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Effect of dietary L-arginine on carcass traits of broilers

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Abstract

A total of 300 one day old Ross 308 broiler chicks were used to examine the effect of supplementing ration with different levels of arginine on productive performance of broiler chickens. The chicks were allocated to 4 treatments groups (75 chicks for each group) and each treatment consisted of five replicates of 15 chicks each. The treatment groups were C, the control group (without any addition of arginine); T1, T2 and T3 groups in which arginine were included in the diet at levels of 0.02, 0.04 and 0.06 %, respectively. Two types of diets were used over the period of experiment, starter diet was used from one to 20 days of chicks' age and then grower diet was used till the end of the experiment (46 days of age). The results revealed that adding arginine to broiler diet especially at the level of 0.04% (T2) and 0.06% (T3) significantly increased ($P<0.05$) carcass weight, dressing percentages, percentages of breast, thigh and drumstick cuts. However, back and wing percentages decreased significantly in treated birds compared to control. The study concluded that arginine can be used as effective feed additive for improving productive performance of broilers.

Key words: Arginine, Carcass Traits, Broiler Chickens

Introduction

Birds appear unable to synthesize the amino acid arginine via the urea cycle, this may be due to lack of carbamoyl phosphate synthetase I in the mitochondria and as a result, birds' dietary requirement for arginine is higher than that of growing mammals (Boorman and Lewis, 1971; Kidd et al., 2001). However, it was reported that birds appear to have carbamoyl phosphate synthetase II in the cytosol. This may be part of the multi enzyme protein CAD (carbamoyl phosphate synthase—aspartate carbamoyl transferase—dihydroorotase) that is responsible for the biosynthesis of dihydroorotate, a pyrimidine precursor. But this is bound on the multi enzyme protein, and it seems unlikely that it would be available for arginine biosynthesis (Lewis, 1996). Corzo and Kidd (2003) indicated that the chick has considerably acute need for dietary arginine at an early age possibly associated with immune system development and early microbial challenges. Furthermore, arginine affects immune status of chicken. Diet supplementation with arginine at levels above that recommended for the starter phase may be necessary for improved muscle development in broilers (Fernandes et al., 2009).

Arginine is a protein constituent that is involved in the secretion of insulin by pancreas β cells (Bolea et al., 1997). It is suggested that L-arginine potentiate glucose-induced insulin secretion that occurs independently of nitric oxide (Thams and Capito, 1999), and involves in the secretion of growth hormone (GH) (Merimee et al., 1969). The effects of GH are mediated by insulin-like growth factors (IGF-I and IGF-II) (Le Roith et al., 2001). IGF is known to trigger numerous anabolic effects on the metabolism of skeletal muscles such as the proliferation and differentiation of satellite cells (Florini et al., 1996) and the aggregation of myofibrillar protein through its combined effects on the synthesis and degradation of proteins (Duclos, 2005). However, arginine is involved in the secretion of growth hormone, chickens rely totally on the dietary supply of arginine. Uricotelic species (i.e., birds) cannot synthesize arginine because they have an incomplete urea cycle. Past researches have clearly demonstrated the importance of providing chickens adequate dietary arginine to support growth

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responses (Cuca and Jensen, 1990). Arginine like most amino acids is traditionally noted for its role in protein synthesis. Many studies recognized the importance of arginine on growth in broiler (Deng et al., 2005). This study was conducted to examine the effect of adding different levels of arginine to the diet on carcass traits of broilers.

Materials and Methods

A total of 300 one day old Ross-308 broiler chicks were housed at a well–ventilated and disinfected room and the management of the four treatment groups was identically carried out. Feed and water were provided *ad libitum* during the whole period of experiment which lasted for six weeks. Two types of diets were used over the period of experiment. Starter diet was used from day one to 20 days of chicks' age and then grower diet was used till the end of the experiment (Tables 1 & 2). The chicks were allocated randomly for four treatment groups (75 chicks for each group) and each treatment consisted of five replicates with 15 chicks each. The treatment groups were C, the control diet group (without any addition of arginine), T1, T2 and T3 diet groups to which arginine was added at the levels of 0.02, 0.04 and 0.06 %, respectively.

