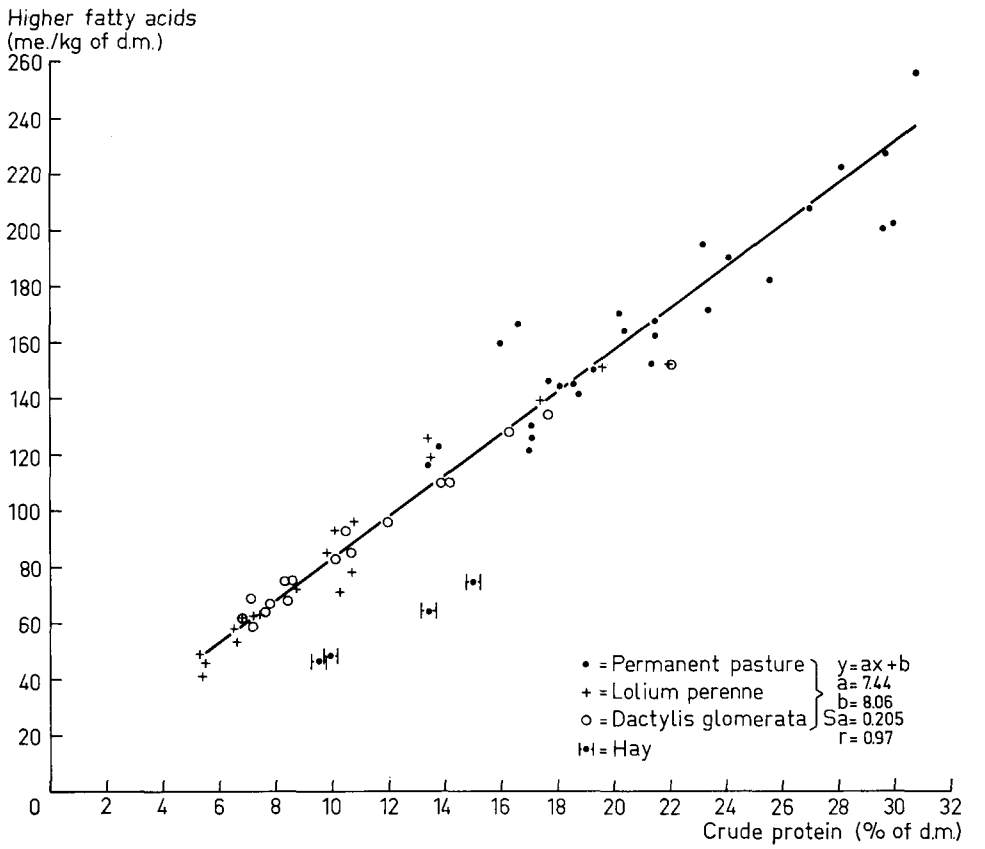

Fig. 1. Relation between crude protein and total higher fatty acids in fresh grass and hay.

was on a normal level for winter rations with an average "availability" of about 25 % within a range of 20–32 %.

The daily magnesium intake during the collection period B decreased somewhat, because a small part of the concentrates was replaced by fat. Since the cows Gerda and Johanna received more fat than Kl. Anke and considerably more than Hendrina and Trui, the magnesium intake was lower for Gerda and Johanna than for Hendrina and Trui. These differences in fat addition resulted in the total higher fatty acid contents of the rations varying from about 170 to 290 me. per kg of dry matter.

The fat additions to the rations caused a considerable change in the excretion of magnesium with the faeces, especially at the high additions for the cows Gerda and Johanna. These animals excreted 80 % of the dietary magnesium intake with the faeces in the collection period A, while this increased after the fat addition from 795 g per day to an average of over 90 %. The apparent availability decreased from around 20 % to less than 10 %. These low values were found earlier in milking cows fed on young grass high in potassium and protein (KEMP et al., 1961). The cow Kl. Anke in the group medium fat also excreted in the collection period B relative-

ly more magnesium with the faeces resulting in a lower apparent availability. The values for "availability" of Hendrina and Trui in the collection period B, however, were not lower than in the collection period A. In comparing the magnesium excretion with the faeces in collection period A with that in the collection period B, it seems reasonable to suggest that a rising fat addition to the rations will increase the magnesium excretion with the faeces, which may considerably decrease the "availability" of the magnesium consumed.

