Importance of L-arginine in poultry reproduction

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Introduction

The genetic improvement of poultry through breeding has produced broiler chickens capable of achieving the higher slaughter weight, carcass yield and the lowest feed conversion rate. However, this success seems to be in contradiction with the decrease in roosters fertility after 45 weeks of age (Leão et al. 2017). Also, the reproductive compromise of broiler breeders hens is negatively affected (Sharideh et al. 2016) during the second laying phase. Arginine, an essential amino acid for poultry, is a substrate for the biosynthesis of various essential compounds, including proteins, nitric oxide, creatine, ornithine, glutamate, polyamines, proline, glutamine, agmatine and dimethylarginase that influence important biological functions in the body of birds (Youseef et al, 2015). Arginine is considered one of the most versatile amino acids for animal cells (Wu & Morris, 1998). In this context, the main objective of this article is to demonstrate the influence of arginine on the reproduction of poultry.

Effect of L-arginine on Poultry Reproduction

The reproduction parameters commonly measured in the 1 day old chicks and fertile eggs production are not sufficient to understand the effect of a nutrients on the reproduction of poultry. Photosensitization in the synthesis of reproductive hormones is a natural factor in poultry during the reproduction phase. However, the relationship between nutrients and hormonal signaling seems to be a crucial point that must be investigated in detail. In human medicine, a diet with poor nutrient profile has a direct correlation with low hormonal signaling. Vitamins, microminerals and proteins are fundamental bases for enzymatic cofactors, synthesis and regulation of several hormones, guaranteeing perfect cell function (Mattoso 2013). In broiler breeder nutrition, the concept is no different. Research with supplemental arginine, exceeding the nutritional requirement, have been shown to increase sexual behavior, justifying the need to establish the adequate consumption of nutrients/bird/day for the optimal rate of egg production, fertility and hatchability.
Ahanger et al.(2017) studied the effect of L-arginine on semen quality and testosterone concentration in 37-week-old roosters, and observed heavier testicle weight, higher testosterone level (Fig. 1A), volume (Fig. 1B) and sperm motility in roosters fed with 2.33 kg of L-Arg/ MT of feed ($P<0.05$).

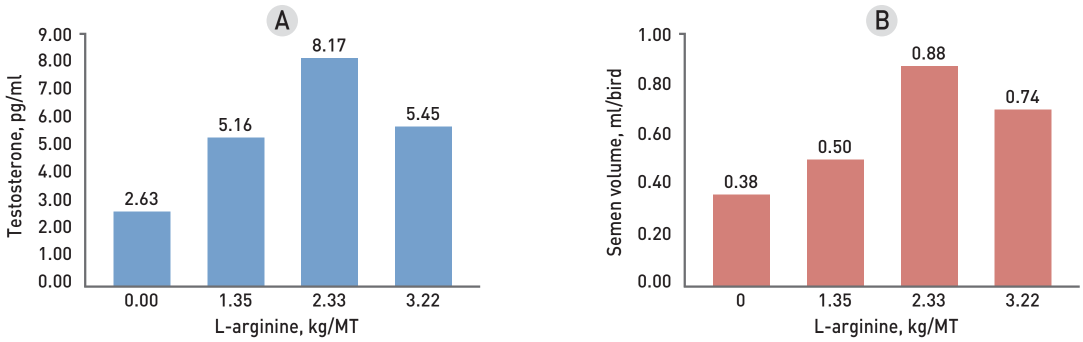

Figure 1. Exceeding the nutritional requirement of arginine impacts the plasma testosterone (A) or semen volume (B) of 37-week-old roosters.

According to Ahanger et al (2017) the increase in the weight of the testicles of roosters fed with L-arginine, may be related to the higher testosterone level, which is also important in spermatogenesis. Arginine is the only substrate for the synthesis of nitric oxide (NO) whose role is crucial in several physiological processes in the body of animals; including, neurotransmitters, vasodilators, cytotoxicity and immunity (Mohamed, 2010). NO stimulates penile erection and relaxes blood vessels, improving the libido of animals (Chen et al 2017). Muhamed (2010) and Sharideh et al. (2016), reported NO increases intracavernous pressure and vasodilation of cGMP dependent synthesis in smooth muscle cells, increasing blood flow in both male and females reproductive organs. L-arginine can increase antioxidant capacity and reduce lipid peroxidation, protecting sperms from oxidative damage (Chen et al. 2017). According to Kumar, et al. (2008) NO plays an important role in the central control of body homeostasis, including steroidogenesis and spermatogenesis. According to McCann et al. (2003), NO via cGMP induces ovulation in females. NO synthesis in the ovary and vascular endothelial cells regulates follicles development, ovulation and corpus luteum formation in rats (Zackrisson et al. 1996). Supplemental arginine fed over the nutritional requirement in breeding poultry diets, Basiouni (2009), observed a elevated rate of luteinizing hormone (LH) when compared to the control treatment (Fig. 2).

