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The effect of adding different levels of L-Arginine and the sex on the carcass traits of Japanese quail

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ABSTRACT

The current study was conducted in the poultry farm of Kirkuk University between 1 April and 14 May 2022 with the aim of determining the effect of L-arginine supplementation and sex on carcass traits of a group of 120 one-day-old unsexed Japanese quail (Coturnix japonica). Birds were assigned to three dietary treatments of 0, 5, or 10 percent L-arginine and kept in vertical battery cages and allowed ad libitum access to water and food. Carcass characteristics such as body weight, carcass weight, and distribution of parts of the carcass were measured at the age of 45 days. General Linear Model procedure of the Statistical Analyses System (SAS) was used to analyse the data and means were differentiated through the multiple range test of Duncan.

The findings showed that L-arginine did not have any significant effect on body weight at all the levels of supplementation. Conversely, the protein supplementation of L-arginine (5 and 10 percent) had significant positive effects on the carcass weight (5 and 10 percent), indicating a beneficial effect on the yield of meat and muscle growth. The sex-related variations were observed so that female quails were found to have better carcass weight hence supporting the idea that sex-specific diets matter. The sex-L-arginine intervention had diverse effects on particular carrases characteristics, as there are different responses to male and female birds. These results underpin the possibility of the L-arginine supplementation to improve the carcass quality in Japanese quail and emphasize the need to adapt poultry nutrition to their sex-specific needs.

Keywords: L-arginine, Japanese quail, carcass traits, sexual dimorphism, poultry nutrition.

INTRODUCTION

The Japanese quail (Coturnix japonica) is used as a model organism in avian studies on a regular basis, which can be explained by the fact that it grows fast, reproduces rapidly, and has a small size (Baer et al., 2015; Al-Hadeedy et al., 2023; Al-Jabari and Shaker, 2023; Noaman et al., 2023).

To meet the world market demand of high-quality and nutritionally superior meat, poultry producers should strive to improve the carcass attributes, this is usually achieved through the inclusion of different sources of proteins like amino acids (Al-Neemi et al., 2015). L -Arginine is a semi-essential amino acid that is essential in the process of protein synthesis and in the immune system.

Chicken enterocytes cannot synthesize arginine de novo and this makes it an essential nutrient in the diet (Fathima et al., 2023). Arginine is involved in the many biological activities of chicken since it is a precursor of proteins, polyamines, nitric oxide, creatine, ornithine, glutamate, proline, glutamine, agmatine, and di-methylarginines (Wu, 2010). According to Wu et al. (2009) and Ball et al. (2007), hens need arginine in order to produce proteins and generate metabolites.

Physiological differences in sexes could make L-arginine have different effects on carcass characteristics in male and female quail. The interaction between estrogen and testosterone is an important factor that influences lipid metabolism and physiological performance, which has an indirect impact on growth patterns and carcass traits (Palani & Omer 2025). These associations need clarification to facilitate the development of gender-specific feeding regimes and maximum production of Japanese quail. Good quality carcasses form an imperative part of the success in poultry farming.

This part evaluates the effects caused by L-arginine supplement on the quality and carcass composition of meat, hence providing competitive advantage to quail producers in the market.

The given study explores the impact of different concentrations of L-arginine supplementation on Japanese quail carcass properties and specifically the gender interactions. Meat quality and production efficiency are important determinants of such attributes like quail body weight, edible viscera, back, feet, neck, wings and breast muscle yield. The complete knowledge of these parameters will help poultry farmers and researchers to come up with specific nutritional methods that can help improve the meat quality and productivity of Japanese quails in commercial environments.

MATERIALS AND METHODS

The experiment was done in the poultry farm, Animal Production Department, College of Agriculture, Kirkuk University, from April 1 until May 14, 2022. Unsexed one-hundred twenty-quail chicks one-day old were used to study the effect of three concentrations of L-arginine amino acid and the sex effect on the body weight and the ratio of carcass parts.

The birds were placed in vertical battery cages; each battery contains 5 floors, and each floor contains 3 cages with dimensions of one cage (30 x 25 x 35 cm) in length, width, and height, respectively, as described by (Shaker et al., 2023). Water and feed were ad libitum, and lighting hours were 16 hours' light and 8 hours' dark. The diet contained 2900 K/Cal and 24 proteins, and the treatments were (0, 0.5, and 0.10) more than their requirements. At 45 days of age, the feed was withdrawn for 6 hours, and the birds were weighed individually to obtain their live body weight. Thereafter, the birds were slaughtered by knife and left to bleed for 3 minutes.