At the end of the experiment (35 days), 10 birds from each treatment were randomly chosen for slaughter to evaluate the carcass traits. Before slaughter, the birds were starved for 12 hours, then weighed, slaughtered and allowed to bleed freely for about 5 minutes. After that the weight of carcass, breast, thigh, drum stick, wing, back, neck and certain organs (heart, gizzard, and liver) were determined. Dressing percentage with and without giblets was also determined.

Statistical Analysis

The Data of the experiment were analyzed by one-way analysis of variance using XLStat (version 7.5). The significant differences between the means of traits were tested using Duncan's multiple range test (Duncan, 1955).

Results

Results in Table 3 denoted that adding arginine to broiler diet especially at the level of 0.04% (T2) and 0.06% (T3) significantly increased ($P<0.05$) dressing percentages with or without giblet and carcass weight. Supplementing arginine to broiler chicken diet (T1, T2, and T3) significantly ($P<0.05$) increased the percentage of the main cuts of the carcass (breast, thigh, and drumstick) compared to control. However, the back and wing percentage decreased significantly in treated birds compared to control (Table 4).

Discussion

In the present study, arginine inclusion in the diet improved carcass yield as shown in Tables 3 and 4. This improvement may be explained by arginine's well-known effect on dilating blood vessels, primarily through increased nitric oxide production (Huk et al., 1997). This is important since it increases the amount

Table 1: Ingredients percentages of the starter diet used in the experiment

Ingredients	Control	Treatment 1	Treatment 2	Treatment 3
Yellow Corn	58	58	58	58
Soya bean meal	27	27	27	27
Protein conc.*	9	9	9	9
Wheat	4	3.98	3.96	3.94
Sunflower oil	1.5	1.5	1.5	1.5
DCP**	0.3	0.3	0.3	0.3
Salt	0.2	0.2	0.2	0.2
Arginine	0	0.02	0.04	0.06
Total	100	100	100	100
Calculated composition***				
Protein	22.01	22.00	22.00	22.00
ME Kcal/Kg	3045	3040	3040	3040
Calcium	0.74	0.74	0.74	0.74
Phosphorus	0.41	0.41	0.41	0.41
Lys.	1.3	1.3	1.3	1.3
Meth.	0.62	0.62	0.62	0.62
Meth. To Cyst.	0.96	0.96	0.96	0.96
Arginine	1.55	1.57	1.59	1.61
Arg:Lys	1.19:1	1.20:1	1.22:1	1.23:1

*Protein concentrate used in the diets was produced in Holland (WAFI) which contains: 40% crude protein, 2100 Kcal/Kg, 5% crude fat, 2% crude fiber, 6.5% calcium, 2.50% phosphorus, %3.85 lysine, 3.70% methionine, and 4% cystine; **DCP: Dicalcium phosphate; ***The calculated composition of the diets was determined according to NRC (1994).

Table 2: Ingredients percentages of the grower diet used in the experiment

Ingredients	Control	Treatment 1	Treatment 2	Treatment 3
Yellow Corn	61	61	61	61
Soya bean meal	24	24	24	24
Protein conc.*	7	7	7	7
Wheat	5	4.98	4.96	4.94
Sunflower oil	2.5	2.5	2.5	2.5
DCP**	0.3	0.3	0.3	0.3
Salt	0.2	0.2	0.2	0.2
Arginine	0	0.02	0.04	0.06
Total	100	100	100	100
Calculated composition***				
Protein	20.15	20.13	20.13	20.13
ME Kcal/Kg	3150	3145	3145	3145
Calcium	0.6	0.6	0.6	0.6
Phosphorus	0.35	0.35	0.35	0.35
Lys.	1.16	1.16	1.16	1.16
Me.	0.54	0.54	0.54	0.54
Meth. To Cyst.	0.85	0.85	0.85	0.85
Arginine	1.387	1.407	1.427	1.447
Arg:Lys	1.19:1	1.21:1	1.23:1	1.24:1

*Protein concentrate used in the diets was produced in Holland (WAFI) which contains: 40% crude protein, 2100 Kcal ME / Kg, 5% crude fat, 2% crude fiber, 6.5% calcium, 2.50% phosphorus, %3.85 lysine, 3.70% methionine, and 4% cystine; **DCP: Dicalcium phosphate; ***The calculated composition of the diets was determined according to NRC (1994).

