Effects of dietary L-arginine on reproductive performance in egg-laying poultry

Abstract

Arginine is a precursor of protein, creatine, proline, polyamines, and nitric oxide. It is one of the key essential amino acids for poultry because they cannot synthesize arginine like mammals. Recent investigations suggested that the dietary arginine level has significant positive effects on production performance of egg-laying hens.

Based on the available literature, this article main summarized the effects of dietary L-arginine on the production performance in broiler breeders, hens, ducks and other poultry during laying.

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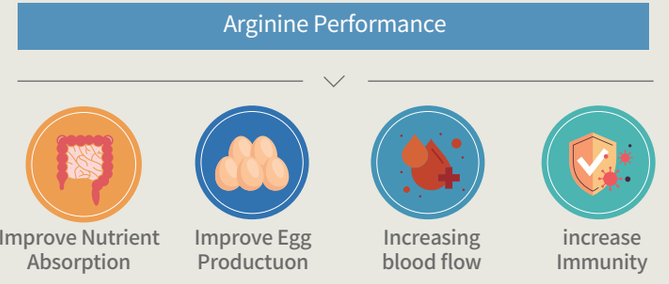
Introduction

For poultry, arginine is an essential amino acid due to the lack of carbamoyl phosphate synthetase and have limited activity of hepatic arginase and ornithine transcarbamoylase.

Arginine has several beneficial effects, Nitric oxide is one of the Arginine metabolite which serve as natural blood vessel relaxer/dilator as a result increasing blood flow and nutrient supply which ultimately improve production performance of hens.

Arginine have been reported to significantly increase IgM, total protein and albumin content in serum which ultimately improve cellular and humoral immunity.

Additionally Arginine has been reported to improve gut health leading to higher nutrient absorption and higher egg production. (Li et al., 2021; Tan et al., 2013; Yazdanabadi et al., 2020). Recent study has found that high arginine level diet positively stimulated the expression of gonadotropins, NO, and IGF-1 in laying hens fed low protine diets. (Uyanga et al., 2022). Based on these advantages, arginine supplementation in laying feed is necessary to met arginine requirements peak laying period.



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Effects of dietary L-arginine in broiler breeder hens

Several studies have investigated the effects of dietary L-arginine on the performance and reproductive traits of broiler breeder hens. Silva et al. (2012) reported that dietary digestible Arg levels quadratically influenced egg production ($p<0.05$), with the highest production obtained when 1.262% digestible Arg was supplemented. Similarly, Duan et al. (2017) added L-arginine at levels of 0.2%, 0.4%, 0.6% in corn-soybean meal-based diets for 7 weeks, demonstrated that broiler breeder hens in 1.36% digestible arginine group has the highest laying rate. Moreover, the total antioxidant capacity in hens' serum, egg yolk, and liver and breast of one-day-old offspring also reached the highest level in 1.36% digestible arginine group.

It is known that physiological levels of arginine and nitric oxide have antioxidative properties. Gou et al. (2017) found that the laying rate and the ratio of glutathione to oxidative glutathione in plasma was the greatest, when Arg:Lys ratio were 1.38% and 1.19% in broiler breeder hens' diets. Thus, we speculate that the quality and the antioxidant ability of offspring could affected by the dietary arginine level of the broiler breeder hens.

Effects of dietary L-arginine in laying hens

As an essential amino acid for laying hens, arg-induced differences might cause diverse initial conditions for hens at the beginning of laying that could serve as carry-over effect from rearing to laying. Lieboldt et al.(2016) compared the production performance of four high/low production strains layers fed with arginine deficient diet.

Parameters fitted to Gompertz function suggested that high performing strains were more sensitive to arginine deficiency in both body weigth and laying performance in 25 weeks.

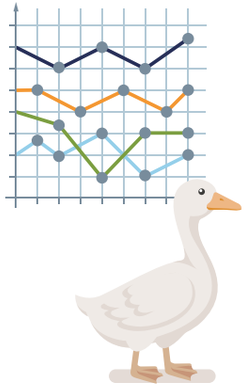
Additionally, breeder recommendation estimated in control environment are relatively low, which causes a big difference in practice field. Yuan et al. (2016) demonstrated that increasing level (from 0.64 to 1.27%) of arginine in the feed of laying hens had a significant quadratic effect on feed intake, daily egg weight, laying rate. And based on quadratic broken-line regression analisis, the arginine require ment was 1.26% and 1.28% of the diet for feed intake and egg mass, respectively. The arginine requirement for laying hens was 0.72-0.75% of the diet considering NCR (1994) .

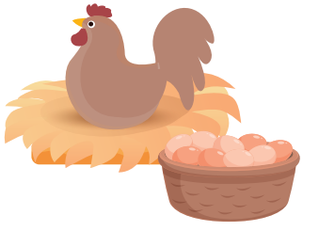
Effects of dietary L-arginine in laying ducks

Appropriate levels of L-arginine may also have positive effects on the nutritional composition of egg yolk and immune indicators in poultry. Wei et al.(2016) added L-arginine at level of 0.20%- 0.80% =in laying ducks diet, increased the yolk color score and the yolk percentage, where the maximum values were obtained with 1.26% arginine. And the total shell percentage and shell thickness was also increased by arginine supplyment, where the maximum values at 1.46% arginine. Similarly, Lei et al. (2019) increased dietary Arg:Lys ratios from 0.87% to 1.34% by adding L-arginine, increased total egg weight, yolk weight and the arginine concentration in the yolk of laying ducks. Latest, Yan et al. (2023) compared the differences between high egg ang light egg weight ducks by integrating transcriptomic and serum metabolomic analysis, speculated that arginine may be a key biomarker influencing differences in egg weight in ducks. For laying ducks, they are particularly susceptible by low temperatures because of the problem heat preservation in floor rearing system. Shu et al.(2018) added 0.2%, 0.5% and 0.8% L-arginine, to the diet of ouxian Sesame ducks during early egg laying and found that upplementing 0.57%-0.59% L- arginine (Arg:Lys=1.4%-1.42%) could improve the laying rate and liver antioxidant capacity of ducks under low-temperature in winter.

Effects of dietary L-arginine in laying quails

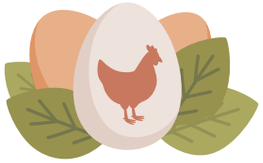
L-Arginine also has a positive impact on the production performance of Japanese quail. Lima. et al. (2022) found that, egg production of Japanese quail was only 10% when 0.361% arginine was added to the feed, but recovered to 97% when 1.3% arginine was added. Therefore to acheive maximum egg production, the recommended dietary level of arginine is 1.2%, with a daily arginine intake of 290 mg/bird. Arginine can alleviate the adverse effects of heat stress in breeding quail. Kalvandi et al. (2022) found that supplementation of arginine at 1.15 times, 1.30 times, and 1.45 times the recommended level according to NRC (1994) can mitigate the detrimental effects of heat stress on egg production, reproduction traits, egg quality, antioxidant capacity, and immune function in breeding quail.





Conclusion

In summary, dietary arginine has numerous positive effects during laying period, including improved egg production, enhanced egg quality, improved immune function, enhanced antioxidant capacity, and better gut health. Thus, due to physiological differences and body size variations among poultry species and strains, the mechanism of arginine metabolites and their effects between different species still needs substantial research.



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