EFFECTS OF MANNAN OLIGOSACCHARIDES IN THE DIET OF BEEF CATTLE IN THE TRANSITION PERIOD

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SUMMARY

Forty-eight male Blond d'Aquitaine calves were used to study the effects of mannan oligosaccharide (MOS) during the first phase of the cattle fattening cycle (48 days). Calves were divided into two treatment diets: Control (straw and pellet feed) and MOS (Control diet plus 0.4% in pellet feed of BIO-MOS®, Alltech, Inc.). The daily weight gain was higher (+3,6%) in MOS group than in Control group. Alpha globulins, beta globulins and NEFA were significantly higher in Control than in MOS group. The calves treated with MOS showed lower levels of stress and showed a better immune system response.

Keywords: mannan oligosaccharide, young bulls, performance, blood proteins, IGF1, NEFA

INTRODUCTION

Since 1st January 2006, it is no longer possible to use auxinic antibiotics in livestock feed in the European Community. In beef cattle alternatives to these molecules have been studied for several years, particularly substances such as prebiotics or parabiotics, "natural" substances which do not constitute any risk to animals or human (so-called additives without residues). Oligosaccharides are promising alternatives to antibiotic growth promoters because they facilitate and support the symbiotic relationship between host and microflora. Fructooligosaccharides (FOS) and Mannan oligosaccharides (MOS) are two classes of oligosaccharides that are beneficial to enteric health, but they differ on their mode of actions. FOS influence enteric microflora by "feeding the beneficial bacteria", which competitively excludes the colonization of pathogens (Mordenti and Panciroli, 1995; Ferket, 2004). Unlike FOS, MOS is not used as a substrate in microbial fermentation, but still exerts a significant growth-promoting effect by enhancing the animal's resistance to enteric pathogens (Ferket, 2004). MOS is a glucomann protein complex derived from *Saccharomyces cerevisiae*. Yeast cells are lysed, and the resulting culture is centrifuged to isolate the cell wall components, which are subsequently washed and spray dried (Spring et al., 2000). MOS have been used with interesting results in various livestock species, demonstrating an improvement in performance, better immune system function and a reduction in intestinal pathogens.

Bio-Mos® (Alltech, Inc., Nicholasville, KY) is the commercial source of MOS that has been used in most of the published research literature. Based on the scientific literature, Bio-Mos® enhances resistance to enteric disease and supports growth performances by the following means: 1) inhibits colonization of enteric pathogens by blocking bacterial adhesion to gut lining; 2) enhances immunity; 3) modifies microflora fermentation to favour nutrient availability for the host; 4) enhances the brush border mucin barrier; 5) reduces enterocyte turnover rate; and

6) enhances the integrity of the gut lining (Newman, 1994; Savage et al., 1996; Spring et al., 2000; Ferket, 2004).

In chickens, immunoglobulins (Ig) concentrations were greater in birds receiving MOS compared with birds receiving a control diet (Savage et al., 1996). Supplementation of broiler chicks with MOS beneficially influenced the bacterial populations in the digestive system (Spring et al., 2000). Several studies in pigs have reported improvements in various measures of performance or immune function such as gain, feed conversion, lymphocyte transformation, and Ig concentrations, compared with unsupplemented animals (Newman and Newman, 2001; O'Quinn et al., 2001; Davis et al., 2002; White et al., 2002). Research with cattle regarding the effects of MOS supplementation has been primarily in calves and heifers and has concentrated on alteration of the intestinal microflora. In calves fed a commercial milk replacer, MOS supplementation resulted in lower faecal coliform concentrations and decreased respiratory disease incidence than non supplemented calves (Newman et al., 1993). Other field data suggest that antibiotics in milk replacers can be replaced with mannan oligosaccharides to obtain similar calf performance (Heinrichs et al., 2003). The supplementation of MOS to cows during the dry period enhanced their immune response to rotavirus and tended to enhance the subsequent transfer of rotavirus antibodies to calves (Franklin et al., 2005).

The objective of this research was to study the effects of MOS on beef cattle, in particular in calves returning to the shed in the first phase of the cattle fattening period (the transition phase).

MATERIALS AND METHODS

Forty-eight male Blond d'Aquitaine calves, just arrived in Italy together from France, by lorry in a journey lasting 8 hours, were weighted and homogeneously divided into 8 boxes with straw bedding (6 calves per box), and assigned to two experimental groups. Control Group: 24 calves, fed with commercial cattle feed (starting feed) and hay (in the first 7 days) and straw; MOS Group: 24 calves, fed in the same way as the Control Group with the exception of the addition to the commercial cattle feed of Bio-Mos® (Alltech, Inc., Nicholasville, KY) at a ratio of 4g per kg of feed (0.4%). The commercial feed (products and by-products of cereals in grains; products and by-products of oily seeds; dried forage; products and by-products of the production of sugar; minerals) was formulated to provide 14% Crude Protein, 4% Fat, 11% Fibre and 7% ash on fresh product basis. In the first 48 hours after the arrival, calves were given access to *ad libitum* hay only which is a normal practice at farm level. Feed and straw were gradually introduced on the third day and until the seventh day.

