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GROWTH PERFORMANCE, HEMATOLOGICAL PARAMETERS, SERUM INDICES, AND HORMONE LEVELS OF KUROILER CHICKENS ADMINISTERED L-ARGININE IN DRINKING WATER

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ABSTRACT

A study was conducted to explore the effects of orally administered L-arginine on the growth performance, blood parameters, and hormonal profiles of Kuroiler chickens. A total of 270 unsexed Kuroiler chickens aged 12 weeks were used. The experiment was conducted over a five-week period using a completely randomized design, with three treatments and 3 replicates. The treatments were: no administration of L-arginine (control); oral administration of L-arginine at 165 mg/L; and oral administration of L-arginine at 330 mg/L in the drinking water given on daily basis. The results revealed significant impacts of arginine on weight gain and feed conversion ratio Specifically, the treatment with L-arginine at 330 mg/L resulted in the highest weight gain. Hematological

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parameters were notably higher in chickens given water containing L-arginine, while liver function enzymes showed a linear reduction. In the treatments where L-arginine was administered, serum glucose levels as well as cholesterol, creatinine, bilirubin, and uric acid concentrations recorded significant reductions, whereas hormone levels, including Triiodothyronine, Tetraiodothyronine, insulin, growth hormone, and insulin-like growth factor, were all significantly higher. The study concludes that the oral administration of L-arginine in the drinking water positively impacts growth performance, enhances hematopoietic activities, and increases hormone production in Kuroiler chickens. Therefore, L-arginine can be used as a supplementation to enhance poultry health and productivity.

Keywords: Food security, health, insulin tolerance, physiology, production, thyroid gland, sustainability.

INTRODUCTION

Poultry assumes a vital role in fulfilling human protein requirements owing to its distinctive characteristics, such as high fecundity, rapid growth rate, short gestation period, and exceptional efficiency in converting nutrients into premium animal protein products (Adedokun et al., 2019). The increasing need for poultry products directly stems from the growing human population. Nonetheless, indigenous poultry breeds encounter hurdles in efficiently satisfying this demand, primarily due to their restricted genetic potential concerning growth and egg production (Yakubu et al., 2023).

Farmers in developing countries frequently opt for exotic commercial broiler and layer breeds due to their enhanced capabilities in growth and egg production. However, the widespread adoption of these breeds is impeded by their high costs, particularly considering the financial limitations of farmers in these regions. Moreover, many of these exotic breeds encounter difficulties in adjusting to local climatic conditions (Teklemariam, 2017; Kpomasse et al., 2023). As a result, there is a noticeable shift towards intensification, which involves the breeding of improved dual-purpose breeds with relatively high productivity and income-generating potential (Wilson et al., 2022). These enhanced crossbred chickens demonstrate reduced nutrient requirements and greater adaptability to alternative feed sources compared to their exotic counterparts.

The Kuroiler chicken emerges as a dual-purpose breed, boasting significant potential due to its high genetic capabilities and adaptability within semi-scavenging systems (Mpenda et al., 2019). It presents a more economical choice for farmers. Originating from India, the Kuroiler chicken was initially introduced to East Africa through Uganda and subsequently disseminated to Kenya. Renowned for its quality meat and prolific egg production, this breed stands out from ordinary local birds by its scavenging tendencies, characterized by almost constant feeding behavior. Furthermore, the breed is regarded as cost-effective as chickens can sustain themselves through scavenging, eliminating the need for expensive commercial feeding. Their robust appetite contributes to rapid weight gain, facilitated by scavenging on food leftovers, grass, termites, and various other sources (Sharma et al., 2015). However, supplementing their diet with commercial chicken feed enhances their growth performance.

The proportion of Kuroiler chicken egg and meat to human protein consumption can vary based on several factors such as the size of the chicken, its growth rate, and the nutritional composition of the meat and eggs produced. A mature Kuroiler chicken typically weighs around 2.5 to 3.0 kilograms (Sharma et al., 2015). The breast meat yield of Kuroiler chickens can range from 25% to 30% of their live weight (Sharma et al., 2015; Lozano-Jaramillo et al., 2019). The average egg production can vary, generally reaching around 150 to 200 eggs per year per bird. Considering an average human protein requirement of approximately 50 to 60 grams per day (for an adult), the protein contribution of Kuroiler chicken meat and eggs to human consumption can be significant, especially in regions where protein intake is a challenge.

