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# MANNAN OLIGOSACCHARIDES – MODES OF ACTION AND POSSIBILITIES FOR USAGE

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**Abstract**: Mannan-oligosaccharides (MOS) are prebiotics that may prevent bacterial adhesion to mucosal surfaces and neutralize their toxins without causing tissue damage. For that reason, they have been used as feed additives for more than 20 years. They exert positive influence on animals by selective stimulation of growth and/or activity of one or limited number of non pathogenic bacteria in the digestive tract. Systemic positive effects of MOS may be attributed to absorption of bacterial fermentation products and by improving hosts health status.

Addition of mannan-oligosaccharides (MOS) to cow's colostrum (5 g/L) resulted in significant enhancement of IgG concentration in neonatal calf's sera. Calves were fed colostrum, supplemented with Bio-Mos (5g/L), three times during the first 24 hrs of life and Ig G concentration was determined at 6, 12, 24 and 48h following birth.

Same phenomenon was documented in numerous experiments on piglets which were allowed to suckle free, followingper oral application of MOS suspension. Piglets were orally dosed with 10 mL of a 75g/L mannan-oligosaccharide suspension in saline water at parturition and 12 hrs after birth. In the piglet's trial, blood samples were collected only 48h after birth.

In our trials, IgG concentration was measured by radial immuno-diffusion (anti-bovine and anti-pig IgG RID plates, INEP, Zemun). In treated, calves and piglets, a significant improvement in IgG sera concentration was achieved. Titersof the antiBHV-1 antibodies in the calvessera 24 hrs after birth and after 7 days, were higher in the Bio-Mosfed group and differences were statistically significant when compared to the control group. Improvement of passive immunological transfer significantly reduced calves mortality rate on the farm.

We have also investigated possibilities for therapy of sows, suffering from puerperal endometritis by intra uterine application of sterile MOS suspension. We have used MOS-based product (Yeast Call Wall, Alltech, Fermin, Senta) in the amounts of 5, 10 and 20g (I, II and III group) suspended in 100 mL of saline. In groups II and III we noted significant

clinical improvement in treated sows and moreover higher body weight gain in piglets.

**Key words**: *calves, endometritis, IgG, mannan-oligosaccharides, piglets, sows, passive immunity*

## INTRODUCTION

Over the past decade we have conducted several studies aimed to explore possibilities for usage of mannan-oligosaccharides in veterinary medicine and animals breeding. Mannan-oligosacharides (MOS) are prebiotcs that exert positive influence on animals by selective stimulation of growth and/or activity of one or limited number of bacteria in the digestive tract. Recently they are named gut active carbohydrates (GAC) and they are derived from the cell wall of yeast which can absorb pathogens expressing type-1-fymbrae, reducing their ability to colonize gastrointestnal tract (Spring et al. 2000). There are published data confirming constant improvements in piglet, sow, broiler and turkey performances where GAC has been fed over cotinuous period of time (Miguel et al. 2002, Hooge at al. 2003, 2004a, 2004b, Sims et al. 2004, Rozeboom et al. 2005). In many trials, the ability of GAC to bind and eliminate pathogeniic bacteria like *Salmonella spp* and *Clostridiim perfrigens* was documented (Spring et al. 2000, Sims et al. 2004). It was postulated that by action of binding and pottentially altering the bacterial populations in the gut, (Fioramonti et al. 2003) and their activity as receptor analogues, oligosaccharides may be involved in the immune cross-talk interactions (Kelly 2004). They can also exert positive systemic effects following absorption of bacterial fermentation products and by improving hosts health status.

### *Investigations of mannan-oligosaccharides influence on colostral IgG absorption in calves*

In the first study we investigated the influence of mannan-oligosacharides on the colostral immunoglobuline absorption in Holstein-Friesiancalves. The experiment was conducted on the total of 36 cows and thier off spring devided in three equal groups according to their sex and bodymass. Calves from the control group (K) were nipple fed with 1,5 L of colostrum 2, 12 and 24 hours after birth. Second group of calves (M) were fed in the same way and with the same amount of colostrum with addition of clinoptillolite (5g/L) and third group was fed colostrum that contained 5g/L of mannan-oligosacharide suspension (Bio-Mos, Alltech, USA).

