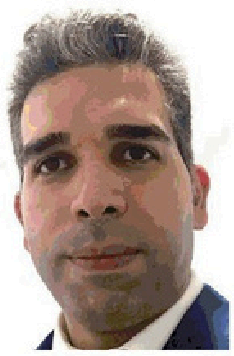
β-mannan in raw materials and β-mannanase application in feed



Non-starch polysaccharides (NSPs) in feed raw materials are indigestible for poultry, as birds lack the necessary endogenous enzymes to break them down. Among NSPs, soluble forms are particularly recognized as key antinutritional factors in poultry diets, write Dr GAO JUN and Dr MEHDI TOGHYANI *. Soluble NSPs increase digesta viscosity, which impairs nutrient digestibility, reduces feed intake, and ultimately diminishes production efficiency. One prominent example of such NSPs is β-mannan, which has a significant antinutritional impact on poultry.

Mannan, a hemicellulosic NSP, is second only to xylan in abundance in nature. β-mannan is commonly found in a wide variety of feedstuffs, including soybean meal (SBM), palm kernel meal, copra meal, and sesame meal. There are four types of mannan subfamilies: glucomannans, galactomannans, galactoglucomannans, and linear mannans.

Generally, galactomannan is the major form of mannan in legumes. The water solubility of galactomannan is determined by the mannose-to-galactose ratio, as galactose binds water effectively and increases viscosity. SBM is widely used as a protein source in feed, and therefore, β-mannan is found in most poultry feeds.

According to Hsiao et al. (2006), SBM contains at least 1.0% β-mannan, with higher concentrations found in non-dehulled samples (1.61%) compared to dehulled samples (1.26%). Although the galactomannan content in SBM is not as high as in palm kernel or guar meals, its presence can still negatively affect nutrient digestibility and feed efficiency due to its antinutritional properties. ▷

Due to its abundance in nature and its antinutritional effects in poultry diets, mannanase has been commercially developed as a feed additive. Exogenous β-mannanase is recognized as an effective nutritional strategy to counteract the adverse effects of galactomannan, particularly in broiler chickens. By breaking down β-mannan, this enzyme reduces intestinal viscosity, enhances nutrient absorption, and improves feed efficiency

β-mannanase is an endohydrolase that cleaves the internal glycosidic bonds of the mannan backbone and produces β-1,4-manno-oligosaccharides and D-mannose. β-mannanase supplementation has been reported to improve performance and nutrient digestibility in poultry-fed corn-SBM-based diets and other mannan-containing raw materials diets like guar meal and copra meal. Consequently, it has drawn significant attention for its potential to optimize feed utilization and improve overall production efficiency.

Modes of action of mannanase

Based on published research, five main modes of action may explain the positive effects of β-mannanase supplementation on performance.

1. Reducing intestinal digesta viscosity.

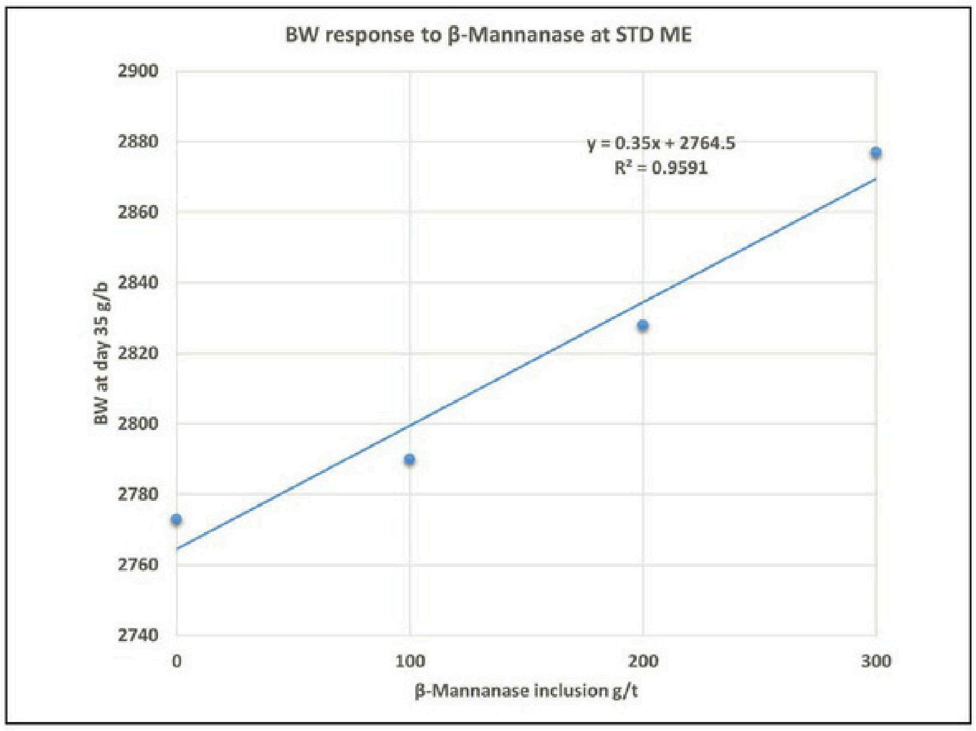
High molecular weight and soluble galactomannans can dissolve in the digestive tract, forming highly viscous digesta. Therefore, the inclusion of feedstuffs with high levels of galactomannan, such as guar meal or copra meal, is associated with a marked rise in digesta viscosity. Degradation of mannan by supplemental exogenous β-mannanase reduces digesta viscosity.

