Effects of dietary exogenous protease and ascorbic acid in broilers

New research from DSM and Massey University (New Zealand) confirms previous reports on the effectiveness of adding protease to feed that is a reduction in crude protein and digestible amino acids. Furthermore, both protease and ascorbic acid may influence gut health through promotion of tensile strength, epithelial morphology and endogenous protein flow.

by José Otávio B. Sorbara, Global Enzymes Category Manager, DSM Nutritional Products. www.dsm.com

Protease, as a mono-component enzyme, is a relatively new addition to the global feed enzyme market compared with incumbents such as xylanase and phytase.

Application of exogenous protease in poultry nutrition is motivated largely by feed cost reduction associated with displacement of expensive protein sources such as soybean meal.

However, 'extra-proteinaceous' effects such as improved gut health and litter quality are also an important part of the value equation.

A recent meta-analysis of the effect of a mono-component protease on apparent ileal amino acid digestibility in poultry revealed that the mean response was approximately +4% over a range of control diets and single feed ingredients.

A role for vitamin C

An insufficiency of ascorbic acid results in formation of collagen with poor structural integrity and this negatively influences the architecture of the skeleton, intestine and integument.

Whilst poultry have the capacity to synthesise ascorbic acid de novo, it is possible that this is inadequate to promote optimal formation of collagen to support the rapid growth of contemporary broiler genotypes, especially under the influence of an external stressor such as high ambient temperature.

Importantly, Gous & Morris (2005) suggest that the thermal neutral zone for modern broilers is declining as rate of gain increases and that sub-clinical heat stress may be common in many geographical regions.

Gastrointestinal permeability is increased substantially during periods of heat stress due to the movement of blood to the periphery of the body, increasing the importance of tight junction integrity. This new research investigated the effect of exogenous protease, supplemental ascorbic acid and their interactions with the nutrient density of the diet, on broiler performance, nutrient digestibility and gut physiology and morphology.

The addition of protease did not affect body weight gain but reduced feed intake by more than 100g at 35 days resulting in a FCR five points better than the treatments without protease (Table 1).

Treatments	Feed/gain (g/g)
Without protease	1.67
With protease	1.62
Probability	0.0001

Table 1. Influence of dietary treatments on the performance of male broilers fed wheat-soy diets (1-35 day post-hatch).

Adding power to proteases

The beneficial effect of exogenous protease on weight gain was increased by the presence of ascorbic acid resulting in a strong tendency for a protease-ascorbic acid synergy. Protease and ascorbic acid supplementation also increased gut tensile strength compared with the birds fed the unsupplemented diets (Table 2).

In the current work, supplemental protease increased gut tensile strength, villus height, and crypt depth, and reduced epithelial thickness and goblet cell numbers.

These morphological changes are indicative of enhanced gut integrity and resilience and are suggestive of beneficial effects of protease that extend beyond increased amino acid recovery.

The effect of exogenous protease on ileal nitrogen and amino acid digestibility coefficients is presented in Table 3.

However, ascorbic acid addition to the diet resulted in an increase (P=0.06) in gut tensile strength independently from exogenous protease suggesting that protease and ascorbic acid may have additive beneficial effects. As ascorbic acid is centrally involved in collagen biosynthesis it is conceivable that additional ascorbic acid in the diet resulted in improved hydroxylation of Pro and Lys and increased integrity of collagen structure.

As ascorbic acid promoted an increase in hydroxyproline concentration in the digesta this contention is plausible and offers a novel mechanism for the involvement of ascorbic acid in gut health.

Finally, ascorbic acid has been found to promote digestion via non-enzymatic scission of plant cell wall polysaccharides, which has been shown to reduce in vivo viscosity in the ileal digesta of broilers.

Ascorbic acid when added alone had no effect on amino acid digestibility but when combined with protease the amino acid digestibility increased the amino acid digestibility from 4.19% (protease alone) to 5.11% (protease plus ascorbic acid).

Main effects	Gut strength (Newton)
Protease	
Without	3.99[a]
With	4.17[b]
Ascorbic acid	
Without	3.98[y]
With	4.18[z]

a,b or y,z† P <0.10

Table 2. Influence of dietary treatments on the gut integrity of broilers, measured on day 35.

Conclusion

It is possible that contemporary broilers may benefit from supplemental ascorbic acid to promote collagen biosynthesis through the conversion of lysine and proline to hydroxylated forms in a production animal scenario that is moving away from the use of prophylactic antibiotics.

A combination of protease and ascorbic acid offers potential to improve the macrostructure of the intestine of broilers and the implications for bone development and the integrity of the integument are self-evident. ■

References are available from the author on request

Table 3. Influence of protease on ileal amino acid digestibility (%) of broilers, measured on day 35.

Treatments	N	THR	VAL	ILE	LEU	LYS	NEAA	EAA	AA
Without protease (%)	0.81[b]	0.78[b]	0.80[b]	0.82[b]	0.83[b]	0.87[b]	0.80[a]	0.84[b]	0.82[b]
With protease (%)	0.84[a]	0.81[a]	0.83[a]	0.85[a]	0.85[a]	0.89[a]	0.82[b]	0.86[a]	0.85[a]

a,b P <0.01 EAA = essential amino acids; NEAA = non-essential amino acids; AA = average of all amino acids