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Estimation of genetic parameters for body weight in different periods of Japanese quail that selected for immune responses and fed different levels of dietary L-arginine

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Abstract:

The current study was done in the farm of animal production department, college of agriculture, Kirkuk University from (1/6/2021 until 1/7/2022), to estimation of genetic parameters for body weight in different periods of Japanese quail that selected for immune responses and fed different levels of dietary L-arginine, by using 750 quail chicks breeding for four generation. The body weight was recorded in three periods, at the sexual maturity (BWSM), at age 90 day (BW90), and 120 day (BW120). Electronic balance was used to record the weight at sensitivity of (0.001) g. Data analysis was conducted using the general linear model method within SAS program to estimate the effect of factors influencing the studied traits. The general weight mean of Japanese quail at the ages of sexual maturity 90 and 120 days was (186, 192 and 201) g, respectively. The current study showed a highly significant effect of the four generations on the weight of birds at sexual maturity, 90 and 120 days. The weight of the birds at sexual maturity was highest in the birds of the base generation. The lowest weight at the age of sexual maturity was in third generation. The weight of the bird was also at the age of 90, and 120 days, the highest weight in the base generation, compared to third generation, which had the lowest weight. The Japanese quail was significantly higher than the males. Also, the weight of females and males differed significantly in the Japanese quail bird, depending on the genetic line that used. The study also showed the presence of positive and high genetic correlations (0.9061) between The weight of the bird at the age of 90 days or the weight at the age of 120 days, and a high and positive morphology (0.9058) between the weight of the bird at the age of sexual maturity and the weight at the age of 90 days.

Keywords: Arginine, body weight, quail, estimation

تقدير المعالم الوراثية لوزن الجسم في فترات مختلفة في السمان الياباني الذي تم انتخابها للاستجابات المناعية والمغذاة على مستويات مختلفة من الأرجينين

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الخلاصة

أجريت الدراسة الحالية في حقل الدواجن في قسم الإنتاج الحيواني - كلية الزراعة جامعة كركوك للفترة من (2021/6/1 ولغاية 2022/7/1)، لتقدير المعالم الوراثية لوزن الجسم في فترات مختلفة من طائر السمان الياباني المنتخب. للاستجابات المناعية وتغذيتها بمستويات مختلفة من مادة الأرجينين باستخدام 750 فرخ طائر السمان لمدة أربعة أجيال. تم تسجيل وزن الجسم على ثلاث فترات، عند النضج الجنسي (BWSM، عند عمر 90 يومًا BW90 BW120 يوماً)، حيث استخدام الميزان الالكتروني لتسجيل الوزن بحساسية (0.001) غم. تم تحليل البيانات باستخدام طريقة النموذج الخطي العام ضمن برنامج SAS لتقدير تأثير العوامل المؤثرة على الصفات المدروسة. بلغ متوسط الوزن العام لطائر السمان الياباني عند عمر النضج الجنسي 90 و120 يوم (186، 192، 201) غم على التوالي. أظهرت الدراسة الحالية ايضا تأثيراً عالي المعنوية للأجيال الأربعة في وزن الطيور عند النضج الجنسي 90 و120 يوماً. كان وزن الطيور عند النضج الجنسي هو الأعلى في طيور الجيل الأساسي. أقل وزن عند سن النضج الجنسي كان في الجيل الثالث. كما كان وزن الطائر عند عمر 90 و120 يوما وهو الوزن الأعلى في الجيل الأساسي مقارنة بالجيل الثالث الذي كان له الوزن الأقل. وكان السمان الياباني أعلى بكثير من الذكور. كما أن وزن الإناث والذكور يختلف بشكل كبير في طائر السمان الياباني حسب الخط الوراثي المستخدم. كما أظهرت الدراسة وجود ارتباطات وراثية موجبة وعالية (0.9061) بين وزن الطائر عند عمر 90 يوما أو الوزن عند عمر 120 يوما، وارتباط مظهري عالية وموجبة (0.9058) بين وزن الطائر عند عمر 90 يوما أو الوزن عند عمر 120 يوما، وارتباط مظهري عالية وموجبة (0.9058) بين وزن الطائر عند عمر 90 يوما أو الوزن عند عمر 120 يوما. الطائر عند سن النضج الجنسي ووزنه عند عمر 90 يوما.

