

## EFFECT OF ARGININE SUPPLEMENTATION ON GROWTH PERFORMANCE AND IMMUNITY OF BROILERS: A REVIEW

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Poultry meat is the main and cheap source of animal protein and fulfilling the protein requirement of growing population of the world. However, maximum growth of broilers is obtained by supplementing various nutrient through diet both from natural and artificial sources. Amino acids are one of the major nutrients required for optimum growth of broilers. Amino acids are building blocks of protein and regulate different pathways which are necessary for growth, maintenance, feed conversion ratio (FCR) and immunity in birds. Amino acid in the diet of broiler belong from both natural and artificial sources. Among amino acids required for growth and immunity of broilers arginine is an essential amino acid that should be supplemented through diet. This review will provide the insight that how different levels of arginine influence both performance parameter and immunity in the broilers. Based on the review we concluded that arginine level of 1.20-1.25% during starter phase and 1.10% during finisher phase is essential to optimize the performance; however, arginine level of 1.20% in the broiler diet is optimum to maintain antibiotic titer of bird that will help to resist birds against the different infectious disease. Therefore, it is recommended that arginine level should be maintained in the diet for optimum performance and immunity in broilers.

**Keywords:** Arginine, animal protein, feed conversion ratio, immunity, broilers.

### INTRODUCTION

The increasing demand of animal protein can be fulfilled by raising meat type broiler chicken (Hussain *et al.*, 2015). Broiler meat is a cheap source of animal protein which is available in local market for consumption, but the demand is increasing day by day. For this purpose, different levels of amino acids can be added in feed to improve growth performance, feed conversion ratio (FCR), metabolism and immunity of the broiler birds. Amino acids are building blocks of protein and regulate different pathways which are necessary for growth, maintenance, feed conversion ratio (FCR) and immunity in birds (Ball *et al.*, 2007). Arginine is considered an essential amino acid for poultry because broilers are unable to synthesize arginine due to lack of major key enzymes like ornithine carbamoyl-transferase and hepatic arginase in the urea cycle (Fouad *et al.*, 2013).

Arginine plays an important role in protein synthesis, growth, immunity and some metabolic pathway (Khajali and Wideman, 2010). Arginine stimulates the release of insulin, insulin-like growth factor and growth hormone in the bloodstream (Silva *et al.*, 2012). The NRC requirement of arginine is 1.25% from 0 to 21st day and 1.10% from 22<sup>nd</sup> to 42<sup>nd</sup> day of the life of broiler birds. These higher arginine requirement in broiler are because of low synthesis of

endogenous arginine and deposition of protein for rapid growth (Ball *et al.*, 2007). Kidd *et al.* (2001) reported that increasing arginine improved growth performance. Similarly, recent study demonstrated that body weight (BW) and FCR improved in birds with increasing the arginine level in the diet of broilers (Ale Saheb Fosoul *et al.*, 2019). Likewise, Castro *et al.* (2019) showed that body weight gain (BWG), FCR and FI was more in broilers birds supplemented with arginine. However, decreasing the level of arginine as compare to recommended NRC level results in decrease growth rate and immunity in broilers (Ale Saheb Fosoul *et al.*, 2019; Jiao *et al.*, 2010; ). Jiao *et al.* (2010) reported that carcass yield, quality and breast muscle yield were lower in birds fed arginine deficient diet. Likewise, Ale Saheb Fosoul *et al.* (2019) concluded that birds fed arginine deficient diet had lower BW and poor FCR than birds fed optimum arginine diets. However, a compiled data on arginine levels on growth performance, FCR, metabolism and immunity of the broiler birds is not available. This review will provide the brief note on the effect of different levels of arginine on the growth performance, FCR, metabolism and immunity of the broiler birds.

**Effect of arginine on the growth performance of broilers:** Growth performance and BWG is mainly dependent upon the dietary amino acid supplementation which are building blocks

of proteins (Ball *et al.*, 2007). A balanced broiler diet having adequate levels of amino acid is necessary to maintain the growth performance of broiler. Cengiz and Kucukersan (2010) reported that feeding broilers according to NRC recommendation of arginine results in higher BWG as compare to lower level of arginine.

