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Review Article

MANNAN OLIGOSACCHARIDE AS A MODULATOR OF GUT HEALTH AND IMMUNITY IN POULTRY - A REVIEW

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Abstract: A prebiotic compound is "a non-digestible feed ingredient that acts beneficially for the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the gut and thus improves gut health." Mannan oligosaccharides (MOS) are among the classes of prebiotics that beneficially affect gut health. MOS at various levels is found to increase the number of beneficial microbes in gut like *lactobacilli, bifidobacteria* which ultimately lead to competitive inhibition of pathogenic microbes as well as immune modulating effect and eventually leads to increased performance in terms of growth, immunity and FCR

Keywords: MOS, Gut health, immunity.

Introduction

Gut microflora play a very important role in growth and immunity of birds. Several interacting stress factors like handling, transportation, confinement; overcrowding etc alters its gut environment and habitat. It is well accepted that there is no substitution for supplementation of quality feed ingredients for maintaining natural gut health. Antibiotics have revolutionized the intensive poultry production system as a feed additive to promote growth, production and feed conversion ratio through improving gut health and reduction of sub-clinical infections during last 50 years. But due to advancement in animal genetics, nutrition, and vaccination programs, the magnitude of benefits from AGP (Antibiotic growth promoter) has lessened. Currently, the sub-therapeutic usage of antibiotics in livestock production is questioned by many health conscious consumers and researchers, because AGP have been linked to the possible development of antibiotic-resistant pathogenic bacteria, which may pose a threat to human health (Smith *et al.*, 2003) .Due to such concerns worldwide and the awareness of public towards health may lead to ban of AGP. Thus it now becomes more important to formulate diet which effects gut health especially for simple stomached animals. This is because maintenance or improvement of gut health is essential for

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the welfare and improving the productivity of animals, when antibiotics are not included in feed.

Impact of MOS on Gut health

The effect of MOS on performance have been analysed in several studies with chickens, prevalence and concentration of different strains of *salmonella* as well as *E. coli*, *is* found to reduce, (Spring *et al.,* 2000). However, reported effects on promoting beneficial bacteria, such as lactobacilli and bifidobacteria are more variable (Baurhoo et al., 2007). The application of molecular techniques allows us to study the composition of the intestinal microflora, which give us more detail about the changes that accur after feeding MOS (Horgan, 2010). The first study testing MOS in poultry showing an improvement in performance was peer-reviewed published in 2001 in which (Paul *et al.,* 2001) observed an improvement in feed conversion, indicating that birds are converting feed more efficiently into body tissue.

MOS supplementation have found to significantly alter the caecal bacterial community structure and the dominant bacteria of the cecum belonged to three phyla, *Firmicutes*, *Bacteroidetes*, and *Proteobacteria*; of these, *Firmicutes* were the most dominant in all treatment groups (Corrigan *et al.,* 2011). The diversity of microbial species in the gut is one of the most important factors for the establishment of a stable ecosystem in the intestinal tract. Diet is the important factor that influences the gut microflora population. It has been seen that Iileal populations of lactobacilli and coliforms in broilers fed on diets containing manno-oligasaccharides (MOS) were decreased, In addition, bird performance was enhanced and energy utilization was improved. (Yang *et al.,* 2008), When in an experiment prebiotic was added at the rate of 2 and 3 g/kg prebiotic or it was ssen that at d 28, the population of lactobacilli and bifidobacteria were highest in birds fed 2 and 3g/kg MOS in comparision to respectively in comparision to avilamicin in basal diet (Afrouziyeh *et al.,* 2014). This shows that a single natural feed additive can have profound effects on gut health.

