

Histidine requirements of broilers for protein synthesis and beyond

Low emissions in industry has been the focus for years and global warming and climate change have shifted part of that focus to agriculture. Thus, huge pressure is on the livestock industry to reduce nitrogen and phosphorus emissions and ultimately help to reduce gaseous pollutions such as CO₂ and methane.

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Phytase has been used for years in order to reduce phosphorus excretion and to increase phytate phosphorus availability to animals. To control nitrogen emissions, modern monogastric diets are switched from protein optimisation to amino acid optimisation. Lysine, methionine, threonine, tryptophan, and valine are commonly used in feed formulations.

Isoleucine and arginine have been recently introduced to the market as supplementary amino acids. Based on these the industry is designing low protein and functional diets to contribute to reducing the impact of animal production on environmental pollution.

Histidine (His) is the next limiting amino acid which is already registered and used in parts of the world and is under registration in the EU. This article looks at the role of His and its requirements in monogastric species.

Requirements in broilers

The His requirement for maximum weight gain and feed efficiency is determined to be no more than 0.31% (8-22 days post hatch) in a diet in which the His digestibility is determined to be 81.4%.

The optimal ratios of digestible His (dHis) with digestible Lys (dLys) for the starter phase in the literature range between 27-36%. Wecke and Liebert (2013) summarised results of 12 experiments and ended up with a His to Lys ratio of 34±4%. The most

recent study on His requirement in broilers was done by Franco et al. (2017), Illinois university, USA. On average a dHis to dLys ratio (His/Lys) of 38% was reported and they also observed a higher His requirement for carcase parameters as compared with body weight and FCR in 8-17 days old birds (Table 1).

Broiler breeder companies (Ross and Cobb) do not currently have His recommendations. Brazilian tables suggest 37% His/Lys for all ages of broilers. Some tables suggest dHis requirements of 0.49, 0.48, 0.46, 0.40, and 0.36% for 1-7, 8-21, 22-33, 34-42, and 43-46 day old high performing broilers

In usual corn soybean broiler feed formulas, His/Lys is around 0.43% (starter phase) under a normal protein condition (21.7% CP).

An attempt to reduce the protein content down to 20% would reduce the His/Lys to 0.38%.

Thus, after arginine and isoleucine, histidine would be the next limiting amino acid in corn soybean diets.

In a wheat corn soybean diet, His/Lys starts from 0.40% in a normal protein condition and a similar attempt to reduce crude protein would cause an isoleucine, leucine and glycine plus serine deficiency as well as a drop in His/Lys to below 0.38%. These are examples showing the importance of His under different formulation conditions.

Physiological role

Histidine is an integral component of a broad set of tissues including skin, feather, bone, ligaments, and obviously muscle. This amino acid also serves to stimulate the digestive secretion of gastrin, a hormone that activates production of hydrochloric acid and pepsinogen, which are essential for digestion of dietary protein.

Histidine together with β-alanine are needed for carnosine synthesis which is a dipeptide synthesised by the carnosine synthase.

A high concentration of carnosine is found in muscle and brain tissues, especially in breast muscle of mammalian and avian species.

Response	Model ¹						Mean ratio ²
	L	Q	95% Quad	LRP	LRP/Quad	QBL	
Body weight gain	40	–	–	–	–	–	–
FCR	–	36	34	31	34	32	–
Breast weight	–	39	37	36	38	40	38
Breast fillet weight	–	41	39	36	39	40	–
Breast yield	–	41	39	37	39	41	–
Breast fillet yield	–	39	40	37	38	42	–

¹Optimal digestible ratio estimates shown for each response in which at least one model was significant.
²Overall mean estimated optimal digestible ratio across all significant response variables per amino acid.
Abbreviations: L, linear; Q, quadratic; 95% Quad, 95% of the asymptomatic parameter of the quadratic model; LRP, linear response plateau; LRP/Quad, LRP-to quadratic regression ratio; QBL, quadratic broken line.

Table 1. Summary of estimated optimal digestible histidine ratios for broiler chicks (adapted from Franco et al. 2013).

Recently, carnosine has gained increasing attention as a functional ingredient for human food because of its high antioxidant activity, high buffering capacity to maintain intracellular pH change, and anti-glycating and anti-aldehyde effects.

Histidine supplementation in broiler diets increases the concentration of carnosine in breast muscle of 1-32 days old broilers.

To increase concentration of carnosine in breast muscle tissue of broilers using L-His or spray dried blood cells (SDBC, a His-rich raw material), only the L-His supplemented diet could increase the concentration of carnosine and improve the antioxidative status of breast muscle.

Whereas, the spray dried blood cells caused a loss in performance parameters probably because of a very high leucine concentration in SDBC contrary to L-His which improves performance.

Breast muscle has about three times higher carnosine concentration than thigh muscle. Moreover, slow growing chickens presented higher carnosine concentration in breast muscle compared with Ross (ad libitum fed or limited fed).

Recently, concentration of carnosine is also linked to the incidence of breast muscle diseases. Severe cases of breast gaping presented a low concentration

carnosine. Thus, there is a potential in His to help the industry solve similar issues.

Some of the nutritional trends of recent decades have been the ban of animal protein sources (meat and bone meal and blood meal) and lowering the concentration of protein in the diets, both of these situations have dramatically reduced the concentration of histidine in feed formulations.

Conclusion

Histidine is receiving fresh attention in broiler nutrition as the next limiting amino acid. New nutritional trends had tremendously reduced the concentration of His in broiler diets. CP reduction has urged the requirement of crystalline His for commercial broiler diets. Histidine is also a functional amino acid with antioxidative properties.

It is related to broiler breast meat issues, thus formulators of broiler diets need to balance for His not only to meet nutritional requirements but also to benefit from functional aspects of His as a new solution available on the market.

References are available from the author on request