4. Discussion

The above evidence suggests that a higher content of total higher fatty acids in the rations may increase the magnesium excretion in the faeces by the formation of insoluble and for the animal non-utilizable magnesium soaps. Although the physiological backgrounds are as yet not quite clear, it may be assumed that pH in parts of the gastro-intestinal tract is high enough to allow their formation.

It was already pointed out that there is a relation between crude protein in grass and the total content of higher fatty acids. Fig. 1 shows these data, collected by IMMINK et al. (1965). Some recent data have been included.

An increase in the crude protein content in the herbage of 10–30 % is associated to an increase in the content of higher fatty acids from about 80 to 230 me. per kg dry matter. This relation and the effect of fat addition to the rations on the magnesium utilization by the animal (Table 2), suggest that the unfavourable influence of nitrogen fertilization on grassland on the magnesium supply to the animal may be completely or partly explained by an increase in the fat content of the herbage.

REFERENCES

BARTLETT, S., BROWN, B. B., FOOT, A. S., ROWLAND, S. J., ALLCROFT, R. and PARR, W. H. 1954 The influence of fertiliser treatment of grassland on the incidence of hypomagnesaemia in milking cows. *Brit. Vet. J. 110,* 3–19.

BROUWER, E. 1944 Sur les modifications de la composition des acides gras de l'herbe pendant la maturation et la conservation. *Rec. Trav. Chim. 63,* 35–38.

BROUWER, E., DIJKSTRA, N. D. en FRENS, A. M. 1943 Over de bijvoedering van het melkvee in de weide met copra, voederbieten en aardappelen, in verband met de stevigheid van de geproduceerde boter. *Versl. Landbouwk. Onderz. 49,* (10) C, 347–406.

DEIJS, W. B., IMMINK, H. J. and WIND, J. 1963 Determination of free fatty acids and soaps in faeces from cattle. Jaarb. I.B.S., pp. 51–54.

ES, A. J. H. VAN and VOGT, J. E. 1959 Separate collection of faeces and urine of cows. *J. Anim. Sci. 18,* 1220–1223.

HVIDSTEN, H. M., ÖDELIEN, M., BAERUG, R. and TOLLERSRUD, S. 1959 The influence of fertiliser treatment of pasture on the mineral composition of the herbage and the incidence of hypomagnesaemia in dairy cows. *Act. Agric. Scand. 9,* 261.

IMMINK, H. J., GEURINK, J. H. and DEIJS, W. B. 1965 The determination of the higher fatty acids in grass and in cow-faeces. Jaarb. I.B.S., pp. 103–107.

KEMP, A. 1958 Influence of fertiliser treatment of grassland on the incidence of hypomagnesaemia and hypomagnesaemic tetany (grass tetany) in milking cows. *Neth. J. Agric. Sci. 6,* 281–297.

KEMP, A. 1960 Hypomagnesaemia in milking cows: the response of serum magnesium to alterations in herbage composition resulting from potash and nitrogen dressings on pasture. *Neth. J. Agric. Sci. 8,* 281–304.

KEMP, A., DEIJS, W. B., HEMKES, O. J. and ES, A. J. H. VAN 1960 Intake and utilization of magnesium from herbage by lactating cows. Proc. Brit. Vet. Assoc. London.

KEMP, A., DEIJS, W. B., HEMKES, O. J. and ES, A. J. H. VAN 1961 Hypomagnesaemia in milking cows: intake and utilization of magnesium from herbage by lactating cows. *Neth. J. Agric. Sci. 9,* 134–149.

ROOK, J. A. F., BALCH, C. C. and LINE, C. 1958 Magnesium metabolism in the dairy cow. II. Metabolism during the spring grazing season. *J. Agric. Sci. 51,* 199.

SJOLLEMA, B. 1931 De minerale samenstelling van een aantal weidegrasmonsters. *Landbouwk. Tijdschr. 43,* 593.

SMYTH, P. J., CONWAY, A. and WALSHE, M. J. 1958 The influence of different fertiliser treatment on the hypomagnesaemia proneness of a raygrass sward. *Vet. Rec. 70,* 846.

WIND, J., DEIJS, W. B. en KEMP, A. 1966 Hogere vetzuren in het voedsel en hun mogelijke rol bij het optreden van hypomagnesaemie in de weide. Jaarb. I.B.S. (in press)