FrontLine®
TECHNICAL INFORMATION FOR TODAY'S FEED PROFESSIONAL

UPDATE…
MANNANOLIGOSACCHARIDES

What is MOS?

Mannanoligosaccharides are a low inclusion feed additive containing mannan-based oligosaccharides derived from the cell wall of yeast. These complex sugars are of interest nutritionally because only certain microbes can utilize them for energy. For example, lactobacilli and bifidobacteria can, but Coliforms cannot. The goal of adding MOS to the diet is twofold:

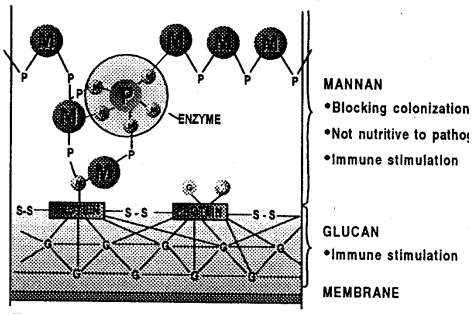

Figure 1. Yeast cell wall

- To provide the lectin on enteric pathogens with a mannose residue to block gut adhesion sites.
- To provide a general stimulation of the immune system as glucomannan serves to enhance cell-mediated immunity, and activate the complement cascade.

Glucan, mannan, and chitin are the main components of yeast cell wall. Glucan makes up the matrix of the cell wall, while mannan sugars protrude from the surface (Fig. 1). The cell wall contains about 30% each of mannan and glucan, with the mannan fraction influencing cell adhesion, and the glucan fraction recognized by the immune system.

Proposed Modes of Action

Currently, MOS is known to influence animals through: 1) selective nutrient utilization by microbes, 2) cell recognition and adhesion, and 3) immune stimulation.

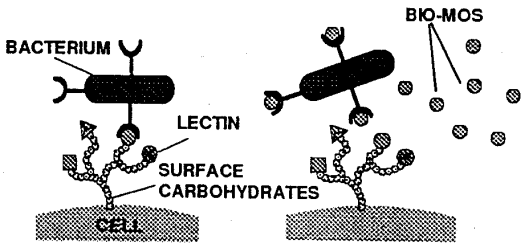

Figure 2.

The adhesive fimbriae used by enteric bacteria to bind the intestinal epithelium are lectin-like structures which recognize and specific surface carbohydrates projected from epithelial cells (Fig.2). The "Type" of fimbriae is based on the hemagglutinating properties of the bacteria. As an example, the Type 1 fimbriae such as those on *E. coli* agglutinate red blood cells, and this agglutination is inhibited by mannose. *Salmonella spp.* Have both Type 1 and Type 2 fimbriae, but Type 1 is more prevalent (Oyofo et al., 1989). By adding MOS to the diet, the lectin on enteropathogens is provided with a mannose residue to block an adhesion site.

1. The presence of mannose or Mannanoligosaccharides in the intestinal tract also aids competitive exclusion. Pathogens bind the gut epithelium when lectins on these microbes recognize mannose-bearing receptors on gut epithelial cells. As pathogens become bound, they are unable to multiply, leading to the theory that beneficial bacteria will then be able to competitively exclude them.
2. Providing nutrients that only certain microbes can use is one way of supporting competitive exclusion. Chandler and Newman (1994) found that a number of beneficial intestinal bacteria were able to utilize MOS; however, most of the enteric pathogens could not. They also noted that the predominant ruminant species were unable to grow on MOS, indicating that MOS is poorly degraded in the rumen.
3. The other area of oligosaccharide supplements is stimulation of immune response. Bacterial cell wall materials, both glucan and mannan, activate the complement system via the alternative pathway. It is generation of the reaction products of the complement that increases the effectiveness

of phagocytic (killer) cells such as macrophages to both speed clearance of antigens, and promoted the inflammatory response (Figure 3).

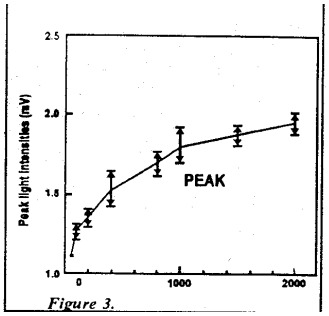

Figure 3.

The Practical Effects of MOS

Alltech Biotechnology Co., an international manufacturer of all-natural feed additives, is currently researching and marketing a MOS based product (trade-named Bio-Mos). In working with Bio-Mos, Alltech has seen the protective effect of adding MOS to the diet demonstrated across several species, including poultry, pigs, rabbits, aquaculture, and calves.