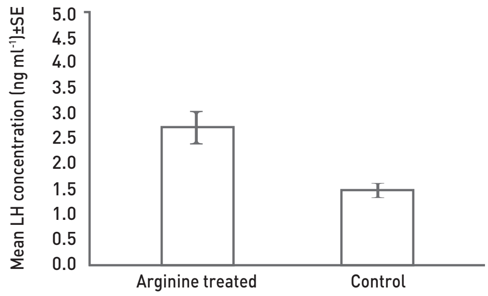

Figure 2. Average LH concentration 9 to 6 hours before oviposition of birds fed with arginine or a control diet.

This effect suggests that the improved performance of broiler breeders may be related to the effect of arginine on LH signaling the secretion that triggers ovulation and the development of the corpus luteum in addition to coordinating progesterone secretion. In order to understand about arginine supplementation in the diet of broiler breeders hens, Silva et al. (2012) used 360 females and 30 Ross males from 25 to 56 weeks of age and 5 levels of digestible ARG (0.943%; 1.093%; 1.243%; 1.393%; 1.543%) with 6 replicates of 12 females and 1 male (received no supplementary ARG) each. There was a quadratic effect (y = 4.21330 + 0.1239X-0.0004908X2 R2: 0.53) in egg production with optimum results for those birds fed with 1.243% digestible ARG level (Fig. 3A). Although the hatchability of the eggs was not affected (P> 0.05) by the treatment, an improvement of 2.55% in the egg hatchability was observed at 1.243% of digestible ARG diet as compared to the control treatment (Fig. 3B).

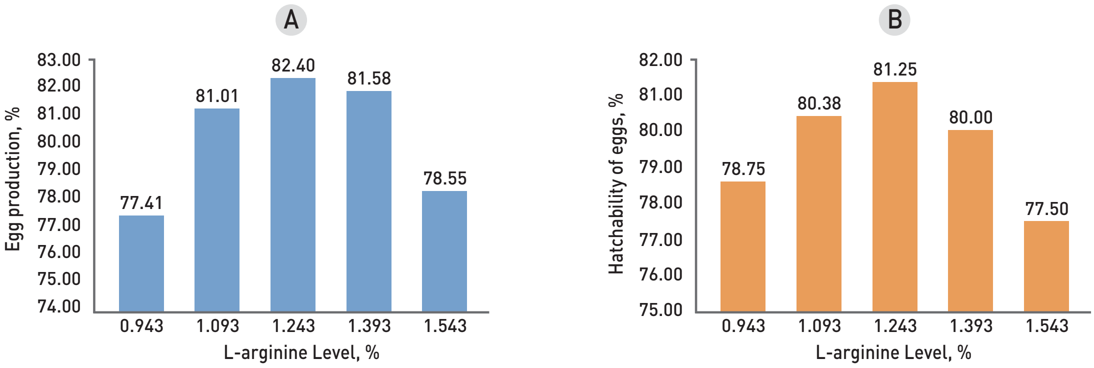

Figure 3. Effect of arginine on egg production (A) and hatchability (B) in broiler breeders from 25 to 56 weeks of age.

Najib and Basiouni (2004) found increased egg production by increasing the arginine level by 1.5% in relation to the requirement presented in the Leghorn strain manual. The results above indicate that the versatility of arginine is beyond the antagonistic understanding of the arginine: lysine ratio or protein metabolism. Feeding arginine at level in excess of nutritional requirement in poultry with high reproductive performance can bring auxiliary benefits via hormonal signaling, especially when the nutritionist aim is to enhance geriatric nutrition (adequacy of nutrients with advancing age of birds) in order to maintain reproductive longevity with the optimum profitability.

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