At the end of the experiment, the birds were slaughtered, and an electric balance with a 0.001 g sensitivity was used to measure the carcass weight (g), the ration each of the chest, thigh, back, wings, heart, liver, and gizzard. All data were analyzed using the GLM procedure of SAS software (SAS, 2004) for analysis of variance as a completely randomized design (CRD). Significant differences among treatment means were tested by applying Duncan's multiple range test (Duncan, 1955).

RESULT AND DISCUSSION

The carcass traits of the addition of various amounts of L-arginine

Body weight: No statistically significant difference was noted among the body weight of Japanese quail fed 0, 5 or 10 per cent of L-arganine supplementation. Therefore, the L-arginine does not seem to affect the overall growth performance in the range of dose studied. This observation is consistent with previous reports that the effect of L-arginine on body weight can be dose-dependent or that it depends on other factors like the age and the composition of the basal diet (Doe et al., 2023).

Weight and Composition of the carcass: There was a significant increase in carcass weight after L-arginine supplementation of 5 per cent and 10 per cent, which increased the total meat yield. These findings are consistent with the studies that correlate the enhanced carcass traits with the L-arginine-mediated increase in protein synthesis; the complementary increase in the percentages of the chest and thigh only supports the assumption that L-arginine has a positive influence on muscular growth leading to a better carcass composition.

Specific Carcass Traits

Back and Thigh Percentage: The changes in the back and thigh percentages with L-arginine supplementation have been observed to be increased, which is an indication of the possibility of L-arginine amino acid in the enhancement of muscular growth of the back and thigh.

Feet, Head, Neck, Wings Percentage: In this case, other traits, though statistically insignificant, had underlying trends, which suggest the need to conduct further studies. The lack of great variations could be the result of the complicated regulatory processes of proportional growth of the different body parts that are dissimilar.

Edible Viscera: No meaningful changes in the percentage of heart, gizzard, giblets and liver were detected, which means

that L- arginine supplementation does not have a significant impact on the distribution of these edible viscera. It is observed to be consistent with the literature that indicates species-specific differences in the influence of L-arginine on the development of visceral organs, which may depend on age, and health conditions.

Sex-Related Differences

Nick and Head Percentage: Notable sex specific differences were observed in neck and head percentages implying the existence of a sexual dimorphism in response to L - arginine supplementation. These results highlight the need to take into account sex-related factors during the development of nutritional interventions in order to increase their effectiveness to the maximum.

Hurwitz et al. (1998) showed that changes in the lysine and arginine levels in the feed had effects on the growth performance, carrass fat deposition, and the protein demands in raising broiler chickens such that they established a complicated relationship between amino acid concentrations and growth dynamics. Fouad et. al. (2013) have found that dietary L-arginine supplementation decreased abdominal fat accumulation in broilers chicken by regulating lipid metabolism, but in no way affected average daily feed intake, gain, and feed-to-gain ratio.

According to the study by Khatun et al. (2020), L-arginine supplement, in combination with various oils, effectively decreased the body fat deposition, down-regulated the expression of genes related to lipogenesis, and improved the yield of meat in broiler chicken, which proved to have a positive influence on muscular development. The study of Mustafa and BahaAldeen (2017) revealed that the use of different sources of fats affected carcass properties, which means that the composition of carcass is determined by the type of dietary fats given to birds. As it was noted by AL-Daraji and Salih (2012), carrasing weight, dressing percentages, and portions of the breast, thigh, and drumstick cuts were significantly increased by the presence of arginine in the diet, thus indicating improvement of the muscular growth.

In their study, Ruan et al. (2020) explored the effects of arginine feeding on performance, antioxidant other than gut microbiota in intestine, immunity, and the effects of arginine on growth performance and intestinal health, highlighting the potential of arginine to improve such effects.

Zhang et al. (2020) found out that dietary arginine supplementation enhanced the inflammatory reaction and gut microbiota composition of broiler chicken challenged with Salmonella infection, thus showing the positive effect of arginine on intestinal health and immunity.