2. Inhibiting proliferation of pathogenic bacteria in the gut.

Mannan oligosaccharides (MOS), produced by β-mannanase, prevent bacterial adhesion in the gut by saturating binding sites on intestinal cells, thereby inhibiting pathogens like E. coli and Salmonella.

MOS also functions as a prebiotic, supporting beneficial microbes such as Bifidobacteria and Lactobacilli while remaining indigestible to harmful bacteria like C. perfringens and E. coli. This dual role enhances gut health and reduces pathogen colonization, making β-mannanase supplementation valuable in poultry nutrition.

Figure 1: impact of VTR β-mannanase supplementation on broiler performance from 1-35 days post-hatch (unpublished data, 2022)



3. Regulating immune responses

Mannose, a pathogen-associated molecular pattern analog, can trigger an energy-intensive innate immune response when recognized by mannose receptors, even in non-infectious conditions. This unnecessary energy expenditure can reduce efficiency.

Adding exogenous β-mannanase to feed hydrolyzes indigestible mannans into mannan oligosaccharides that are not recognized by mannose receptors. This prevents feed-induced immune activation and conserves energy for growth and production.

4. Increasing nutrient digestibility.

NSPs decrease nutrient digestibility by encapsulating the starch and protein bodies inside the cereal endosperm. As an NSP-degrading enzyme, β-mannanase can destroy the encapsulation effect and improve nutrient digestion. Digestibility of crude protein, crude fiber, and metabolizable energy was reported to increase by β-mannanase supplementation.

Boost feed performance with β-Mannanase for enhanced digestibility.

5. Degrading mannan to mannose as an energy source.

β-Mannan is degraded to mannose by β-mannanase and β-mannosidases, and animals can utilize mannose as an energy source.

VTR β-mannanase application experiment

A trial was conducted at the University of Sydney, Australia, to investigate the effect of VTR mannanase supplementation on the performance of broilers fed a corn-SBM diet. The dietary treatment followed a 2 × 4 factorial arrangement consisting of four levels of β-mannanase inclusions and two dietary metabolizable energy levels.

A total of 720 one-day-old male Ross 308 birds (parent line) were randomly assigned to 48-floor pens with 15 birds per pen and 6 replicate pens per treatment. The energy reduction in negative control diets in starter, grower, and finisher diets were 40, 50, and 50 kcal/kg, respectively. All diets were supplemented with VTR phytase at 1000 FTU/kg.

A treatment interaction ($P = 0.030$) was observed for weight gain because responses to β-mannanase were of a linear nature in birds offered standard energy density diets. The 300 mg/kg β-mannanase inclusion numerically improved weight gain by 3.75% (2887 versus 2773 g/bird) (Figure 1).

For low-energy diet treatments, the highest weight gain was observed in the 100 g/MT β-Mannanase treatment (2931 g/ bird). This study showed that supplementation of β-Mannanase in corn-SBM diets in addition to phytase is still beneficial to performance, especially during starter and grower phases.

Conclusion

β-Mannan, an anti-nutritional factor present in many feed ingredients, negatively impacts digesta viscosity, nutrient absorption, metabolism, and overall animal performance. Supplementing feed with exogenous β-mannanase mitigates these effects by breaking down β-mannan.

This enzyme is particularly effective in monogastric animal nutrition, offering multiple mechanisms of action. Its efficiency depends on factors like diet composition, the enzyme source, animal type, and hygienic conditions. Proper consideration of these variables is essential to maximize β-mannanase's benefits and optimize feed efficacy. ■

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β-Mannanase in feed for better growth.