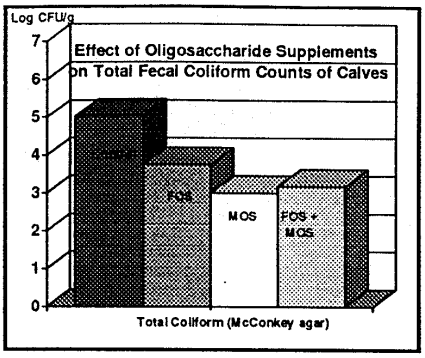

Figure 4.

In a trial comparing Bio-Mos and a fructan-based product (FOS) added to milk replacer, the ability of MOS to affect gut microbiology was demonstrated by a reduction in both total fecal Coliforms and *E. coli* in the feces of calves (Jacques and Newman, 1994). Total coliform counts were reduced by more than 1 log by both supplements, reflecting a possible change in the intestinal microbial population. *E. coli* counts in feces were reduced significantly by MOS, but not by FOS ($P<.10$). These changes may have had an indirect, positive effect on performance as gain was significantly enhanced by Bio-Mos (Fig. 4).

In two additional trials, Holstein bull calves were purchased at auction and raised in confinement. Bio-Mos, when added to the milk replacer, was associated with a lower incidence of respiratory disease occurring during weeks 4-6. This was associated with an increase in rate of gain during this period (Fig. 5 and 6).

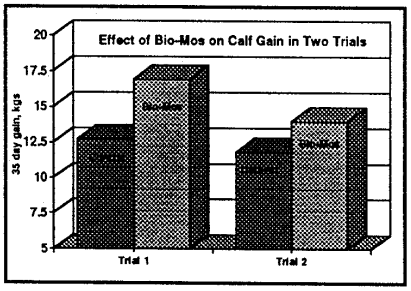

Figure 5.

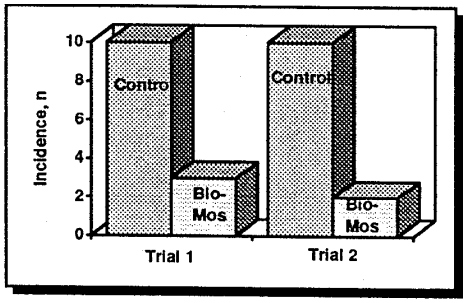

Figure 6.

Last, Newman and Jacques (1993) found that both Bio-Mos addition and acidification of milk replacer tended to improve rate of gain during the first three weeks. Acidification had less impact than Bio-Mos on rate of gain between weeks 3 and 5; however, inspection of the interaction means revealed that calves given acidified milk replacer plus Bio-Mos had the highest rates of gain (35d ADG, lbs/d:Control, 1.39;Acidified,1.63;Bio-os,1.87;Acidified=Bio-Mos,2.00) (Fig. 7).

The Bottom Line of MOS

The above research indicates there could be several positive benefits to including MOS in a milk replacer. Comments heard from calf producers using it in the field include faster starter intake, increased calf activity, and reduced treatment costs. However, other research has been variable. It is possible that performance of MOS may be more closely related to level of stress in the animal than first though. Alltech is continuing to devote a great effort to further quantifying its effects. Milk Products, Inc. currently has Bio-Mos available upon request.

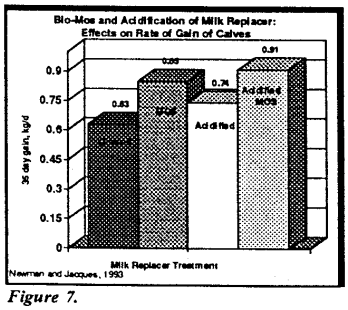

Figure 7.

KA Jacques and KE Newman, 1994, "Effect of Oligosaccharide Supplements on Performance and Health of Holstein Calves Pre- and Post-weaning," *J. Anim. Sci.* (Vol 72 (Suppl.1), 295.

KA Newman, KA Jacques and R. Buede, 1993, "Effect of Mannanoligosaccharide on Performance of Calves Fed Acidified and Non-Acidified Milk Replacers," *J. Anim. Sci.* 71(Suppl. 1), 271.

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Nathan Sharon and Halina Lis, "Carbohydrates in Cell Recognition," *Scientific American*, Vol. 268 No.1 (January 1993), 82-89.

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