Our results indicated that mean values of the Ig G concentration in blood sera of cows from all three groups were similar and with in physiological range. The mean values for Ig G concentration in primary,

secondary and tertiary colostrum were also similar when compared between different groups. Within the same group of cows, differences in Ig G concentration between primary, secondary and tertiary colostrum were significant. The highest Ig G concentration was measured in primary and the lowest in tertiary colostrum. In all three groups of calves, the total colostral Ig G intake was nearly the same during the first 24 hours and no statistical differences were documented between them. Ig G concentration, estimated from the 6th hour of life till the day 21. was higher in the group of calves fed colostrum with Bio-Mos addition when compared to other two groups. Addition of Min-A-Zelal so enhanced colostral Ig G uptake, but these differences were statistically significant only 6 hours after partitution ($p<0,01$). After 48 hours, Ig G concentrations in groups M and K were nearly the same while in the group fed colostrum with Bio-Mos, elevated values were recorded till the day 21. Efficiency of colostral Ig G was highest in the gruop fed Bio-MOS supplemented colostrum. The mean BHV-1 antibody titar values in the primary colostrum of cows were similar in all three groups and no statistically significant differences were documented. The titers of anti BHV-1 antibodies in the calvessera 24 hrs after birth and after 7 days were highest in the Bio-Mos fed group and these differences were statistically significant when compared to the other two groups. In the clinoptilolite fed group, the similar effect was noted but differences were not statistically significant. Finally, the improvement of passive immunological transfer significantly reduced the calves mortality rate on the farm (Shabanovic 2005, Lazarevic et al. 2010).

### *The influence of mannan-oligosaccharides on piglets blood biochemical profile and body weight gain up to weaning*

The main goal of this study was to explore effects of Bio Mos (Alltech, SAD) administered orally twice within the first 12 hrs of piglets life on their body weight and values of the following biochemical parameters in piglets sera: total protein, albumin, triglyceride, cholesterol, Ig G, glucose andIGF concentrations and activity of enzymes AST and ALT during the first 30 days of their life. Ten litters origating from the Yorkshire sows was included in the trial with total of 94 piglets (50 in treated and 44 in control group). Very shortly after farrowing and once again after 12 hrs. half of the litter was adminstred 10 mL of Bio Mos suspension (75 g/L). The second half of litter was treated in the same manner and at the same intervals with 10 mL of saline (Tokic 2012, Lazarevic *et al.* 2012).

Glucose level was estimated from the whole blood samples on days 2, 5, 10 i 30 after partitution. Blood sampling and sera collection was performed on days 2, 5, 10 and 30 after partitution in order to measure (a) concentration of total proteins, albumine, triglyceride, cholesterol, Ig G and

IGF I and (b) activity of ALT i AST. Body weights of piglets from the treated and control groups was measured on the days 2, 5, 10 and 30 after partitution. Thereafter, mean body weight, total and daily body weights were calculated for the monitored intervals.

We were able to conclude that peroral application of Bio Mos (twice within the first 12 hrs of piglets life, 0,75g per piglet) resulted in statistically significant rise in total protein (+12,6%) and Ig G concentrations after 48 hrs (+19,4%). This treatment did not affect albumine concentration showing continous elevation up to the age of 30 days. The same treatment did not alter concentrations of triglycerides, cholesterol and IGF I in the piglets sera. Glucose level in the sera was highest on days 2 and 5 and decreased to basic levels thereafter. Treatment with MOS did not influence this parameter either. Moreover, activity of ALT and AST was not changed during the trial. Treated piglets were in average of 505g hewier at weaning when compared to controles and BWDG (body weight daily gain) was +21,8g MOS also reduced the number of piglets died and incidence of diarrhea.

Similar results in piglets regarding Ig G absorption enhancement were reported by Hengartner et al. 2005 and in piglets and calves (Lazarevic 2003, 2003a, 2005).

### *Mannan-oligosaccharides in therapy of sow´s with puerperal uterine infection*

In this study, we investigated effects of intra uterine application of sterile mannan-oligosaccharide (MOS) suspension to sows suffering from puerperal endometritis (Miljas, N. 2014, Lazarevic et al. 2012). As mannan-oligosaccharides may prevent bacterial adhesion to mucosal surfaces and neutralize their toxins without causing tissue damage, it was postulated that this approach may result in successful curing, lower percent of recidivism and positive effects on piglet's growth due to improved milk production.

A trial was conducted in four experimental and one control group of sows consisting of 10 animals each. Experimental groups were formed of sows with purulent vaginal discharge, 2−3 days post farrowing along with reduced apetite. Animals were fed standard food mixtures (AOC Tables, 1993). Clinical examination was performed on the day of therapy and 2−5 days later.