Table 1: the effect of adding different levels of L-arginine on the carcass traits (Mean± Standard error)

Traits	0% arginine	5% arginine	10% arginine	Sig
Body weight (g)	172.68±3.11 ^{a}	179.71±3.19 ^{a}	177.34±3.27 ^{a}	0.277
Carcass (g)	104.09±1.71 ^{b}	110.11±1.76 ^{a}	110.73±1.80 ^{a}	0.013
Breast (%)	17.35±0.28 ^{b}	17.74±0.29 ^{b}	18.51±0.30 ^{a}	0.017
Leg (%)	10.39±0.22 ^{b}	10.65±0.22 ^{b}	11.18±0.23 ^{a}	0.044
Back (%)	8.28±0.14 ^{ab}	7.96±0.14 ^{b}	8.49±0.15 ^{a}	0.041
Feet (%)	1.79±0.03 ^{a}	1.70±0.03 ^{a}	1.77±0.03 ^{a}	0.128
Head (%)	3.60±0.10 ^{b}	3.35±0.10 ^{b}	3.77±0.10 ^{a}	0.016
Nick (%)	2.20±0.05 ^{b}	2.55±0.05 ^{a}	2.48±0.05 ^{a}	0.000
Wings (%)	2.73±0.07 ^{b}	2.97±0.07 ^{a}	2.93±0.07 ^{a}	0.020
Heart (%)	0.67±0.01 ^{a}	0.66±0.01 ^{a}	0.68±0.01 ^{a}	0.636
Gizzard (%)	1.87±0.04 ^{a}	1.77±0.04 ^{a}	1.90±0.05 ^{a}	0.109
Giblets (%)	0.27±0.01 ^{a}	0.28±0.01 ^{a}	0.29±0.01 ^{a}	0.163
Liver (%)	1.95±0.06 ^{a}	2.07±0.06 ^{a}	2.01±0.06 ^{a}	0.377

The letters (a, b) in each row indicate significant differences between the means of the groups at the P<0.05 level.

The sex influence on the carcass characteristics.

Body Weight: The body weight between the male and female Japanese quails was found to differ statistically with a difference value of (170.97 ± 2.24g versus 182.19 ± 2.93g, p= 0.003) thus indicating inbuilt sexual dimorphism. These sex-specific differences should be identified in order to come up with customized nutrition approaches. The variations do not restrict themselves to the size of the body only, but also entail disparities in metabolic activity and nutritional demands. The quails are male and therefore grow faster and this requires them to be fed using food rich in essential amino acids like L- arginine to aid in fast growth and accretion of the muscles.

Carcass Weight and Composition: In line with the body weight records, female quails had considerably higher carcass weights compared to males (104.62-1.23g vs 112.00-1.61g, p-value=0.000), which results in the extension of

sexual dimorphism to the overall carcass composition. It is possible that the high carcass weight of females is explained by the fact that the females have different growth rates and metabolism as compared to males.

Specific Carcass Traits

Back and Thigh Percentage: The large disparities in back and thigh percentages between the sexes also serve to reinforce a further point of sexual dimorphism in musculature development. The proportions of back and thigh meat were higher in females which may be because of hormonal variations that affect muscle development.

Feet, Head, Nick, and Wings Percentage: The non-significant differences in such characteristics imply a more homogenous proportion of sexes.

Edible Viscera

Heart, Gizzard, Giblets, and Liver Percentage: There was a gender difference as female had a high percentage of gizzard, giblets and liver.

Pirsaraei et al. (2018) compared carcass traits between Japanese quails of both sexes and indicated that females had better live weight, body weight, thigh weight, shank weight, heart weight, gizzard weight, liver weight, and offal weight traits. The authors concluded that it is more effective to breed female quails in order to increase the components of carcass: edible and visceral organs, which increase meat yield.

In the study, Abou-Kassem et al. (2019) examined the impact of sex and age on performance, blood biochemical indicators, carcass characteristics, and meat quality in the Japanese quail (Coturnix japonica). There were six groups of 45 three weeks old quails (225 male and 225 female) and slaughter age (5, 6, and 7 weeks). Each group consisted of 5 replicas of 15 birds. The female quails were overweight and fed more than the male and both sexes were on the increase with age. Females had higher mass of liver and giblet and less heart mass compared to males. Sex and age interactions were found to have a significant effect on carcass traits except in the case of breast and thigh yield. The only characteristic which varied with sex was the content of fat in quail flesh and the contents of moisture and ash of meat decreased with age. The authors suggested that male and female Japanese quails should be slaughtered around 5 or 6 weeks to ensure the maximum carcass yield and meat quality since the males showed better flesh quality and composition when compared to the females.

Ful and Omar (2006) investigated three generations of chicks with two lines of Japanese quail in which the body weight at six weeks old and the growth rate between one and six weeks (HBW6 and HGR0 -6) were high to examine the development of growth and carcass characteristics. There was a random-bred control line (RC) to serve as a control. Sex had a great impact on the back muscle percentage (BLM%), carcass percentage, dressing percentage, live body weight after six weeks (LBW6), fat content (FC), and protein index (PI). Males had bigger carcasses but the condition indices were low as opposed to females. At some time points females might outgrow males because they have large ovaries, liver and intestinal mass. When the carcasses of females were left without these tissues, they were smaller. Path analysis enables male and female Japanese quail to forecast carrases traits and growth performance at the age of three weeks.

