

EFFECT OF MONENSIN, SODIUM BICARBONATE AND VITAMIN A ON FEEDLOT GAIN IN CATTLE

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OPSOMMING: INVLOED VAN MONENSIN, NATRIUMBİKARBONAAT EN VITAMIEN A OP VOERKRAALTOENAME VAN BEESTE

Vier en twintig Hereford osse is in 'n 2×2 faktoriale rangskikking gebruik om die invloed van monensin en natriumbikarbonaat (NaHCO_3) in voerkraalrantsoene, op massatoename en doeltreffendheid van voeromsetting van vleisbeeste te ondersoek. Monensin is gebruik teen 'n peil van 34ppm (droë basis) terwyl natriumbikarbonaat teen 1% in die basale rantsoen, wat reeds 1% kalksteen (CaCO_3) bevat het, ingesluit is. Monensin het nie die tempo van liggaamsmassatoename beïnvloed nie maar dit het wel voerinnname, veral tydens die vroeë fase van die voerperiode, aansienlik onderdruk. Die netto uitwerking was 'n 16,4% verbetering in die doeltreffendheid van voeromsetting. Karkas uitslagpersentasie is nie betekenisvol beïnvloed nie. Natriumbikarbonaat het liggaamsmassatoename nie betekenisvol beïnvloed nie maar dit het 'n geringe onderdrukking in voerinnname veroorsaak en het doeltreffendheid van voeromsetting ietwat verswak. Vitamien A inspuittings het geen meetbare uitwerking op liggaamsmassatoename gehad nie.

SUMMARY:

Twenty-four Hereford oxen were used in a 2×2 factorial arrangement of treatments in order to investigate the response in terms of gain and efficiency of feed conversion to the inclusion of monensin and sodium bicarbonate (NaHCO_3) in a feedlot ration. Monensin was added at a rate of 34ppm (DM basis) whereas NaHCO_3 was included at a rate of 1% in a basal ration which already contained 1% limestone (CaCO_3). Monensin did not influence rate of live mass gain, but it did markedly depress feed intake, particularly during the early phases of the experiment. The net effect was 16,4% improvement in efficiency of feed conversion. Carcase dressing percentage was not significantly influenced. Sodium bicarbonate had no significant influence on rate of gain, but it did have a slight depressing effect on feed intake and a small decrease in efficiency of feed conversion was observed. Vitamin A injections had no measurable effect on feedlot gain.

Monensin has been extensively used as a feed additive in the United States of America. This compound has now also been officially sanctioned for use in ruminant feeding in South Africa. Monensin exerts its effect on animal production mainly by modifying the rumen fermentation processes, causing propionic acid levels to increase in relation to the other rumen volatile fatty acids (Raun, Cooley, Rahmacher, Richardson & Potter, 1974; Dinius, Simpson & Marsh, 1976; Richardson, Raun, Potter, Cooley & Rathmacher, 1976). The net result is invariably an increase in the efficiency of feed conversion (Perry, Beson & Mohler, 1976; Potter, Raun, Cooley, Rahmacher & Richardson, 1976; Raun, Cooley, Potter, Rahmacher & Richardson, 1976; Utely, Newton, Ritter & McCormick, 1976; Boling, Bradley & Campbell, 1977). Although the effect of monensin in ruminant feeds has been extensively investigated in other countries, there is no published information on its use under local conditions.

During the past 20 years there have been two major changes in the feeding of ruminants. These are the feeding of ever increasing levels of grain and the use

of chopped or milled roughages in ruminant diets. The feeding of high grain diets results in the rapid fermentation of highly digestible carbohydrates to organic acids causing acidosis. Both grain feeding and the fine milling of feed results in a reduction of saliva secretion during eating and ruminating. Since the main function of saliva is to provide buffers to neutralize the volatile fatty acids produced during fermentation any reduction in saliva output will be reflected in a more acid rumen. Drastic or sudden changes in rumen pH will result in loss of appetite, a loss of production and, in extreme cases, death through D-lactic acidosis.

Because of these undesirable side effects, much interest has been shown in the use of buffers such as sodium or potassium bicarbonate (Nicholson & Cunningham, 1961; Nicholson, Cunningham & Friend, 1963; Wise, Blumer, Craig & Barrick, 1965; Huntington, Emerick & Embry, 1977b), sodium bentonite (Burkitt, 1969; Colling & Britton, 1975; Huntington, Emerick & Embry, 1977a; Huntington *et al.*, 1977b) and magnesium or calcium carbonate (Wheeler & Noller, 1976).