This dual-purpose breed harbors the potential to uplift the livelihoods of chicken-keeping communities, enhance food security by improving food and nutrition quality, and generate household income (Ngongolo et al., 2021).

Arginine plays a pivotal role in numerous physiological processes, encompassing reproduction, fetal and postnatal development, wound healing, immune function, tissue integrity, and the prevention and treatment of endothelial dysfunction. Hristina et al. (2014) propose that arginine or its precursor, l-citrulline, may present innovative and effective therapeutic strategies for conditions such as obesity, diabetes, and metabolic syndrome. In fact, due to its distinctive and positive effects on developmental and health concerns, arginine stands out among amino acids, potentially positioning it as a valuable "nutraceutical." Furthermore, it is recognized as a functional amino acid (Castro and Kim, 2020), which suggests that it regulates crucial metabolic pathways, contributing to enhancements in health, growth, and other physiological processes. Apart from serving as a precursor to creatine, arginine acts as a precursor to nitric oxide, a vasodilator that regulates blood flow. This attribute may be particularly pertinent in preventing pulmonary hypertension, a common issue in birds raised at high altitudes and/or under temperature-challenged conditions.

Arginine stands as an essential amino acid for various species, including birds, mammals, neonates, cats, fish, and ferrets, as well as adult humans under specific physiological conditions. Its importance becomes notably pronounced when dietary lysine is sufficient. In addition, this amino acid has a crucial role in modulating the protective immune response (Fathima et al., 2024), and serves as a vital substrate for the immune system.

Yang (2016) has demonstrated that arginine supplementation can diminish proteinemia and alter erythrocyte characteristics, resulting in an increase in their mean volume and a decrease in mean corpuscular hemoglobin load. Ramos-Pinto et al. (2020) observed that an excess of arginine can be used as an effective strategy for regulating both the innate and adaptive immune responses in fish.

A study conducted by Yang et al. (2016) reported positive outcomes from L-arginine supplementation and observed improvements in the immune status and yolk IgY content of layer chickens. Simultaneously, positive effects were observed on the weight of the proventriculus and duodenum, with no adverse impacts on laying performance, egg quality, or blood parameters. Additionally, Xu et al. (2018) found that supplementing L-arginine in the diet enhances performance, carcass quality, and immunity in chickens.

This study aims to explore the effects of oral supplementation on the hematological, biochemical indices, and growth hormone levels in Kuroiler chickens.

MATERIAL AND METHODS

Research location and duration of the experiment

The research was conducted at the Poultry Unit of Landmark University Teaching and Research Farm and Animal Nutrition Laboratory in Omu-Aran, Kwara State, spanning a period of five (5) weeks. Its geographical coordinates are Latitude 8.9 ^{O}N and Longitude 50.61^{O} E.

Sources of L-arginine

The L-arginine tablet (Mason L-arginine 500 mg) was procured from a reputable Veterinary pharmacy in Ibadan, Oyo-State, Nigeria.

Experimental chicks and design

The study utilized a total of two hundred and seventy (270) mixed-sex Kuroiler chickens aged twelve weeks. Ninety (90) chicks were allocated to each of the three groups (1, 2, and 3) using a completely randomized design. Within each treatment, there were three replicates, each consisting of thirty (30) chicks. The chickens were housed in clean deep litter compartments with access to orally supplemented L-arginine and feed ad libitum.

The birds received oral supplementation of L-arginine in drinking water at three treatment levels: 0 mg/L (Treatment 1, serving as the control); 165 mg/L (Treatment 2); and 330 mg/L (Treatment 3) of L-arginine in 9 liters of drinking water per replicate daily for a consecutive five-week period. Routine vaccination, medication, and other management practices were conducted following the procedures laid out by the Landmark University Ethical Committee. The diet composition included 15.74% Crude Protein (CP) and 2618 Kcal/kg metabolizable energy (ME), as detailed in Table 1 below:

Growth performance evaluation

The growth parameters, including body weight, weight gain, feed intake, and feed conversion ratio, were assessed. Chickens were weighed weekly. The weekly weight gain was determined by subtracting the initial weight of the birds from their weight at the end of each week. Subsequently, the feed conversion ratio (FCR) was computed by dividing the feed intake by the weight gain.

$$FCR = \frac{Feed\ intake}{Weight\ gain}$$

Blood and hormone assays

At the conclusion of the five-week period, three birds were randomly selected from each replicate, and venipunctures were performed at the brachial plexus. Blood samples were obtained in the morning from birds that had undergone an overnight fast. Two sets of 5 mL blood were drawn from each bird, with one set collected in EDTA-coated bottles for hematological indices and hormone assay, and the other set collected

Table 1. Diet composition.

Ingredients	%
Maize	60.00
Wheat Offal	16.00
Soya bean meal	19.60
Bone meal	2.60
Oyster shell	1.00
DL-Methionine	0.20
Lysine	0.10
Salt	0.25
Premix*	0.25
Total	100.00
Calculated Analysis:	
Crude protein (%)	15.74
Metabolizable energy (Kcal./kg)	2618.28

*Premix/kg of feed: vitamin A =12,000 IU; vitamin D3 = 4,000 IU; vitamin E, 30 IU; vitamin K3, 3 mg; thiamine, 2.2 mg; riboflavin, 10 mg; D-pantothenicacid, 7 mg; folic acid, 0.55 mg; pyridoxine, 4 mg; niacin, 37 mg; cobalamin, 0.02 mg; biotin, 0.20 mg; cholinechloride, 400 mg; iron, 85mg; copper, 8 mg; manganese, 75 mg; zinc, 69 mg; iodine, 0.4 mg; and selenium, 0.3 mg. 2 Analyzed.

in plain bottles for serum indices. Plasma and serum were obtained by centrifuging the blood at 1500×g for 20 min and stored at −20 °C until analysis.

For hematological indices and hormone assay, whole blood samples from the EDTA vacuum tube were analyzed for hematological indices using an automatic blood analyzer (ADVIA 120, Bayer, Tarrytown, NY, USA). The values of plasma insulin, insulin-like growth factor-1 (IGF-1), growth hormone (GH), and thyroid hormones (T3 and T4) were assessed using a commercial kit, COBAS model c111 (Roche Digitals, Basle, Switzerland).

The serum biochemical indices were analyzed using fully automatic biochemistry Analyzer NEUES120 (Neuvar Inc. 3790 El Camino, Ca) following strictly the manufacturer's recommendations.

Statistical analysis

All the generated data were subjected to a one-way analysis of variance with the treatment group effect using the general linear model procedure of SAS-9.03 (SAS, 2007) as follows:

$$Yij = \mu + Ti + eij$$

where: Yij = Observation measured, μ = Overall mean, Ti = Effect of L-arginine (1, 2, and 3 and 4), Eij = Random error component was normally distributed assumed. The significant differences between treatment means were determined by using Duncan Multiple Range Test (Duncan, 1955). The results were considered significantly different if $p < 0.05$ and tendencies were noted at p-values 0.10.

RESULTS AND DISCUSSION

Growth performance

Table 2 illustrates that the weight gain and feed conversion ratio (FCR) were influenced ($P<0.05$) by the oral administration of L-arginine, while the feed intake remained unaffected ($P>0.05$). Weight gain increased with the administration of L-arginine, with the highest gains observed in birds receiving a higher dosage. Total weight gain rose from 569.75 g in the control group to 653.40 g in birds administered 330 mg/L of L-arginine. Additionally, the FCR improved from 5.47 in the control group to 4.74 at the higher dose of L-arginine. These findings are consistent with Xu et al. (2018), who observed enhanced weight gain and FCR in broiler chickens supplemented with L-arginine. Similarly, Ruan et al. (2020) observed enhanced growth performance in yellow-feathered chickens fed dietary L-arginine.

The enhanced weight gain and FCR, indicative of improved growth performance in Kuroiler birds administered oral L-arginine, may stem from its role in regulating crucial metabolic pathways, thereby contributing to enhancements in health, growth, and other physiological

Table 2. Growth performance of Kuroiler chickens administered with oral L-arginine.