Table 3: Dressing percentages and carcass weight (Mean ± SE) of broilers fed the dietary arginine treatments

Treatments	Dressing percentage		
	Dressing percentage with giblets (%)	Dressing percentage without giblets (%)	Carcass weight (g)
C	74.05 ± 9.18^{b}	69.73 ± 10.57^{b}	1414 ± 57.13^{b}
T1	74.68 ± 8.43^{b}	70.70 ± 7.44^{b}	1432 ± 54.23^{b}
T2	79.37 ± 9.93^{a}	75.11 ± 11.07^{a}	1552.5 ± 48.22^{a}
T3	79.90 ± 7.85^{a}	75.45 ± 10.09^{a}	1582 ± 50.34^{a}

C: control group; T1, T2 and T3: added arginine to the diet of broilers at the levels of 0.02, 0.04 and 0.06%, respectively; [a, b, c]Mean on the same column having different superscript differ significantly (P<0.05)

Table 4: Carcass cuts (Mean ± SE) of broilers fed the experimental dietary treatments

Treatments	Breast (%)	Thigh (%)	Drumstick (%)	Back (%)	Wing (%)	Neck (%)
C	26.95 ± 0.65^{c}	25.61 ± 0.40^{c}	11.76 ± 1.24^{c}	20.99 ± 0.68^{a}	11.16 ± 0.44^{a}	2.34 ± 0.85^{a}
T1	28.36 ± 0.75^{b}	26.6 ± 0.98^{b}	11.83 ± 0.92^{b}	19.17 ± 0.45^{b}	11.10 ± 0.33^{b}	1.98 ± 0.48^{a}
T2	30.6 ± 0.59^{a}	27.45 ± 0.92^{a}	12.58 ± 0.79^{a}	17.39 ± 0.43^{c}	9.74 ± 0.47^{c}	2.21 ± 0.72^{a}
T3	31.75 ± 0.51^{a}	28.56 ± 0.72^{a}	13.12 ± 0.86^{a}	16.75 ± 0.52^{c}	8.47 ± 0.38^{c}	2.22 ± 0.71^{a}

C: control group; T1, T2 and T3: added arginine to the diet of broilers at the levels of 0.02, 0.04 and 0.06%, respectively; [a, b, c]Mean on the same column having different superscript differ significantly (P<0.05)

of blood flow to the muscles. The increased blood flow allows greater delivery of hormones, protein, carbohydrates and other nutrients to the muscles and therefore helps in growth of muscle (Charmusopollert et al., 2002). Increased nitric oxide levels have a positive effect on muscle mass by stimulating the rate of protein synthesis within muscle cells (Stevens et al., 2000).

Mendes et al. (1997) reported improved carcass yield and reduced abdominal fat in broilers as a result of feeding arginine. Kim et al. (2004) observed increased weight gain in swine by supplementation of arginine in the starter phase. They added that this is probably due to improving of the efficiency of nutrient usage. This process is related to the protein turnover efficiency (the net balance between protein synthesis and degradation) as defined by Tesseraud et al. (1996). It was reported that arginine facilitates muscle growth (by inhibiting muscle loss). It is required for the transport of the nitrogen used in muscle metabolism, and it improves glucose uptake into muscle cells (Barbul, 1986). Fernandes et al. (2009) reported that diet supplementation with arginine at levels above that recommended for the starter phase (1.490, 1.590, 1.690, and 1.790%) with arginine and lysine ratios of 1.103, 1.183, 1.262, 1.341, and 1.421%, respectively, may be necessary for improved muscle development in broilers. They also reported a positive effect of arginine levels on breast and breast fillet weight in the starter phase compared to control with basal diet of 1.390% digestible arginine.

Conclusion

In conclusion, dietary supplementation of L-arginine resulted in significant improvement in carcass weight, dressing percentages, main cuts of carcass of broilers. Therefore, L-arginine can be used as important feed additive for improving productive performance of broilers.

References

Barbul, A. 1986. Arginine biochemistry, physiology, and therapeutic implications. *Journal of Parenteral and Enteral Nutrition*, 10: 227- 238.

Bolea, S.J., Martin, G.F., Sanchez-Andres, J.V. and Soria, B. 1997. Regulation of pancreatic β-cell electrical activity and insulin release by physiological amino acid concentrations. *European Journal of Physiology*, 433: 699-704.