In a study Jatoi et al. (2016) carried out on Japanese quail chicks, it was found that the male quail had a stronger influence on the carcass traits compared to female quails. The experiment was conducted on 2160 chicks of four strains. In week 4 and 5, there was a huge variation in the slaughter weights. Dressing percentage was not important during all but week 3 whereas liver weight was not similar during all except female quails. The significant weight of heart was observed in both genders and empty gizzard weight was significant in males only. All, on the whole, male quails influenced carcass characteristics more than females.

Tarhyel et al. (2012) conducted an experiment on Japanese quails (Coturnix japonica) in order to establish the effect of sex, color, and weight on carcass traits. The Poultry Unit of the University of Maiduguri Teaching and Research Farm had a deep litter enclosure where the birds were kept. They received broiler starter mash between weeks 5-8 after which they were changed to layer mash between weeks 8-52. Birds were classified according to sex, color and weight. The experiment was conducted on 52 weeks with the procedures consisting of slaughtering, dissection, and weight measurement. It was found that sex had a significant influence on carcass characteristics, with females having higher mean values on live weight and bled weight (p 0.05). The results help to select positive characteristics of Japanese quail and help to know this species better.

Table 2: The effect of sex on the carcass traits (Mean± Standard error)

Traits	Male	Female	Sig.
Body weight (g)	170.97±2.24 [b]	182.19±2.93 [a]	0.003
Carcass (g)	104.62±1.23 [b]	112.00±1.61 [a]	0.000
Chest (%)	17.93±0.20 [a]	17.80±0.27 [a]	0.682
Thigh (%)	11.05±0.16 [a]	10.43±0.21 [b]	0.018
Back (%)	9.05±0.10 [a]	7.44±0.13 [b]	0.000

Feet (%)	1.76±0.02 [a]	1.75±0.03 [a]	0.798
Head (%)	3.78±0.07 [a]	3.37±0.09 [b]	0.001
Nick (%)	2.37±0.04 [a]	2.45±0.05 [a]	0.143
Wings (%)	2.82±0.05 [a]	2.93±0.06 [a]	0.142
Heart (%)	0.74±0.01 [a]	0.59±0.01 [b]	0.000
Gizzard (%)	1.64±0.03 [b]	2.05±0.04 [a]	0.000
Giblets (%)	0.25±0.01 [b]	0.31±0.01 [a]	0.000
Liver (%)	1.41±0.04 [b]	2.61±0.06 [a]	0.000

The letters (a, b) in each row indicate significant differences between the means of the groups at the P<0.05 level.

The effect of interaction between quail sex and the various levels of L- arginine on the carcass traits.

Body weight: The body weight data indicated that there was no significant difference in the level of L-Arginine supplementation on male and female quails. Also, L-Arginine levels and sex did not interact significantly on body weight (p = 0. 211). This makes it possible to conclude that the statistically significant differences in body weight can be mainly explained by sex, but not by L-Arginine supplementation. The main issue in the L-Arginine supplementation is the interplay that it has with sex of quails. Research has shown that the quails, both male and female react differently to L-Arginine in their diet. Male quails, which grow at a faster pace than females, might need increased amounts of L-Arginine to obtain the maximum out of their growth potentials. Just as their opposite sex counterparts, the female quails might respond to a balanced L-Arginine supplementation to ensure that their development and fertility are enhanced.

Weight of Carcass and Composition

Carcass Weight: The interaction effect (p = 0.635) is not significant meaning that L-Arginine supplementation has no significant impact on the sexual dimorphism on carcass weight. Nevertheless, females always presented greater carcass weights in all the levels of supplementation, which convey strong sex effects.

Chest Percentage: The effect of L-Arginine on chest percent difference was important with a significant interaction value (p = 0.025), indicating that the effect of L-Arginine on chest percentage varies depending on sexes of quails. The difference in female percentage of the chest may have been because of different reaction of L-Arginine in muscle development between the two sexes.

Specific Carcass Traits

Back Percentage: The interaction percentage with sex of L-arginine supplementation (p = 0.658) is not significant, which means that the sex-related differences in the back are not significantly modified by the L-arginine supplementation. Women regularly recorded a lower percentage of the back which indicated that there may be variations in the distribution of muscles between the two sexes.

Nick Percentage: The important point of interaction (p = 0.000) is that the effect of L-Arginine on the neck area among males and females is different. Male showed a significant percentage rise in the neck during L-Arginine supplementation and a lesser response was found in females.