	Levels of L-arginine (mg/L)				
Parameters (g)	**0 mg/L**	**165 mg/L**	**330 mg/L**	**SEM ±**	***P*-values**
Initial weight	1320.50	1320.50	1320.55	0.05	2.25
ADWI (mL/bird)	44.60	46.02	52.14	1.56	0.85
Feed intake	3112.90	3094.20	3100.25	0.28	1.11
Feed intake/day	88.94	88.41	88.58	0.32	0.98
Final weight	1889.25[b]	1968.00[a]	1973.85[a]	1.58	0.02
Total weight gain	568.75[b]	647.50[a]	653.40[a]	1.20	0.05
Daily weight gain	16.25[b]	18.50[a]	18.65[a]	1.50	0.01
Feed conversion ratio	5.47[a]	4.78[b]	4.74[b]	0.60	0.01

a-b Means with different superscripts between the L-arginine levels are significantly different (P<0.05); SEM = Standard error of mean; ADWI = Average daily water intake.

processes (Kurhaluk, 2023). As an essential amino acid in avian species, its deficiency can impair the weight gain of chickens (Castro and Kim, 2020). Xu et al. (2018) previously suggested that greater arginine amounts were needed for optimal FCR. The observed improvements in FCR and weight gain in this study could also be attributed to the modulation of gut microbiota, thereby enhancing the digestion and absorption processes. L-arginine supplementation has been shown to increase the activity of digestive enzymes in the GIT of broiler chickens. This can enhance the breakdown and absorption of nutrients from feed, potentially leading to improved growth and feed efficiency. It may also contribute to maintaining intestinal barrier function and integrity (Ruan et al., 2020). This can reduce the permeability of the intestinal lining, which is beneficial in preventing the entry of pathogens and toxins into the bloodstream.

L-arginine is a precursor to nitric oxide (NO), which has immunomodulatory effects. Increased NO production can enhance the immune response in the GIT, helping to combat infections and promoting overall gut health (Kim et al., 2022). L-arginine supplementation could influence the composition of gut microbiota in Kuroiler chickens. A balanced gut microbiota is crucial for nutrient digestion, immune function, and overall health of the birds.

Impact of orally administered L-arginine on hematological indices

Table 3 shows the impact of orally administered L-arginine on select hematological indices (erythrocytes, hematocrit, hemoglobin, and leukocyte count) of Kuroiler chickens. The indices exhibited significant increases ($P < 0.05$), being consistent with the findings of Lala et al. (2022), who observed increased hematological indices in guinea fowls when fed 0-1 g of L-arginine per kg of feed. Similarly, Attia et al. (2024) also noted elevated hematological parameters in dual-purpose hens, such as Kuroiler chickens, with increased dietary L-arginine. The increases in these parameters may be explained by the enhancement of growth hormone (GH) and insulin-like growth factor-1 (IGF-1). Regarding hemoglobin, hematocrit, and leukocytes, the highest and lowest values were recorded in the highest dose of L-arginine (330 mg/L) and the control (0 mg/L arginine). Furthermore, there was an increase in leukocyte concentration. These findings agree with Ali and Zaed (2023), who also suggested that L-arginine could potentially enhance antibody production and elevate white blood cell count, thereby reinforcing disease-fighting capabilities and increasing the activity of specific antioxidant enzymes in the bloodstream. However, all hematological values in the present study fall within those reported by Bounous and Stedman (2000); the normal ranges of hematological parameters in chickens are RBC (2.5-3.5 $x10^6$ μL), PCV (22-35%), Hb (7-13 g/dL), and leucocytes (12-30 x 10^3 μL). Arginine serves as a substrate for the synthesis of nitric oxide (NO) by activating NO synthase in all cell types; NO enhances the immune system and regulates cardio-pulmonary blood flow (Li et al., 2022). Furthermore, Kiani et al. (2022) reported on the beneficial effect of L-arginine supplementation in improving blood circulation by stimulating nitric oxide production. Therefore, it can be inferred that oral L-arginine supplementation in Kuroiler chickens poses no adverse effects on their health, since hematological parameters serve as good indicators of health. The results of this study corroborate the findings of Castro and Kim (2020), who reported that arginine supplementation had no adverse effects on the health status of broilers and improved some blood traits.

