Histidine importance in poultry and swine feeding

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Abstract

Maximizing the efficiency of utilization for both proteins and amino acids are very essential to reduce production cost and optimize performance. Currently there is a focus on crude protein (CP) reduction while satisfying the requirements for essential amino acids (EAA) with the use of crystalline amino acids to ensure growth and to sustain the animals' physiological needs. Commercial production of synthetic amino acids already includes lysine, methionine, threonine, cysteine, valine, arginine, isoleucine, tryptophan and, recently, histidine (His). Histidine is a very important amino acid for salmon industry. Histidine may be regarded as the sixth limiting EAA in practical nursery pig diets when considering diets with low CP levels. Histidine-rich ingredients and L-His increase concentration of carnosine in muscle, improve antioxidative enzymes activity, and improve performance . Carnosine, together with anserine, are grouped as His heteropeptides which play several vital roles in anti-oxidation, anti-aging, anti-fatigue, and muscle buffering.

INTRODUCTION

Dietary protein content is getting serious attention from different countries worldwide. Proteins are essential for the optimum growth and reproduction of animals. Protein is also one of the most expensive nutrients in the animal feed, thus, protein reduction can also be economic. Thus, crude protein (CP) reduction while satisfying the requirements for essential amino acids (EAA) continues to be a focus for nutritionists. Supplementation of synthetic amino acids provides an opportunity to achieve the amino acid requirements of the animals with less dependency on protein sources, reduce feed cost, improve digestibility, and less nitrogen excretion (Han and Lee, 2000).

Histidine is a very important amino acid in salmon, but it is now also recognized as an EAA that must be fulfilled by dietary sources for monogastric animals. In fact, His is considered marginally deficient in a corn-soybean meal diet with 11% CP for growing pigs (Figueroa et al., 2003).

Importance of histidine in monogastric animals

In swine, aside from the contribution of L-His in balancing the amino acid requirements of animals fed with a low crude protein diet, 1.8% and 1.9% of colostrum and milk immunoproteins, respectively, consisted of His (Han and Lee, 2000).

Histidine supplementation combined with valine on diets containing 11% CP, exhibited similar feed intake and weight gain compared to pigs fed diets with either 16% or 12% CP with great reduction in plasma urea concentration (Figueroa et al., 2003; Moro et al., 2020). There was limited synthetic His production in the past years only for salmon application. Therefore, most of the animals' requirements were supplied by ingredients that contains high levels of His such as spray-dried blood cells (SDBC) or blood meal. However, due to possible health issues, costs, nutritional content and other concerns in animals, the usage of SDBC are restricted or forbidden in the feed formulations. Nevertheless, broiler chickens fed a diet supplemented with His-rich ingredients like SDBC and synthetic L-His had an increase in concentration of carnosine in breast muscle, improved antioxidative enzymes activity, and improved body weight in turkeys (Kopec et al., 2016). Carnosine, together with anserine, are grouped as His heteropeptides which play several vital roles in anti-oxidation, anti-aging, anti-fatigue, and muscle buffering (Kopec et al., 2016; Moro et al., 2020; Xu et al., 2019). Carnosine scavenges reactive oxygen species (ROS) and alpha-beta unsaturated aldehydes formed from peroxidation of cell membrane fatty acids during oxidative stress. Dietary His supplementation at 0.3% induced an increase of carnosine by 8.88% in breast muscle tissues and was further boosted to 25.96% with 0.5% inclusion rate with an eventual improvement in meat quality (Moro et al., 2020). Moreover, His supplementation allows the increase of superoxide dismutase activity in muscles and erythrocytes and glutathione peroxidase activity in plasma (Moro et al., 2020).

In an experiment in hatching eggs, in-ovo injection of 1% L-His into amnion significantly increased the hatchability rate, explaining that His can be utilized for energy production during certain emergencies or adverse conditions and stimulates the nutritional status of hatchlings and improves their rate of hatchability (Xu et al., 2019).

Histidine requirement in swine and poultry

Histidine may be the sixth limiting EAA in practical nursery pig diets (Cemin et al., 2018). The requirement for amino acids are affected by different factors such as stage of growth, genotype or strain, sex, physiological status, environmental and health status, production level of the animals, and efficiency of nutrients utilization (Han and Lee, 2000; Ravindran et al., 2013). SID His requirement supposed to be 28% and 31% of lysine for growth performance of 7 to 11-kg pigs, respectively (Wessels et al., 2016 and Cemin et al., 2018). A 10% reduction in the ratio of SID His to Lys level is associated with an 11% decline in the ADG (Wessels et al., 2016). For 10 to 20 kg pigs, Li et al. (2002) reported 30% SID His:Lys ratio which is lower than the 36% reported by Isquierdo et al. (1988) and equal to Moro et al. (2020) indicating 36% SID His:Lys ratio as the optimum requirement for 20 to 50 kgs pigs.
For poultry, the optimum SID His:Lys ratio also differs depending on the production function and stage of growth of the animals. In meat-type chickens, the requirement for histidine ranges from 31% to 32% according to Moro et al. (2020) and Ravindran (2013), while 35 to 37% from the reports of Han and Lee (2000) and Ravindran (2013). On the other hand, laying hens tend to have a requirement between 36 to 38.5% SID His:Lys ratio reported by Han and Lee (2000) which is higher that the recommendation stated by Ravindran et al. (2013) at 24 to 25 %.

Table 1. Histidine requirement table

	Broilers	Broiler Breeders	Turkeys	Pullets	Layers	Piglets	Finishing pigs	Sows
CJ Recommendation	38%	31 – 32%	31%	37%	29%	34%	36%	34 – 35% (Gestation) 40% (Lactation)
Cemin et al. (2018)						31%		
Han and Lee (2000)	35 – 37%				36 – 38.5%			
Isquierdo et al. (1988)							36%	
Li et al. (2002)							30%	
Moro et al. (2020)	31 – 32%						36%	
NRC (1994)	32%	27%	31%	37%	24%			
NRC (2012)						34 – 34.5%	34%	34 – 35% (Gestation) 40% (Lactation)
Ravindran et al. (2013)	31 – 32%				24 – 25%			
Rostagno et al. (2017)	37%	31 – 32%		37 – 39%	29%	33%	33%	34 – 35% (Gestation) 40% (Lactation)
Warnick and Anderson (1973)			34.5%					
Wessels et al. (2016)						28%		

Conclusion

Histidine is an essential amino acid that becomes more limiting with increasing levels of vegetable-based ingredients and when reducing the dietary CP levels. Reducing CP content of a practical corn-soybean meal diets for poultry and swine requires supplementation of additional synthetic amino acids to reduce possible negative effects on performance. Aside from its role in protein metabolism, histidine also has functional benefits for specific metabolic roles to improve both the quality and quantity of end-products. Additional studies are recommended to identify the histidine requirements of animals fed with low CP diets and in different stages of reproduction for both poultry and swine.

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