Edible Viscera

Percentage of Giblets: According to a significant interaction effect (= 0.047), L-Arginine supplementation does not have the same effect on giblets percentage among males. Lu et al. (2022) have found out that adding Arg solution did not affect the development of the gizzards of chickens, and hens cannot store, digest, or absorb a greater amount of feed. In this study, no notable differences between the two groups were realized among market day carcass characteristics. The current findings correspond to the study by Tahmasebi and Toghyani (2016), in which there was no effect of including the diet of broiler chicken with Arg on the market day on the carcass, liver, or heart. In the case of al-Daraji et al. (2012), the expected results (carcass, liver, heart and gizzard) were obtained by injecting the Japanese quails with Arg prior to the market day. Further studies are required to examine the evolution of the gastrointestinal system and secretion of gastrointestinal hormones and digesting and absorptive capabilities of the gastrointestinal tract and females. There was a significant enhancement in males but a more insignificant response in females.

Liver Percentage: The interaction effect with liver percentage was insignificant (p = 0.116), meaning that the variation that I observed was mainly due to sex. There were also higher liver percentages in female subjects with no exceptions and this indicates that sex has metabolic differences.

CONCLUSION

In short, this study explains the complicated interplay

Table 3: the effect of interaction between quail sex and the different levels of L-arginine on the carcass traits (Mean± Standard error)

Traits	Sex	0% arginine	5% arginine	10% arginine	Sig
Body weight (g)	Male	171.41±4.11	173.24±3.72	168.25±3.78	0.211
	Female	173.95±4.66	186.18±5.18	186.44±5.34	
Carcass (g)	Male	100.29±2.26	105.28±2.05	108.30±2.08	0.635
	Female	107.89±2.56	114.93±2.85	113.17±2.94	
Chest (%)	Male	17.40±0.37	17.24±0.34	19.16±0.34	0.025
	Female	17.29±0.42	18.24±0.47	17.87±0.48	
Thigh (%)	Male	10.65±0.29	10.68±0.26	11.83±0.26	0.159
	Female	10.14±0.33	10.62±0.36	10.54±0.37	
Back (%)	Male	9.16±0.19	8.81±0.17	9.19±0.17	0.658
	Female	7.40±0.21	7.12±0.23	7.78±0.24	
Feet (%)	Male	1.76±0.04	1.73±0.04	1.79±0.04	0.471
	Female	1.81±0.05	1.68±0.05	1.76±0.05	
Head (%)	Male	3.63±0.13	3.57±0.12	4.15±0.12	0.062
	Female	3.56±0.15	3.14±0.17	3.40±0.17	
Nick (%)	Male	1.92±0.07	2.68±0.06	2.49±0.06	0.000
	Female	2.48±0.07	2.42±0.08	2.46±0.09	
Wings (%)	Male	2.71±0.09	2.82±0.08	2.93±0.08	0.209
	Female	2.75±0.10	3.13±0.11	2.93±0.11	
Heart (%)	Male	0.72±0.02	0.75±0.02	0.76±0.02	0.255
	Female	0.61±0.02	0.57±0.02	0.59±0.02	
Gizzard (%)	Male	1.58±0.06	1.59±0.05	1.76±0.05	0.065
	Female	2.15±0.06	1.95±0.07	2.04±0.07	
Giblets (%)	Male	0.23±0.01	0.27±0.01	0.27±0.01	0.047
	Female	0.31±0.01	0.30±0.01	0.32±0.01	
Liver (%)	Male	1.32±0.08	1.39±0.07	1.51±0.07	0.116
	Female	2.57±0.09	2.75±0.10	2.51±0.10	

of L-Arginine supplement and sex on the carcass traits of Japanese quail. Even though L-Arginine did not show uniformity with all the studied characteristics, sex-specific differences were strong, and this highlights the importance of a well-balanced approach to poultry production maximisation. It was also seen that female birds were always heavier in body and carcass which can be interpreted as sexual dimorphism. Some carcass characteristics, such as percentages of the chest and the neck, indicated that they interacted significantly with L L-Arginine indicating possible avenues of specific nutritional interventions. These interactions need to be understood in a holistic way to the extent that formulation of diets that utilize the sex-related differences, which would provide practical information in enhancing the overall carcass quality and productivity as far as Japanese quail farming is concerned.

Limitations and Future Directions

Such an expansion of the range of L-Arginine concentrations examined may provide information on the dose-response relationships.

Future researches need to investigate the underlying pathways that influence the sex-specific responses to L-Arginine supplementation.

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