Table 3. Effects of oral administration of L- arginine on the hematological indices of Kuroiler chickens.

	Levels of L- arginine (mg/L)					
Indices	**0 mg/L**	**165 mg/L**	**330 mg/L**	**SEM ±**	***P*- values**	**NHPK**
Erythrocytes (x10^6/mL)	2.86b	3.44a	3.50a	0.40	1.35	3.64-3.94
HB (g/dL)	11.35b	13.19a	13.86a	0.64	4.82	11.50-12.96
HCT (%)	35.03b	38.57a	39.46a	5.08	6.13	34.50 -38.12
LEU (x10^9/L)	11.18c	13.78a	14.65b	5.10	1.22	18.00–18.60

a, b, c: means within the same row bearing different superscripts differ significantly (P<0.05); SEM = Standard error of mean. NHPK = Normal hematological range for Kuroiler chickens (Anju and Chauhan, 2020); HB = Hemoglobin; HCT = Hematocrit; LEU = Leucocytes.

Effect of oral administration of L – arginine on serum biochemical indices

The results of serum biochemical indices are presented in Table 4. There was no significant effect (P > 0.05) of orally administered L-arginine on liver function indicators. However, there was a linear reduction in serum concentrations of the enzymes alkaline phosphatase (ALP), alanine transaminase (ALT), and aspartate aminotransferase (AST), which is consistent with the findings of Pirsaraei et al. (2018). In the present study, the decreases in ALP, ALT, and AST concentrations with increasing levels of arginine suggests good health status and normal liver functioning. Elevated concentrations of liver enzymes are typically associated with liver abnormalities, stress, disease conditions, and cirrhosis (Islam et al., 2020).

Oral administration of L-arginine significantly affected (P < 0.05) the concentration of serum protein. The values increased as the arginine level in the drinking water increased. The rise in total serum protein and albumin concentrations of Kuroiler chickens with increasing oral L-arginine administration suggests improved health status and efficient dietary protein utilization. Insufficient dietary arginine directly affects protein synthesis in birds. The trend observed in our study agrees with the results of Chen et al. (2023), who reported increased total serum protein and serum albumin following arginine supplementation. Increased serum protein concentration could be attributed to the stimulating effect of arginine on pancreatic and pituitary hormones. Arginine deficiency can lead to reduced growth and disrupted levels of blood and muscle energy metabolites (phosphocreatine and creatinine) (Portocarero and Braun, 2021). Arginine stimulates the release of pituitary and pancreatic hormones, including glucagon from the α-cells of the Islets of Langerhan, and growth hormone, which in turn increases protein synthesis (Nicholls et al., 2016; Pirsaraei et al., 2018).

A study conducted by Kaiser et al. (2022) established normal serum biochemical reference ranges for domestic chickens (*Gallus gallus domesticus*) as follows: AST 110-247 μ/L, creatinine 0.5-1.5 mg/dL, glucose 195-301 mg/dL, cholesterol 47-200 mg/dL, total protein 3.5-6.7 g/dL, urea nitrogen (BUN) 15-25 mg/dL, and uric acid 1.5-11.9 mg/dL. In our study, the concentrations of glucose, cholesterol, total bilirubin, creatinine, and uric acid were significantly reduced in chickens administered oral L-arginine. In fact, serum glucose decreased iwith increasing levels of L-arginine in water, with is consistent with the findings of Hu et al. (2022). Regarding total cholesterol, levels decreased with the administration of arginine in drinking water, being in line with previous results (Miczke et al., 2015; Yang et al., 2016). Arginine lowers serum cholesterol levels, reduces insulin resistance, and improves sugar removal from the blood (Szlas et al., 2022). With respect to serum creatinine, values significantly decreased from 0.96 at 0 mg/L to 0.34 mg/dL at 330 mg arginine/L of water. Creatinine is an important indicator of renal health and muscle metabolism. The reduction in serum creatinine concentration may indicate proper kidney function and the absence of muscle wasting (Zhang and Parikh, 2019; Thompson and Joy, 2022). Serum uric acid decreased as the level of arginine increased in the water, suggesting improved protein utilization and reduced deamination following arginine supplementation in a dose-dependent manner. High serum uric acid concentrations are typically associated with inefficient protein utilization (Long and Liu, 2022). Hyperuricemia can be a risk factor for gout in chickens.