The sanitary condition of the calves was checked every day. The consumption of feed offered to the calves in each box was evaluated daily. The research lasted 48 days and during this period blood samples were obtained from 24 calves (12 per group). Blood samples were collected in vacutainer tubes without anticoagulant via jugular venipuncture on days 0, 22 and 48 and analysed for serum protein concentrations (albumin, alpha, beta and gamma globulin), IGF1 and NEFA. On the last day of the test and at the time of the last blood sample the calves were re-weighted in order to calculate the overall live weight gain and the average daily weight gain. On their arrival day (the first day of the experiment) all the calves were vaccinated against respiratory illnesses (IBR, Syncitial Virus and Pasteurella), against BVD and treated with Ivomec® (against intestinal parasites). After about 20 days a second vaccination took place (booster).

All the data obtained were subjected to mathematical-statistical elaboration, using analysis of the variables (SAS System, 1996).

RESULTS AND DISCUSSION

During the research all the calves ate regularly both feed and straw. In Table 1, performance of the calves during the course of the research is shown. As can be observed the average live weight at the beginning of the trial was almost similar for both treatments (225.83 kg *vs* 226.25 kg, respectively for Control and MOS Group). The final live weight, at 48 days of trial, was 281.665 kg and 284.09 kg, respectively for Control and MOS Group. The total average live weight gain for Control Group was 55.835 kg, while the MOS Group had an average increase of 57.840 kg. Therefore, calves in MOS Group showed a greater daily weight gain (DWG) than those in the Control Group (1.205 kg *vs* 1.163 kg per head per day). The biggest increase in weight in the MOS Group (+ 3.6%), however, cannot be explained by a greater consumption of feedstuffs. Indeed, the average daily feed consumption (shown in Table 1), for the two groups was similar (3.968 kg *vs* 3.990 kg per head per day, respectively for Control and MOS Group). Regarding health, animals experienced only the classic problems occurring at the return of cattle to the shed (respiratory and intestinal diseases above all due to the stress of the transport and mixing of animals from various origins). The better daily weight gain of the calves of MOS Group may be attributed to the presence in the feed of the Mannan Oligosaccharides, as the number of animals treated by drugs during the research period was the same in each Group (16 calves).

Table 1. Performance of calves during the research

		CONTROL	MOS
Calves	n	24	24
Initial weight	kg	225.83	226.25
Final weight	kg	281.665	284.09
Total Weight gain	kg	55.835	57.840
DWG	kg	1.163	1.205
Daily Feed intake (concentrate)	kg/d	3.968	3.990

As far as the blood proteins are concerned (Table 2), it should be underlined that while the albumin values are the same (48.71% *vs* 48.84%, respectively for Control and MOS Group), an interesting response by the calves to the globulins is observed. A significant difference (P=0.017) in the alpha globulins in the 3rd blood sample is found, corresponding to the 48th day of the research (17.65% *vs* 16.34%, respectively for Control and MOS Group) and for the beta globulins (P=0.018) as a medium value during the course of the research (11.57% *vs* 10.81%, respectively for Control and MOS Group). The gamma globulins showed a tendency towards higher values in the MOS Group as compared to the Control Group (25.68% *vs* 27.41% on the 48th day, and average values of 22.28% *vs* 23.25%, respectively in Control and MOS Groups). Whilst not being significant differences in this case, this result has practical meanings as higher figures for alpha and beta globulins in the Control Group are a general indicator for the organism's response to inflammatory factors; the higher quantities of gamma globulins, on the other hand, can be linked to a better response of the calves to the vaccination (and subsequent booster). Overall, therefore, it can be concluded that the Mannan Oligosaccharides in Bio-Mos® contributed to the better immune system response of the treated calves. This is confirmed by NEFA results (Table 2): the lower values found in the MOS Group in the blood tests on the 48th day of research (124.58uEq/l *vs* 195.42 uEq/l), demonstrate that the mobilization of the fatty acids was significantly lower (P=0.046). This indicates as well that the animals showed lower levels of stress or, more simply, that the calves have responded better, thanks to the Mannan Oligosaccharides to the various elements of stress in this delicate phase in the fattening process. Recently re-introduced to the shed and just arrived from France, calves are indeed exposed to various stress factors (starting with the removal from pasture, mixing with other calves, transport in lorries, fasting which can last 48–72 hours, formation of new groups in new places, etc.) and the response to such factors is now well known. The evaluation of the NEFA, therefore, is a useful index of the stress of the animal. The significantly lower values in the calves given MOS indicate a better response of these animals to the situation and it is confirmed by the greater increase in weight in this period.

