

AMINO ACIDS

Arginine is a key to health and wellbeing specially under stress conditions

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Abstract

Arginine as a multifunctional amino acid plays important roles under heat stress and diseases in terms of adaptation and optimum growth. Heat stress causes a reduction in feed intake, reduces blood flow to internal organs thus exerts a challenge to the intestine and to the growth of animals. Diseases can exert similar negative effects. Coccidiosis is the most prevalent parasitic disease in poultry production causing huge economic losses. Herein, we review the potential of arginine as part of a solution for the industry to cope well with stress conditions. Animals fed with diets supplemented with L-arginine at or above recommendations could benefit from both extra growth and from the beneficial effects beyond growth such as ameliorating negative effects of the stress caused by heat or diseases.

Arginine a multifunctional amino acid

Arginine is a multifunctional amino acid involved in different physiologically relevant metabolic pathways (Figure 1). Nowadays, animals are subject to different stress factors. Two importance stress factors are: heat stress and diseases both of which arginine plays an important role in terms of adaptation and optimum growth. Different actions can be taken to minimize the impact of stress. Nutritional modifications such as higher energy and digestible lysine (dig Lys) in diet are common. Modification of dietary arginine content without increasing feed crude protein content is highlighted in the newest publications (Morales et al., 2021).

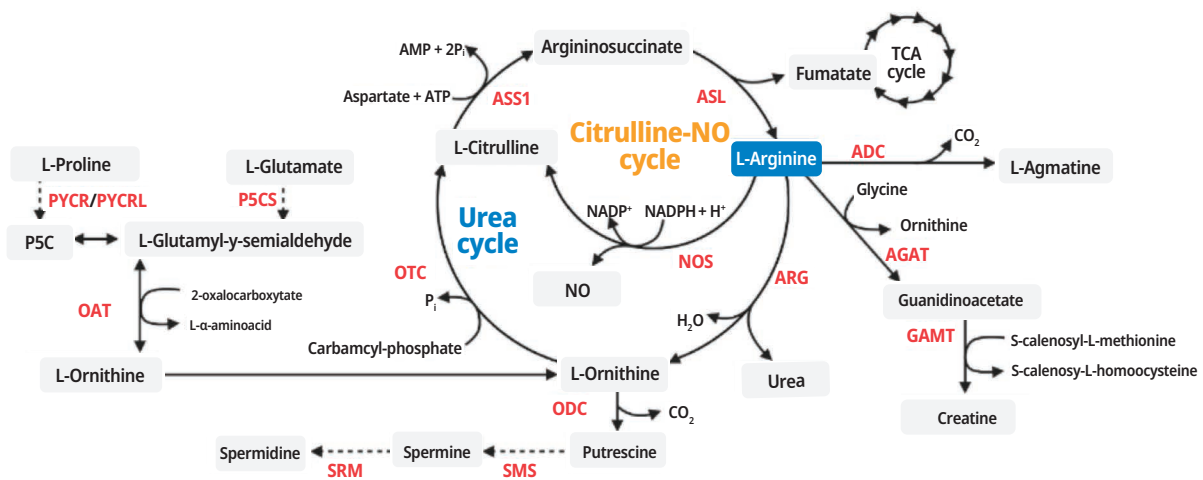


Figure 1. Overview of pathways involved in arginine metabolism

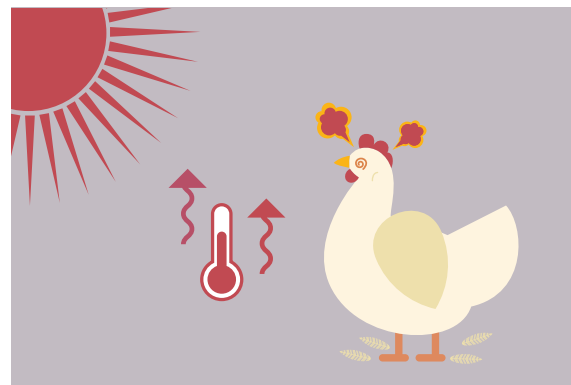
AGAT arginine:glycine amidinotransferase, GAMT guanidinoacetate N-methyltransferase ARG arginase, NOS nitric oxide synthase, ASL argininosuccinate lyase, ODC ornithine decarboxylase, ASS1 argininosuccinate synthase 1, OTC ornithine carbamoyltransferase, SMS spermine synthase, SRM spermidine synthase, P5CS delta-1-pyrroline-5-carboxylate synthase, PYCR pyrroline-5-carboxylate reductase, PYCLR pyrroline-5-carboxylate reductase-like, OAT ornithine aminotransferase (adapted from Lindez and Reith, 2021).

Get support of arginine under heat stress

Warm season is coupled with heat stress. Even in Europe, farmers have been facing heat stress conditions repeatedly in recent years. Heat stress causes a reduction in feed intake, reduces blood flow to internal organs thus exerts a challenge to the intestine and to the growth of animals (Morales et al., 2018).

There are different management actions to be taken to control the negative effects of heat stress on animals; among other actions, nutritional modifications are typically considered including an increase in the energy and dig Lys content of feed (Morales et al., 2018). Recently, Morales et al. (2021) presented the importance of adding 0.16% L-arginine to the diet of 25 kg pigs. Addition of 0.16% L-Arg to pigs feed improved small intestine functionality and consequently improved amino acid absorption through an increase in the abundance of amino acid transporters in the intestine and an increase in the seral amino acid concentration was observed. Pigs fed with 0.16% L-arginine had also lower respiratory frequency compared with the control group showing a higher respiration rate.

Aviagen recommends higher dig Arg in addition to higher dig Lys, dig Met+Cys, dig Trp and dig Thr for breeder turkeys (Aviagen turkeys). For broilers, Aviagen recommends to increase amino acid digestibility rather than density. Also, amino acids need to be balanced to minimize protein excess (Asensio, 2016). Broilers responded to higher dig Arg levels in their feed under higher thermal conditions (Brake et al., 1998) and it was assumed to be related to lower Arg absorption from intestinal epithelium under heat stress condition.



Get support of arginine under disease challenges

Coccidiosis is the most prevalent parasitic disease in poultry production caused by protozoa of the genus *Eimeria* (Williams, 2005). The annual cost with coccidiosis surpasses £38 million in the United Kingdom, which includes losses associated to prophylaxis, treatment, and subclinical effects on the performance (Williams, 1999).

Arginine supplementation is demonstrated to improve the total antioxidant capacity in quails and broiler breeders (Atakisi et al., 2009; Duan et al., 2015). Moreover, Arg is a strong superoxide and hydroxyl radical scavenger, and its supplementation increases the activity and expression of important molecules in the antioxidant system, such as glutathione and superoxide dismutase (SOD) (Liang et al., 2018).

Nitric oxide, which is derived from Arg (Figure 1), is an important vasodilator and immune-modulator and to promote metabolic regulation by increasing hormone sensitive lipase and downregulating genes associated with lipogenesis and gluconeogenesis (Moncada et al., 1991; Jobgen et al., 2006; Morris, 2006; Khajali and Wideman, 2010), as well as to have direct toxic effect on other protozoa parasites (Vespa et al., 1994; Alvarez et al., 2011).

Recently, Castro et al. (2020) showed that dietary arginine levels ranging from 1.24 to 1.44% improves overall growth, intestinal integrity and morphology in broilers subjected or not to *Eimeria* challenge.

Conclusions

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Animals fed with a diet supplemented with L-arginine at or above recommendations could benefit from both extra growth and from the beneficial effects beyond growth such as ameliorating negative effects of the stress caused by heat or diseases.

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