Recent study of Barekatin *et al.* (2019) reported that reduced protein (RP) @ 5g/kg arginine in broiler bird's diet resulted in reduced BWG during finisher phase (22-35 days) and overall phase (7-35 days). Influence of body weight by arginine level has also been investigated in another recent study of Castro *et al.* (2019). Castro *et al.* (2019) reported that by increasing the arginine level from 70 to 110% of recommend requirement of broilers enhanced the BWG, however, the maximum supplementation should be @100 %. But other researchers reported increased BWG when arginine level in feed of broilers were increased from 0 to 1.35% (Xu *et al.*, 2018). Similarly, in other study it is reported that increasing the arginine level from 1.10 to 1.34% increase BWG (Atencio *et al.*, 2004). Contrary to previous findings, Fouad *et al.* (2013) reported that BWG were not affected as the arginine supplementation was increased from 0.25 to 1%. Likewise, Emadi *et al.*, 2010 reported that increasing the arginine level from 0.52 to 2.08% in the diet of broilers increased the BWG in the finisher phase. The contradiction of results of supplementation of arginine above the recommended level and its variable influence on body weight of the broilers could be due to several reason including age, sex, strain of bird as well as region of where birds are rearing. However, based on based on review, it seems that maintaining the arginine level of 1.20-1.25% in diet during starter phase and 1.10% during finisher stage optimize the growth performance of broilers which is higher than the NRC recommended level. Therefore, it is suggested that further research is required to optimize the level of arginine based on age, sex, strains of broilers and rearing conditions.

**Effect of arginine on feed conversion ratio:** Converting of feed into meat by broilers is also influenced by various nutritional, managemental and genetic condition of broilers. It has been reported that FCR is mainly dependent upon the dietary amino acid supplementation which are building blocks of proteins (Ball *et al.*, 2007). A balanced broiler diet having adequate levels of amino acid is necessary for better FCR in broilers birds. Arginine is one of the essential amino acid which play an important role in better FCR in broiler birds both in starter phase and growing phase (Barekatin *et al.*, 2019; Castro *et al.*, 2019).

Recent study of Barekatin *et al.* (2019) reported that reduced protein (RP) by altering arginine @ 5g/kg in broiler birds diet causes poor FCR during starter phase (7-21 days). Effect of arginine level on FCR in broilers were further supported by Castro *et al.* (2019) who reported that increasing the arginine level from 70 to 110% of recommend requirement of broilers reduced feed intake and FCR. Similarly, in other study it is

reported that increasing the arginine level from 1.10 to 1.34% reduce FCR (Atencio *et al.*, 2004). Likewise, Mendes *et al.* (1997) reported an improvement in FCR as the arginine to lysine ratio in the broiler diet was increased. In another study Emadi *et al.* (2010) supported the previous findings and reported that FCR improved as the arginine level was reduced from 3.35 to 1.10%. Similarly, Liu *et al.* (2019) reported that FCR was optimum when 14.7 g/kg arginine was supplemented in the broiler diet. Ebrahimi *et al.* (2014) reported that as the arginine supplementation in the broiler diet was increased from 100% of requirement to 183%, the FCR improved significantly. Likewise, Jahanian and Khalifeh-Gholi (2018) reported that arginine supplementation according to NRC recommendation improved the FCR of the broiler birds.

Contrary to previous findings, it has been reported that increasing the level of arginine in the diet of broilers both in starter and grower phase don't influence the FCR (Bulbul *et al.*, 2013; Fouad *et al.*, 2013; Xu *et al.*, 2018). Increasing the arginine level from 90 to 130% of the requirement suggested by NRC results in similar FCR with recommended level of arginine (Bulbul *et al.*, 2013) Similarly, findings has been reported by Fouad *et al.* (2013) who found that FCR was not affected as the arginine supplementation when it was increased from 0.25 to 1%. Supporting these findings, Xu *et al.* (2018) also reported that FCR was not effective when dietary arginine supplementation was increased from 0 to 1.80% in the broiler diet. Likewise, it has been reported that when arginine supplementation is done 0.2 and 0.4% over and above NRC recommendation in canola meal-based diet, FCR was not effected (Khajali *et al.*, 2011). Another study supported these findings and reported that FCR was not affected when arginine supplementation was increased from 100% of NRC recommendation to 120% (Kidd *et al.*, 2001). The contradiction of results of supplementation of arginine above the recommended level and its variable influence on FCR of the broilers could be due to several reasons including age, sex, strain of bird as well as region of where birds are rearing. However, based on based on review, it seems that maintaining arginine level of 1.10% in the broiler is necessary to optimize the feed conversion ratio. However, this requirement can vary according to the genetics and environmental conditions.

**Effect of arginine on the immunity:** The immunity is an important aspect as it saves birds from the disease and infectious agents. Arginine acts as a precursor for different components including nitric oxide which acts as a potent vasodilator and an important component of macrophages in birds which are involved in phagocytosis and thus improve immunity (Khajali and Wideman, 2010).

