

# Managing the impact of an unnecessary feed induced immune response

by Marco A. Martinez-Cummer,  
Christophe Bostvironnois, Karl Poulsen,  
Elanco Animal Health, 2500 Innovation  
Drive, Greenfield, IN, 46140, USA.

**F**eed Induced Immune Response (FIIR) as a response to galacto mannans are a potential threat to broiler performance and uniformity.  $\beta$ -mannans can be considered as the leading molecules and are most prevalent in a wide variety of feed ingredients including soybean meal, sunflower meal, palm kernel meal, copra meal, and sesame meal.

Since soybean meal (SBM) is a major protein source in feeds produced around the world,  $\beta$ -mannan is present in most feeds.

$\beta$ -mannans in SBM are linear polysaccharides composed of repeating  $\beta$ -(1-4) mannanose  $\beta$ -(1-6) galactose and/or glucose units attached to the  $\beta$ -mannan backbone.

They are highly viscous, water soluble, heat-resistant compounds that survive the drying/toasting phase of soybean processing.  $\beta$ -mannans can be recognised by the innate system and considered by the intestinal mucosa as Pathogen Associated Molecular Patterns (PAMP) by several Pattern Recognition Receptors (PRR), including the serum protein mannanose binding lectin MBL as well as several cell surface receptors on key immune system cells including mannanose receptor (MR) and others (DC-SIGN) on key immune system



cells. Consequently, they provoke an intestinal micellimmune response which is energy consuming and wasteful.

The association of mannan with the surface of numerous pathogens has likely led to mannan's conserved recognition by the innate immune system. Recently MBL has been recognised to be involved in the phagocytosis of mannanose containing pathogens and recycle of necrotic cells that effectively aligns cell surface TLR binding for signal transduction.

The innate immune system is activated by molecular patterns commonly found in pathogens, and high molecular weight man-

nan present in leguminous feedstuffs such as soybeans is one of the patterns that induce a strong and costly response.

Acute phase proteins (APP) are an aspect of the innate immune system and some APP which accumulate in blood to high levels in response to various forms of stress.

Measuring APP provides a convenient tool to monitor stress in birds. Results from the attached studies suggest that APP levels measured were predictive for the growth performance in broilers and turkeys. The APP called  $\alpha$ -1-acid glycoprotein (AGP) is known to be very responsive in birds and is readily measured by a radial immune diffusion assay.

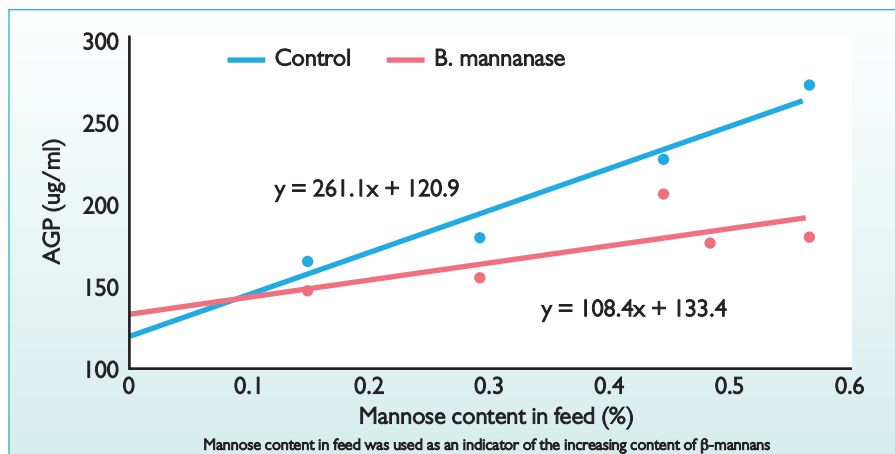
It has been practical and convenient in chicken and turkey experiments, to test for innate immune system stimulation by measuring the level of the APP,  $\alpha$ -1-acid glycoprotein (AGP) as it correlates with innate immune response by radial immune diffusion.

Results from a broilers pen trial shows significant improvement in feed conversion, and also significant reduction in AGP when  $\beta$ -mannanase hydrolyses non start polysaccharide strands (galacto mannans) found in leguminous feedstuffs and prevents the innate response from mounting an innate immune response.