Uterus content samples for bacteriological and cytological examination were collected on the day of first clinical examination and immediately after that, sterile MOS suspension or Lotagen were administered by means of catheter. After 2−5 days, a second sampling was performed. We have used MOS-based product (Yeast Call Wall, Batch No 6.9.175, Alltech, Fermin, Senta) in the amounts of 5, 10 and 20g (I, II and III group) suspended in 100 mL of saline. Sows from the group IV were treated in the same way by 100 mL of 2% Lotagen solution.

Smears for cytological analyses were stained by May-Grunwald Giemsa method and analyzed by means of direct light microscopy (Olympus BH-2, Japan), using immersion objective and at total magnification of 1000 X. We have determined presence of neutrophil and eosinophil granulocytes, lymphocytes, monocytes, epithelial cells and bacteria as well as their structure.

Bacteriological examination was performed by standard plating procedures on Columbia agar (CM331, Oxoid, Basingstoke, UK) with addition of 5% ovine blood and MacConkey agar (CM115, Oxoid). Plates were incubated in aerobic conditions at 37 $^{0}$C over 24−48 hrs. Grown colonies were counted in plates containing 30−300 colonies to estimate number of CFU (Colony Forming Unites).

Piglets from each litter were weighed individually on the day of sow´s therapy, 2−5 days later at control examination and at the moment of weaning in order to calculate total and daily body weight gains. Body weight was measured by electronic scale with sensitivity of 10g. In the last trial phase, reproductive results of sows were determined in their next breeding cycle. We have recorded a total number of piglets born, number of alive and stillborn and percent of piglet's loss after 3 days post farrowing.

Treatment of sows with puerperal dysgalactia by intrauterine application of MOS suspension resulted in significant clinical improvement and percent of recidivism was the smallest in groups treated with 10 and 20g.

On the stained smears of uterine content a presence of neutrophil and eosinophilgranulocytes, lymphocytes, monocytes, epithelial cells and bacteria was noted. In all experimental groups, very highly significant differences were present between mean number of neutrophilgranulocytes, at the moment of therapy and 2−5 days later. The best effects in therapy were achieved by 10 and 20g of MOS suspended in 100 mL of saline. Following treatment, highly significant differences were noted between groups treated with 5 g and 10g and 20g. Differences between groups treated with Lotagen and those treated with 10 and 20g of MOS were very highly significant.

Degree of bacterial colony number reduction was the highest in groups treated by intrauterine application of 10 and 20g of MOS ranging from 1361 to 1444 times. In the sows treated with Lotagen solution this value was 32.

The most abundant bacterial species isolated from sow's uterine content were: *E. coli, Streptococcus dysgalactiae subspecies equisimilis, Staphylococcus aureus, Arcanobacterium pyogenes* andcoagulase negative *Staphylococcus*.

At the moment of weaning, piglets from the groups of sows treated with 10 and 20g of MOS were heavier then piglets from the control and Lotagen treated group of sows.

Treatment of sows with PDS by intra uterine application of MOS suspension and Lotagen did not significantly influenced number of piglets born in the next reproductive cycle and between experimental groups no statistically significant differences were noted. A total piglet´s loss during first days of life was the highest in the control group.

Treatment of sows with PDS by intra uterine application of MOS suspension resulted in significant clinical improvement with small percent of recidivism and exerted positive effects on piglets body weight gain up to the moment of weaning.

## CONCLUSION REMARKS

Based on the numerous literature data and our personal experiences, from three different field trials, we are able to conclude that there are numerous possibilities for application of MOS based feed additives in animal breeding. Apart from the well-known and well documented benefits of MOS as growth promoters, and gut health regulators, improvement in IgG absorption and enhancement of the passive immunity in new born piglets and calves is of substantial importance. In addition, surprisingly constant recovery of sows suffering from puerperal dysgalactia, for sure deserves more attention.

Possible mechanisms of MOS action includes: prevention of bacterial adherence to gut mucosa, adsorption of bacterial and other toxins in the intestinal lumen, stimulation of beneficial bacterial growth and absorption of their products. Finally, improvement of IgG absorption may be attributed to MOS capability to stimulate phagocytosis, but this hypothesis still needs experimental confirmation. These findings are of special interest because, in some cases, this approach may decrease needs for antibiotic treatments.

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