Increasing levels of arginine supplementation above the recommended level of NRC from 0.02 to 0.06% results in increase in red blood cells (RBC), hemoglobin, packed cell volume (PCV) and total leucocytes (WBC) while significant

**Table 1. A short overview of influence of arginine levels on growth performance, feed conversion ratio and immunity in broilers.**

Dietary Arginine Levels	Results	Source
<b>Body Weight Gain</b>		
90 to 130%	Highest body weight gain @ 110% L-Arg supplementation	(Bulbul <i>et al.</i> , 2013)
70, 80, 90, 100 and 110%	Body weight gain was maximum at 100% Arg.	(Castro <i>et al.</i> , 2019)
25, 50, 75 and 100%	Maximum body weight gain at maximum Arg. level	(Cengiz and Kucukersan, 2010)
0, 0.45, 0.90, 1.35%	Maximum body weight gain at maximum Arg. level	(Xu <i>et al.</i> , 2018)
<b>Feed conversion ratio</b>		
70 to 110 (0.73 to 1.05%)	Decrease FCR with increasing arginine level	(Castro <i>et al.</i> , 2019)
1.10 to 1.34%	Decrease FCR with increasing arginine level	(Atencio <i>et al.</i> , 2004)
1.10 to 3.35%	Increased FCR when arginine level was increased to 3.35%	(Emadi <i>et al.</i> , 2010)
0.25 to 1%	No significant effect on FCR	(Fouad <i>et al.</i> , 2013)
<b>Immunity</b>		
0.02, 0.04 and 0.06%	Higher RBC, hemoglobin, PCV and WBC while there is lower heterophil to lymphocyte ratio (H/L) ratio	(Hazim J. Al-Daraji and Salih, 2012)
90, 100, 110, 120 and 130%	Higher antibody titers for the infectious bursal disease @ 110% Arg.	(Bulbul <i>et al.</i> , 2014)
25, 50, 75 and 100%	Similar antibodies titers	(Cengiz and Kucukersan, 2010)
90, 100, 110 and 120%	Higher antibodies titers at higher Arg. level	(Kidd <i>et al.</i> , 2001)
90, 100 and 110%	Relative weight of bursa of Fabricius and spleen increased in birds fed 100% Arg.	(Jahanian and Khalifeh-Gholi, 2018)
90, 100, 110, 120 and 130%	Arg. Levels 120 and 130%, relative weight of spleen was more. 110% arginine level had more weight of bursa of Fabricius weight	(Bulbul <i>et al.</i> , 2014)
25, 50, 75 and 100%	Higher spleen weight at higher level of arg.	(Cengiz and Kucukersan, 2010)

decrease in heterophil to lymphocyte ratio (H/L) (Al-Daraji and Salih, 2012). Arginine level also influence the antibody titers for various diseases (Bulbul *et al.*, 2014). Jahanian and Khalifeh-Gholi (2018) reported that increasing the level of arginine 100% in the diet of broilers results in increase in antibodies titer. Similarly, Bulbul *et al.* (2014) reported that the antibody titers of infectious bursal disease (IBD) was more in the grower phase of broiler fed arginine level 110% as compare to NRC recommended level. Levels of arginine influences the weight of internal organs of the broilers which take part in the immunity of broilers (Bulbul *et al.* 2014). Bulbul *et al.* (2014) reported that increasing the level of arginine from 120 and 130% increased the weight of spleen while diet containing 110% arginine level had more weight of bursa of Fabricius. Similarly, Jahanian and Khalifeh-Gholi (2018) reported that the relative weight of bursa of Fabricius and spleen were more in birds fed 100% level of arginine. Likewise, Liu *et al.* (2019) reported that when arginine supplementation was increased from 9.8 to 23.4 g/kg, serum immunoglobulin's (IgM and IgG) were increased. Kidd *et al.* (2001) reported that when dietary arginine levels were decreased the antibody titer of the birds reduced significantly. Contrary to previous findings, it has been reported that

increasing the level of arginine in the diet of broilers both in starter and grower phase don't influence the immunity parameters (Cengiz and Kucukersan, 2010). Cengiz and Kucukersan (2010) reported that antibodies titers were not affected by arginine supplementation according to NRC recommended level and increasing the level of arginine in the diet had no effect on immunity parameters.

The contradiction of results of supplementation of arginine above the recommended level and its variable influence on immunity of the broilers could be due to several reasons including age, sex, strain of bird as well as region of where birds are rearing. However, based on review, it seems that maintaining arginine level of 1.20% in the broiler is necessary to optimize the immunity in broilers chicks. However, this requirement can vary according to the genetics and environmental conditions.

**Conclusion:** The arginine level of 1.20-1.30% during starter phase and 1.05 to 1.10% during finisher phase is essential to optimize the performance however, arginine level of 1.20% in the broiler diet is optimum to maintain antibiotic titer of bird that will help to resist birds against the different infectious disease. Therefore, it is recommended that arginine

level should be maintained in the diet for optimum performance and immunity in broilers.

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