Of the various available buffering agents limestone (calcium carbonate) and dolimitic limestone (calcium-magnesium carbonate) are the least expensive and also most freely available in South Africa. Limestone is, furthermore, routinely used in feeds, not only as a buffer, but also as a source of calcium needed to balance the relative excessive phosphorus levels in grains and their by-products. It is, therefore, of interest to establish whether any benefit is to be derived from using NaHCO_3 in addition to CaCO_3 at the inclusion rates commonly applied in commercial practice.

The purpose of this experiment was therefore to investigate, by means of a factorial arrangement of treatments, the effect of both monensin and NaHCO_3 , fed individually or in combination, on the rate of livemass gain in feedlot cattle fed a basal ration containing limestone.

Procedure

Experimental animals

Twenty-four Hereford-type oxen, approximately 18 months of age, were used.

Experimental layout

A 2×2 factorial arrangement of treatments was used to study the effect of monensin (2 levels), NaHCO_3 (2 levels) and their possible interaction.

Treatments

The experimental animals were restrictively randomized according to initial body mass into the following 4 experimental groups:

- Group 1 : Basal ration
- Group 2 : Basal ration plus 1% NaHCO_3 (as-fed basis)
- Group 3 : Basal ration plus 30ppm monensin-Na (as-fed basis)
- Group 4 : Basal ration plus 1% NaHCO_3 plus 30ppm monensin-Na (as-fed basis)

The basal ration was a complete feed consisting of yellow maize meal (42,1%), hominy chop (15,0%), sugarcane pith pellets (15,0%), urea (1,1%), sugarcane molasses (12,5%), salt (0,3%), limestone (1,0%), mono-calcium phosphate (0,5%), dried brewer's grain (7,5%), sunflower seed oilcake meal (2,0%), and wine yeast (3,0%). Representative feed samples of the raw materials and blended rations were taken at regular intervals. Chemical analysis were conducted according

to AOAC (1975) methods. The ration contained 11,9% moisture on an as-fed basis. On a dry matter basis, it supplied 13,8% crude protein, 12,6% crude fibre, 0,76% calcium, 0,39% phosphorus, 78,0% TDN and 4,67% MJ/kg NEg. In treatments 3 and 4 monensin-Na was included at a rate of 34ppm (DM basis) as this appears to be the approximate optimum level for promoting the most efficient livemass gain (Brown, Carroll, Elliston, Grueter, McAskill, Olson & Rathmacher, 1974; Raun, Cooley, Potter, Richardson, Rathmacher & Kennedy, 1974; Potter *et al.*, 1976; Raun *et al.*, 1976).

In treatments 2 and 4 the basal ration was supplemented with NaHCO_3 at a rate of 1,14% (DM basis).

In order to investigate the effect of vitamin A on rate of livemass gain a commercial vitamin A preparation was administered, by intramuscular injection, to half of the animals in each of the above-mentioned groups. This was achieved by random selection of 3 animals in every group and injecting each of them with 7,5 ml vitamin A preparation at the beginning of the experiment followed by a further 7,5 ml 75 days later. The product used contained 500 000 IU vitamin A, 75 000 IU vitamin D and 50 IU vitamin E per ml. This resulted in each of the treated animals receiving an equivalent of approximately 50 000 IU vitamin A per day.

Observations

In order to minimise differences in body composition between the experimental groups each animal was fed to a fixed final livemass of approximately 340 kg. Intermediary measurements were conducted every 14 days. Both the initial and final body mass was determined after depriving the animals of food and water for a period of 15 hours. Intermediary mass determinations were done on full stomachs.

The animals were group-fed so that feed intakes and feed conversion rates, as reported, are based on group averages. In order to establish the effect of the various treatments on feed intake during the different stages of the experiments, average feed intake per animal was calculated over intervals of 14 days throughout the trial.

Results and Discussion

The results in Table 1 summarise the effects of the 4 treatments on livemass gain, feed intakes, feed conversion rates and carcass dressing percentages. An analysis of variance showed that there were no interactions between the treatments. This made it possible to combine the results in order to allow a comparison of the main effects of monensin (Table 2) and of NaHCO_3 (Table 3).