Table 2. Blood protein, IGF1 and NEFA values of calves from Control and MOS Group

		CONTROL (n = 12)	**MOS (n = 12)**	P value
Blood proteins				
Albumin				
Day 0	%	53.85 ± 2.05	53.48 ± 1.85	0.642
Day 22	%	47.02 ± 2.02	47.66 ± 2.16	0.465
Day 48	%	45.25 ± 4.23	45.40 ± 3.28	0.923
Average 0–48 days	%	48.71 ± 4.73	48.84 ± 4.22	0.898
Alpha				
Day 0	%	16.12 ± 1.08	16.65 ± 1.23	0.270
Day 22	%	18.53 ± 0.95	18.30 ± 1.17	0.597
Day 48	%	17.65 ± 1.43	16.34 ± 1.02	0.017
Average 0–48 days	%	17.43 ± 1.52	17.10 ± 1.41	0.335
Beta				
Day 0	%	12.35 ± 0.95	11.42 ± 1.67	0.109
Day 22	%	10.95 ± 1.05	10.14 ± 1.08	0.077
Day 48	%	11.42 ± 1.66	10.85 ± 0.90	0.302
Average 0–48 days	%	11.57 ± 1.36	10.81 ± 1.34	0.018
Gamma				
Day 0	%	17.68 ± 2.79	18.45 ± 3.22	0.539
Day 22	%	23.49 ± 2.67	23.90 ± 2.64	0.709
Day 48	%	25.67 ± 5.15	27.41 ± 3.57	0.348
Average 0–48 days	%	22.28 ± 4.97	23.25 ± 4.84	0.405
Total Proteins				
Day 0	g/l	65.58 ± 3.06	64.25 ± 4.69	0.418
Day 22	g/l	60.42 ± 2.31	63.08 ± 10.72	0.408
Day 48	g/l	64.33 ± 7.10	65.25 ± 5.08	0.719
Average 0–48 days	g/l	63.44 ± 5.05	64.19 ± 7.21	0.610
IGF1				
Day 0	ng/ml	5.44 ± 4.04	5.83 ± 5.90	0.851
Day 22	ng/ml	12.77 ± 8.57	14.37 ± 11.30	0.699
Day 48	ng/ml	24.63 ± 13.77	16.49 ± 13.70	0.160
Average 0–48 days	ng/ml	14.28 ± 12.34	12.23 ± 11.48	0.468
NEFA				
Day 0	uEq/l	494.98 ± 195.71	552.39 ± 244.68	0.532
Day 22	uEq/l	125.79 ± 49.90	107.29 ± 33.55	0.298
Day 48	uEq/l	195.42 ± 96.58	124.58 ± 64.58	0.046
Average 0–48	uEq/l	272.07 ± 205.28	261.42 ± 253.13	0.845

Results on total proteins (Table 2) show no difference between the 2 groups (average 63.44 g/l *vs* 64.19 g/l, respectively for Control and MOS Group) but the tendency towards lower values for alpha and beta globulins and higher values for gamma globulins is definitively a positive result of this research.

The IGF1 values, also in Table 2, do not show significant differences, either during the course of the blood samples or as average. It is worth considering, however, that the figures show a high level of variation within the 2 groups, particularly in the last blood sample. The average values produced by the research are 14.28 ng/ml *vs* 12.23 ng/ml, respectively in the Control and MOS Groups.

CONCLUSIONS

Positive effects of MOS on sow reproductive performance were reported by Funderburke (2001): when added to the gestation and lactation diet in a mixed parity herd weaning at 21 days, an increase in birth weight, a decrease in pre-weaning mortality, increased pre-weaning growth rate and a quicker return to oestrus were noted; the study also showed a significant increase in the immunoglobulins levels in the colostrum. It has also been noted that MOS can modulate intestinal flora, significantly reducing numbers of harmful intestinal bacteria without damaging the lactobacillus and can also reduce diarrhoea problems in the weaning phase of the piglets (Spring et al., 2000; Newman and Newman, 2001; White et al., 2002). Positive effects have also been noted in relation to improved performance in turkeys, due, above all, to the capacity of MOS to strongly reduce Gram-negative pathogens (particularly *Enterococcus*) in the intestine (Savage et al., 1996). In newly born calves a tendency to improve the immune response to rotavirus has been noted by giving MOS to the mothers in the three weeks prior to the birth which is transferred through the colostrum (Franklin et al., 2005).

The results of this first research regarding the effects of Mannan Oligosaccharides (Bio-Mos®) on the performance of calves in the return to the shed phase have given interesting ideas for discussion.

Our results indicate a greater average daily weight gain (+ 3.6%) and a better response to stress for the calves of MOS Group compared with those of Control Group. The highest levels of gamma globulins (approximately 1 gram extra per litre of blood) found in the blood of calves which have been given MOS in their diets for 48 days, the lower levels of alpha and beta globulins and, above all, the significantly lower values of NEFA, indicate that the calves have responded better to the stress of this delicate phase.

These first results need further development, but the general trend indicated in this research leads us to state that there are positive aspects on the performance and metabolic response to stress in calves that are given Mannan Oligosaccharides (Bio-Mos®, Alltech, Inc., Nicholasville, KY) in their diets at a ratio of 4 g per kg of feed (0.4%) in the first 48 days after the return to the shed.

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