Boorman, K.N. and Lewis, D. 1971. Protein metabolism. In: Physiology and Biochemistry of the Domestic Fowl. Bell, D.J. and Freeman, B.M., (Eds.). Academic Press, New York.

Chamruspollert, M., Pesti, G.M. and Bakalli, R.I. 2002. Dietary interrelationships among arginine, methionine, and lysine in young broiler chicks may be related to arginase activity and creatine biothensesis pathways. *British Journal of Nutrition*, 88: 655-660.

Corzo, A. and Kidd, M. 2003. Arginine needs of the chick and growing broiler. *International Journal of Poultry Science*, 2 (6): 379-382.

Cuca, M. and Jensen, L. 1990. Arginine requirement of starting broiler chicks. *Poultry Science*, 69: 1377-1382.

Deng, A.K., Wong, A.C. and Nolan, A.J. 2005. Long-term effects of early life L-arginine supplementation on growth performance, lymphoid organs and immune responses in Leghorn-type chickens. *British Poultry Science*, 46 (3): 318-324.

Duclos, M.J. 2005. Insulin-like growth factor-I (IGF-I) mRNA levels and chicken muscle growth. *Journal of Physiology and Pharmacology*, 56: 25-35.

Duncan, D.B. 1955. Multiple range and multiple F – test. *Biometrics*, 11: 1-42.

Fernandes, J.I., Murakami, A.E. Martins, E.N. Sakamoto, M.I. and Garcia, E.R. 2009. Effect of arginine on the development of the pectoralis muscle and the diameter and the protein: deoxyribonucleic acid rate of its skeletal myofibers in broilers. *Poultry Science*, 88: 1399-1406.

Florini, J.R., Ewton, D.Z. and Coolican, S.A. 1996. Growth hormone and the insulin-like growth factor system in myogenesis. *Endocrinology Review*, 17: 481-517.

Huk, L., Nanobashvili, J., Neumayer, Punz, A., Mueller, M., Afkhampour, K., Mittlboeck, M., Losert, U., Polterauer, P., Roth, E., Patton, S. and Malinski, T. 1997. L-arginine treatment alters the kinetics of nitric oxide and superoxide release and reduces ischemical reperfusion injury in skeletal muscle. *Circulation*, 96: 667-675.

Kidd, M.T., Peeples, E.D., Whitmarsh, S.K., Yetman, J.B. and Wideman, R.F. 2001. Growth and immunity of broiler chicks as affected by dietary arginine. *Poultry Science*, 80: 1535-1542.

Kim, S.W., Mcpherson, R.L. and Wu, G. 2004. Dietary arginine supplementation enhances the growth of milk-fed young piglets. *Journal of Nutrition*, 134: 625-630.

Le Roith, D., Bondy, C., Yakar, S., Liu, J. and Butler, A. 2001. The somatomedin hypothesis. *Endocrinology Review*, 22: 53-74.

Lewis, S. 1996. Avian Biochemistry and Molecular Bbiology. ISBN 0 521 45510 3. Cambridge University Press. P: 12.

Mendes, A.A., Watkins, S.E., England, J.A., Saleh, E.A., Waldroup, A.L. and Waldroup, P.W. 1997. Influence of dietary lysine levels and arginine: lysine ratios on performance of broilers exposed to heat or cold stress during the period of three to six weeks of age. *Poultry Science*, 76: 472- 481.

Merimee, T., Rabinowitz, D. and Fineberg, S. 1969. Arginine initiated release of human growth hormone. Factors modifying the response in normal man. *The New England Journal of Medicine*, 280: 1434–1438.

NRC, National Research Council. 1994. Nutrient Requirements of Poultry. 9th (rev. Ed.) National Academic Science. Washington, DC.

Stevens, B., Godfrey, M., Kaminski, T. and Braith, R. 2000. High intensity dynamic human muscle performance enhanced by a metabolic intervention. *Medicine and Science in Sports and Exercise*, 32 (12): 2102-2104.

Tesseraud, S., Maaa, N., Peresson, R. and Chagneau, A. 1996. Relative responses of protein turnover in three different skeletal muscles to dietary lysine deficiency in chicks. *British Poultry Science*, 37: 641-650.

Thams, P. and Capito, K. 1999. L-Arginine stimulation of glucose-induced insulin secretion through membrane depolarization and independent of nitric oxide. *European Journal of Endocrinology*, 140: 87-93.