Table 1*Effect of NaHCO₃ and monensin on mass gain and efficiency of feed conversion*

Group treatments	1 Control	2 NaHCO ₃	3 Monensin	4 Monensin + NaHCO ₃
Number of animals	6	6	6	6
Days to slaughter	114	114	117	114
Initial live mass (kg)	220,0	233,0	218,0	218,0
Final live mass (kg)	347,7	345,0	340,0	338,3
Live mass gain (kg)	125,7	112,0	122,0	120,3
Feed intake (as-is basis) (kg)	9,83	9,36	8,00	8,22
Daily live mass gain (kg)	1,10	0,98	1,04	1,06
Carcass mass (kg)	193,3	195,8	187,3	184,4
Dressing percentage (%)	55,6	56,7	55,1	54,5
Kg feed/kg live mass gain (kg)	8,94	9,55	7,69	7,75

Table 2*Main effects of monensin on gain and efficiency of feed conversion*

Group treatments	1 + 2 Without monensin	3 + 4 With monensin
Number of animals	12	12
Days to slaughter	114	116
Initial live mass (kg)	227,5	218,0
Final live mass (kg)	346,4	339,2
Live mass gain (kg)	118,9	121,2
Feed intake (as-is basis) (kg)	9,60	8,11
Daily live mass gain (kg)	1,04	1,05
Carcass mass (kg)	194,6	185,9
Dressing percentage (%)	56,2	54,8
Kg feed/kg live mass gain (kg)	9,23	7,72

It is evident from Table 2 that monensin, at an inclusion rate of 34ppm (DM basis) had no significant ($P < 0,01$) effect on livemass gain, but it did depress feed intake over the experimental period by an average of 15,5%. The net result was a 16,4% improvement in efficiency of feed conversion. These results are in agreement with the findings of many investigations which show that although the gain response to monensin in feedlot cattle is variable, a decrease in feed

intake and concomitant improvement in efficiency of feed utilization is almost always observed (Perry *et al.*, 1976; Potter *et al.*, 1976; Raun *et al.*, 1976; Boling *et al.*, 1977).

It is also of interest to record that the initial effect of monensin on feed intake (Fig. 1) was far more pronounced than is reflected by the average value (15,5%) arrived at from the data reported in Table 2

During the first 4 weeks of the trial the feed intake of the monensin-fed animals was, for example, 32% lower than that of the groups fed the monensin-free diet. Feed intake of the monensin-fed animals, however, gradually improved until the difference in daily feed intake between the treated and untreated animals, towards the end of the trial, eventually dwindled to about 5%. Differences in feed consumption due to the inclusion of monensin were therefore primarily due to the drastic differences in feed intake during the first few weeks of the feeding period. This observation is in agreement with the results reported by Davis & Erhart (1976) who found that the reduction in feed intake following the use of monensin at 33ppm (90% DM basis) was far more prevalent during the first 21 day period than later. Their results, however, failed to show any advantage in feed conversion rate by reducing the rate of monensin inclusion during the early phases of feeding. Riley, Corah & Fink (1976) also failed to find any advantage in reducing the level of monensin inclusion during the first 28 days of a 112 day finishing trial.

Table 3

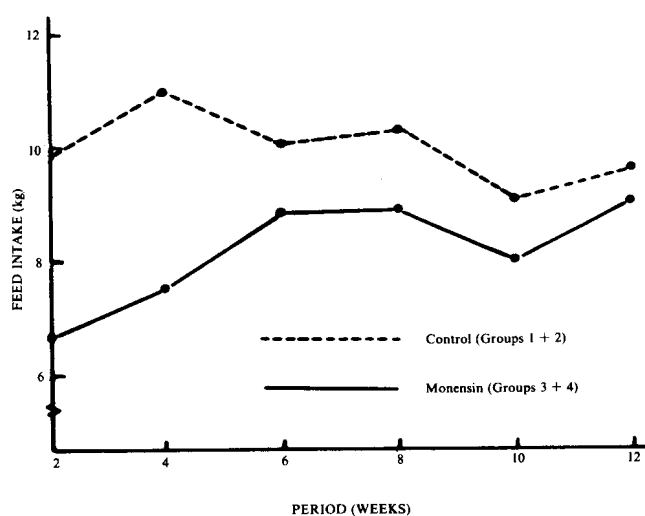
Main effects of NaHCO₃ on mass gain and efficiency of feed conversion