The reduction in the concentration of liver function indicators (ALP, AST, and ALT), serum glucose, creatinine, and uric acid resulting from oral administration of L-arginine supports the findings of Ali and Zaed (2023), who supplemented broiler diets with L-arginine.

Table 4. Effects of oral administration of L-arginine on serum biochemical indices of Kuroiler chickens.

Indices	Levels of L-arginine (mg/L)				
	0 mg/L	165 mg/L	330 mg/L	SEM ±	*P*-value
Alkaline phosphate (μ/L)	2.09	1.83	1.80	0.01	0.55
Aspartate transferase (μ/L)	22.40	21.55	21.30	0.14	2.22
Amino transferase (μ/L)	14.03	13.27	12.46	1.08	1.96
Total protein (mg/dL)	4.52b	5.58ab	5.93a	5.10	0.01
Albumin (mg/dL)	1.36b	1.85a	1.85a	0.23	0.01
Glucose (mg/dL)	120.67a	105.10b	98.34c	1.12	0.04
Cholesterol (mg/dL)	137.40a	125.22b	120.65b	3.82	0.02
Bilirubin (mg/dL)	3.64a	3.48b	3.20c	0.55	0.02
Creatinine (mg/dL)	0.96a	0.55b	0.34c	1.58	0.01
Uric acid (mmol/L)	5.64a	4.15b	3.49c	0.21	0.03

a, b, c: means within the same row bearing different superscripts differ significantly ($P<0.05$); SEM = Standard error of mean.

Impact of oral administration of L-arginine on hormonal profile

The results of the hormone analysis revealed that the oral administration of L-arginine had a significant effect on the hormones of Kuroiler chickens, resulting in increased concentrations of all investigated hormones (Table 5). Specifically, there was an increase in T_3 and T_4 concentrations in Kuroiler chickens administered oral arginine at 167 mg/L. However, there was a drop in the concentration of these thyroid hormones at 330 mg/L of L-arginine, which agrees with the findings of Pirsaraei et al. (2018). In the present study, the increase in T_3 and T_4 concentrations may be associated with an increased metabolic rate, particularly related to energy production, as well as improved growth and development of the birds. Thyroid hormones (T_3 and T_4) play pivotal roles in various metabolic activities influencing energy production, growth, and development (Mullur et al., 2014). Abdalla and Bianco (2014) suggested that T_3 is more active than T_4, influencing bio-oxidation processes in cells, regulating oxygen consumption, heart rate, and body temperature in growing chickens, albeit in smaller quantities. The higher the amount of T_3 and T_4 circulating in the blood, the faster the metabolism.

Insulin, growth hormone, and insulin-like growth hormone significantly increased as the level of arginine increased in the drinking water. This finding validates the reports of Xu et al. (2018) and Sirathonpong et al. (2019), who observed that extra dietary arginine stimulates the secretion of insulin, GH, and IGF-1 in broilers. Growth hormone (GH) and insulin-like growth factor 1 (IGF-1) are pivotal growth factors in animals. IGF-1 is a key regulator of muscle development and metabolism in chickens (Fujita et al., 2019). It acts as a potent mitogen, enhancing cell division and regulating the growth of various tissues, including muscle and brain. Oral administration of L-arginine stimulates pancreatic secretion of insulin and growth hormone, which may be responsible for the enhanced growth observed in the present study. Liang et al. (2017) and Forzano et al. (2023) also observed that arginine increases the release of growth hormone and enhances muscular growth. Arginine is believed to induce IGF-1 secretion by either inducing GH secretion and consequently stimulating IGF-1 translation and secretion or releasing IGF-1 retention in the endoplasmic reticulum (Oliveira et al., 2022). Yu et al. (2018) reported an increase in IGF-1 levels in the serum of broilers as the dietary arginine level increased.