MOS and Gut morphology

The relative length of the small intestine were affected by the addition of MOS and the effects were dependent on the age of birds as well as the dosage level of MOS. (Yang *et al.,* 2007). Medium and/or high MOS treatment also increased the villus height of the small intestine of birds at different ages. The addition of MOS tended to reduce the coliform load at the gut mucosa. (Yang *et al.,* 2008). (Pourabedin *et al*., 2013) observed increased villus height and goblet cell numbers in the ileum and jejunum. These results provide a deeper insight into the microbial ecological changes after supplementation of MOS prebiotic in poultry diets. A higher bacterial diversity was observed in the cecum of MOS-supplemented birds. (Markovic *et al.,* 2009) observed that Bio-MOS increased length and width of intestinal villa and decreased depth of crypts, while the number of goblet cell*s* did not significantly differ among experimental groups. (Juśkiewicz *et al*., 2006) observed that after feeding the turkeys for 16 weeks, their caecal metabolism was affected by dietary MOS to some extent. Although MOS did not change the caecal pH or the bacterial enzyme activity, when applied at medium and higher doses it decreased ammonia as well as SCFA concentration (mainly acetate) in the caecal digesta. Dietary MOS had no significant effect on the caecal populations of *Bifidobacterium* and *Lactobacillus*, whereas the populations of caecal *E. coli* were observed to decrease, especially upon medium and high experimental concentrations.

MOS and immune system

MOS has been assumed to have a direct effect on the immune cells through its mannan molecule. Recent discovery has revealed that TLR4 and MR (mannose receptor) may be involved in the recognition of mannan. It is now known that MR on macrophages and other 12 cells recognizes mannan (Davis *et al*., 2004), Altered cytokine expression of chicken macrophages stimulated with a mannan-rich fraction was mediated via a transitory decrease in the mRNA expression of TLR4. (Singboottra *et al.* 2006), TLR4 also recognizes mannan and mannan-associated molecules. (Sheng *et al.,* 2006). Inclusion of toxin binder MOS at 0.05 per cent level do not alleviate the penicillic acid toxicity (20 ppm) in broiler chicken. (Pazhanivel *et al*., 2014)

Humoral immune response

In a study the effect of different treatments on the humoral immune response by means of antibody production after a simultaneous vaccination against NDV was seen. Ocular and subcutaneous vaccines were administered at 10 days of age and antibody production was measured at 7 and 14days post-vaccination. At 14 days of age, YCW induced higher NDV antibody titers. There were no differences in antibody titers between vaccine and coccidiostat. The immune-regulatory effect was also observed at 21 days of age. YCW induced the higher NDV antibody titers. (Gabriela *et al.,*2009). Antibody titres against influenza and reovirus were higher in prebiotic (MOS) fed group, (Hajati *et al*., 2014) but there were no significant differences among the other blood antibody titers. Dietary inclusion of prebiotic-based mannanoligosaccharide and *β*-glucan has no significant effect on immune parameters on chicks in the non-infected group, but it displays an efficacy on chicks in the group infected with pathogens and can improve the immune responses and health of infected chicks. (Sadeghi *et al*., 2013). The inclusion of MOS resulted in increased antibody titers against IBDV in the fourth and fifth weeks, and against NDV in the third, fourth and fifth weeks of age. MOS was effective in stimulating the humoral immune responses against IBDV and NDV vaccine viruses. (M.C. Oliveira et al., 2009)

Mucosal immune response

YCW (yeast cell wall) and Vaccine increased mucosal concentrations of intestinal IgA compared to control and coccidiostat, respectively. In tracheal samples, increased concentrations of mucosal IgA were found in YCW fed group as compared to other groups. Dietary supplementation of 0.05% of YCW has found to increase local mucosal IgA secretions, humoral and cell-mediated immune responses, and reduced parasite excretion in feces. (Gómez et al., 2009)

Cell-mediated immune response

In an experiment, cell-mediated immune response was examined by the cutaneous basophilic hypersensitivity test (This method reveals the status of T-cell response) and it was found that YCW(yeast cell wall) increased cell-mediated immune response, (Gabriela *et al.,* 2009), also hens fed diet supplemented with 0.05% MOS had significant increase in the values of antibody titers of broiler breeders (Shashidhara and Devegowda 2003).

Conclusion

MOS has been found to be more or less equally competent with antibiotis growth promoter, it appears to promote growth of beneficial microflora in the gut there by reducing pathogenic load and maintaining gut health , also has been found to enhance immunity as gut microflora also play a vital role in growth and immunity of birds. MOS as a natural feed additive has found to improve the over all performance in terms of FCR, growth and immunity of the poultry birds.

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