Group treatments	1 + 3		2 + 4	
	Without NaHCO ₃		With NaHCO ₃	
Number of animals	12		12	
Days to slaughter	116		114	
Initial live mass (kg)	220,2		225,4	
Final live mass (kg)	342,8		341,7	
Live mass gain (kg)	122,6		116,3	
Feed intake (as-is basis) (kg)	8,92		8,79	
Daily live mass gain (kg)	1,07		1,02	
Carcass mass (kg)	190,3		190,1	
Dressing percentage (%)	55,3		55,6	
Kg feed/kg live mass gain (kg)	8,32		8,65	

The addition of NaHCO₃ to the basal ration did not result in any measurable improvement in rate of live mass gain, carcass dressing percentage or efficiency of feed conversion (Tables 1 and 3). In fact, there was slight, although statistically non-significant ($P > 0,05$) depression in rate of live mass gain. The animals fed NaHCO₃ also had a slightly lower average feed intake and required approximately 4% more feed per unit live mass gain. The slightly lower feed intake and consequent poorer performance could conceivably be associated with the higher sodium intake (0,18% vs 0,45%) of the animals fed NaHCO₃, as the sodium content of the experimental rations had not been equalized.

It will be noted from Table 2 that carcass dressing percentages were slightly depressed when monensin was fed. This difference was, however, not statistically significant ($P < 0,05$). In most studies where carcass measurements have been made, monensin has been shown to have a small, but mostly non-significant depressing effect on dressing percentage (Potter *et al.*, 1976; Boling *et al.*, 1977; Dartt, Boling & Bradley, 1978; Heinemann, Hanks & Young, 1978; Steen, Gay, Boling, Bradley, McCormick & Pendlum, 1978).

Fig. 1 *Effect of monensin on average daily feed dry matter intake measured over a period of time*



From these results it is obvious that there is no advantage to be gained from adding NaHCO₃ to rations which already contain limestone. This does not mean that positive results would not have been obtained had NaHCO₃ been used as the only buffering agent. It should be pointed out, however, that results obtained with NaHCO₃ in fattening cattle (Preston, Whitelaw, MacLeod & Charleson, 1962; Lassiter & Alligood, 1967; Kellaway, Grant & Hargreave, 1976) and sheep (Lassiter, Cullison & Warren, 1962; Lassiter & Cook, 1963; Kromann & Meyer, 1966; Saville, Davis, Willats & McInnes, 1973; Huntington *et al.*, 1977b) fed high-concentrate diets have often been variable or even negative.

The disappointing results obtained with sodium and potassium bicarbonates may be due to the fact that these buffers are not particularly long acting as the Na and K ions are absorbed relatively quickly from the digestive tract when compared to Ca and Mg (Wheeler & Noller, 1976) and are therefore not likely to affect the pH of the lower digestive tract (i.e. small intestine) where starch, which escapes rumen digestion, is normally broken down. It has been demonstrated (Long, 1961) that the rate of pancreatic alpha amylase activity in the small intestine is reduced at pH values below 6,9. Wheeler, Noller & Lowrey (1976) reported that steers fed all-concentrate diets had considerable quantities of starch in their faeces with intestinal pH values well below neutrality. In further experiments Wheeler & Noller (1976) were able to demonstrate that both calcium and magnesium limestone increase faecal pH values and reduce the loss of starch in the faeces. Their experiments, conducted with both lactating cows and heifers, showed that limestone buffers markedly increase rate of gain and improved efficiency of feed conversion. It would thus appear that limestone is not

only less expensive, but due to its longer lasting effect, is also superior in promoting the digestion of starch and improving feed efficiency in animals fattened on grain-rich diets.

It will be noted from Table 4 that vitamin A injections, applied by intramuscular injection at a rate equivalent to 50 000 IU per day, had no advantage in terms of live mass gain. This result supports earlier findings by Kargaard & van Niekerk (1977) with feedlot animals fed under similar conditions.

Conclusion

These results confirm the widely reported advantages of monensin as a feed additive for feedlot cattle. The inclusion of NaHCO₃ as a buffer in the ration does not appear to have any positive effect on feedlot gain, at least not when fed in combination with CaCO₃. The application of vitamin A as an intramuscular injection produced no measurable effect on animal performance.

Table 4

Effect of vitamin A on mass gain and efficiency of feed conversion

Treatment		Vitamin A	Control
Number of animals		12	12
Days to slaughter		113	117
Initial live mass	(kg)	224,3	221,5
Final live mass	(kg)	338,6	345,9
Live mass gain	(kg)	114,3	124,4
Daily live mass gain	(kg)	1,01	1,06
Final carcass mass	(kg)	187,9	191,8
Dressing percentage	%	55,5	55,4

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