Birds cannot endogenously synthesize arginine due to the absence of a functional urea cycle. Therefore, arginine is considered an essential amino acid that must be supplied in the feed. One reason arginine can affect growth is its ability to stimulate beta cells of the islets of Langerhans to secrete insulin, thereby increasing the release of insulin, GH, and IGF-I into the bloodstream (Silva et al., 2012). Furthermore, Oh et al. (2017) suggested that L-arginine may have dual functions in cell proliferation and tissue growth.

CONCLUSIONS

The results of the present study show that oral administration of L-arginine significantly improves growth performance in Kuroiler

Table 5. Effects of oral administration of L-arginine on hormone levels of Kuroiler chickens.

Indices	Levels of L- arginine (mg/L) 0 mg/L	165 mg/L	330 mg/L	SEM ±	*P* - value
T_3 (ng/mL)	5.25b	6.58a	6.32a	0.05	0.01
T_4 (ng/mL)	12.35c	13.91a	12.86b	0.64	0.04
Insulin (U/mL)	2.98b	4.65ab	4.50a	1.15	0.02
IgF - 1 (ng/mL)	24.60b	28.28ab	30.10a	1.08	0.02
Growth hormone (ng/mL)	6.92b	9.45a	9.65a	2.39	0.01

a, b, c: means within the same row bearing different superscripts differ significantly (P<0.05); SEM = Standard error of mean; $T_{3=}$ Triiodothyronine; $_{T4}$ = Tetraiodothyronine; IgF -1 = Insulin like growth Factor.

chickens, with effects on various physiological parameters. Specifically, increased doses of L-arginine led to enhanced weight gain and improved feed conversion ratio (FCR), highlighting its beneficial impact on growth efficiency. Moreover, L-arginine supplementation influenced hematological parameters by increasing erythrocyte counts and other blood indices, possibly due to elevated levels of growth hormone and insulin-like growth factor-1. Additionally, L-arginine positively affected liver function indicators by reducing serum enzyme concentrations, indicating improved liver health. The study also demonstrated that L-arginine had favorable effects on serum biochemical parameters, such as decreased levels of glucose, cholesterol, creatinine, and uric acid, suggesting improved metabolic regulation and efficient protein utilization. Overall, these findings emphasize the potential of L-arginine supplementation to enhance growth, health, and physiological functions in Kuroiler chickens without any adverse effects, supporting its practical application in poultry nutrition strategies.

Applications

The results underscore the potential of oral L-arginine supplementation as a means to enhance growth performance, improve health status, and optimize metabolic functions in poultry production. The findings could have practical implications for poultry farmers and nutritionists seeking strategies to enhance productivity and overall well-being of chickens.

Recommendations

Based on the outcomes of the study, the following recommendations are proposed:

1. Incorporation of L-arginine in Poultry Diets: Poultry producers should consider incorporating L-arginine supplementation in poultry diets to optimize growth performance and health parameters, thereby maximizing production efficiency.
2. Optimization of L-arginine Levels: Further research is warranted to determine the optimal dosage of L-arginine supplementation in poultry diets to achieve the desired growth and health outcomes while ensuring cost-effectiveness and sustainability.
3. Monitoring and Management of Metabolic Parameters: Poultry producers should regularly monitor metabolic parameters such as serum protein concentrations, glucose, cholesterol, creatinine, and uric acid levels in birds supplemented with L-arginine to assess health status and metabolic efficiency.
4. Evaluation of Long-term Effects: Future studies should investigate the long-term effects of L-arginine supplementation on poultry growth, health, and reproductive performance to ascertain its sustained benefits and potential implications for overall flock management.

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Author Contributios

Razaq Adekunle Animashahun and Olayinka Olubunmi Alabi developed the protocol and methodology of the study; Aduragbemi Adesina, Mary Ayeni and Bolaji Adebola did the bibliographic review; Precious Adesina, Adedeji Peculiar Animashahun, Abiodun Idowu, Noah Edozie, and Princess Odhe carry out the field trial work; Precious Adesina, Adedeji Peculiar Animashahun, Abiodun Idowu performed the statistical analysis; Noah Edozie, Princess Odhe,

Aduragbemi Adesina, Mary Ayeni and Bolaji Adebola discuss the results; Razaq Adekunle Animashahun and Olayinka Olubunmi Alabi supervised and reviewed the work. All the authors approved the final version of the article.

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