Once beta mannanase hydrolyses galacto mannans, the resulting mannan oligosaccharide fragments can no longer be recognised

*Continued on page 9*

**Fig. 1. Linear correlation between circulating AGP and feed and soybean derived mannanose content (Dale, 1997).**



Continued from page 7

by toll like receptors (MBL). Thus, by negating the FIIR, beta mannanase helps conserve valuable energy and this energy can go towards growth and performance.

## Materials and methods

A series of studies conducted at the University of Georgia were done to demonstrate the association between the mannose content in feed by adding leguminous feed-stuffs rich in galacto mannans and AGP in blood serum measured by acid hydrolysis and gas chromatography.

A basal diet was formulated with highly refined components to be a 'low stimulation' diet for the innate immune system to which test materials were added.

AGP ( $\mu\text{g/ml}$ ) levels in serum were measured as the innate immune response criteria in 0-2 week old chick serum. The results are summarised in Fig. 1.

In addition, a broiler experiment was conducted to evaluate the effects of beta mannanase on live performance and uniformity at market age (Table 1). Treatments included a positive control and a reduced energy negative control treatments with the enzyme added to the negative control.

## Results and discussion

Results demonstrate that AGP increased in response to increasing levels of galacto mannans in the diet. The addition of pure beta mannanase reduced AGP levels and the AGP response was proportional to the mannan content in feed (based on mannose content measured by GC).

Measured mannose content in feed was used an indicator of the increasing content of beta galacto mannans. The studies demonstrate that FIIR is a reality and can impact broiler performance. Beta mannans are good models to replicate their impact. Beta mannanase has the potential to limit their impact and reduce the cost of mounting an unnecessary feed induced immune response. An improvement in live weight

Treatment	BW (g)	FCR	WAFC	Mort. (%)	% CV
Positive control (PC)	2046	1.897	1.874	4.81	9.98
PC (42Kcal/kg ME)	1969	1.886	1.892	4.81	11.17
PC (77Kcal/kg ME)	1923	1.966	1.988	3.61	12.19
PC (42Kcal/kg ME + 225g/metric ton beta mannanase)	2059	1.894	1.867	3.85	9.81
Effect of beta mannanase @ 225g/metric ton	4.6%	-0.8	2.5	NS	-1.36
PC (77Kcal/kg ME+ 400g/metric ton beta mannanase)	2091	1.807	1.768	4.57	9.47
Effect of beta mannanase @ 400g/metric ton	8.7%	15.9	22.0	NS	2.72

**Table 1. The effect of beta manannase on broiler productivity and weight uniformity (% coefficient of variation) in commercial broilers (Knox, 2009).**

uniformity in grow-out barns will translate to an improvement in the consistency of processed poultry products. Several pen trials with beta mannanase with poultry have been done in order to evaluate its effects on live weight uniformity and have shown promising results.

Results from the present study showed that adding  $\beta$ -mannanase at 225 and 400g/metric ton significantly increased 43 day weight by 4.6 and 8.7% and improved with decreases in the %CV by 1.4 to 2.7 units (Table 1). These studies also demonstrate that FIIR is a reality and can impact broiler performance. Beta mannans are good models to replicate their impact. Beta mannanase has the potential to limit their impact and reduce the cost of mounting an unnecessary feed induced immune response.

## Conclusions

The effectiveness of beta mannanase associated with improving the feed/grain performance and body weight uniformity of poultry is primarily due to the degradation of galactomannans that are present in currently used feed formulations by the endo-B-D-mannanase enzyme activity.

The AGP level was significantly elevated in broilers after infection with three Almeria species, and also by the exclusion of the antibiotic (BMD) from the diet.

In trials with broilers at 21 and 42 days, as well as turkeys at market weight, the addition of  $\beta$ -mannanase to the corn/soybean diets significantly reduced the blood AGP level, while also providing significantly increased growth performance as shown by a decrease in weight adjusted feed conversion.

These effects may also be associated with the enzyme's effect on viscosity in the gut.  $\beta$ -galacto-mannan is a viscous polysaccharide, which may contribute to hyperplasia of digestive organs resulting in an increased secretion of pancreatic fluid, thus increasing the energy demand of the intestine.

Beta mannanase can also reduce the CV by approximately 2% by reducing the proportion of birds in lightweight categories.

The value of this improvement will most likely be realised at the processing plant, but it could improve the without giblets yield by approximately 0.4 percentage points. ■

References are available  
from the author on request