الكلمات المفتاحية: أرجينين، وزن الجسم، السمان، التقدير.

Introduction:

The Japanese quail was used for the first time as an experimental animal to study genetic selection, due to its small size and short generation period (Yalçın, 1995; Vali, et al., 2005). As it explain by the experiment carried out by (Manville and Caron, 1990) the Japanese quail responds quickly to selection for body weight. This is why the Japanese quail farm has expanded for meat production in many countries (Jatoi, 2012), due to the fact that the meat quality is moderately heritable (Oguz and Turkmut, 1999).

It is known that in any program for genetic improvement, body weight and carcass characteristics are among the most important traits studied, this is due to several reasons, including its relationship to meat production as well easy to measure (Caron and Manville, 1990). Hassani, et al., (2013) noticed in his study, there were statistically significant differences in weekly body weight between different generations and selection methods. Where the second generation showed the highest weight weekly for the body from one-day-old to day 21. This may be due to the selection for their higher body weight show a positive response to the election.

And as (Bothina, et al., 2014) noted an improvement in the body weight of the Japanese quail selected to increase body weight. Where one-quarter of the generation had the highest average body weight at the ages of 14 and 21 days (66.09 and 109.19) g, respectively, while the average body weight in the first generation for the same age period was (60.67, 103.07) g. All weekly body weight was also affected by age 7, 14, 21, 28, 35 days, largely within the selected line compared to the process control line.

Arginine amino acid was classified as a semi-essential amino acid, it is conditionally necessary to recover tissues and survive (Geiger, et al., 2016), where in developing animals, it is necessary for optimal growth and nitrogen balance (Efron and Barbul, 1998). Most mature mammals can manufacture arginine to meet their requirements, while birds cannot manufacture arginine, and therefore they are fully dependent on nutritional arginine to meet their protein needs and other functions (WU, et al., 1995), in addition to growth requirements, it has recently appeared in many studies Arginine has a beneficial effect on the immune state of animals and that the supply of diets with arginine supplements has significantly improved wound healing (Evoy, et al., 1998), and survival in humans, chicken and mice used to study oncology (Moriguchi, et al., 1987; Reynolds, et al., 1990; Taylor, et al., 1992; Brettenden, et al., 1994), indicating that arginine can positively affect disease resistance.

The aim of current study is to estimation of genetic parameters for body weight in different periods of Japanese quail that selected for immune responses and fed different levels of dietary L-arginine

Materials and methods:

The current study was done in the farm of animal production department, college of agriculture, Kirkuk University from (1/6/2021 until 1/7/2022). The based generation birds were obtained from general directory of agricultural research in Abu Ghraib. The experiment design, breeding, and immunizing method were explain in (Shaker, et al., 2023). The body weight was recorded in three periods, at the sexual maturity (BWSM), at age 90 day (BW90), and 120 days (BW120). Electronic balance was used to record the weight at sensitivity of (0.001) g.

Data analysis was conducted using the general linear model method within SAS (2005) program to estimate the effect of factors influencing the studied traits. The CIA-Common Intercept Approach was adopted to reach the point of inflection (Convergence) in estimating the components of the variance in the fastest time and with the least number of cycles (Schaeffer, 1979), and then a matrix of variance and covariance (VCV) was formed from the variances and co-variances for each From random effects (Sire and error) separately, then the positive definite test was conducted, as these matrices must have realistic values (Exist) and the associated eigenvalues matrix must be positive and determined for the purpose of obtaining Estimates of genetic parameters (heritability, genotypic correlation, phenotypic correlation) are within the permissible limits (shaker, et al., 2023).

This test was conducted on the matrices of variances and variations of the father and the error for each group of traits studied separately by calculating the eigenvalues associated with the test matrix. It was found that some of traits were negative, so the Bending process had to be performed (Hayes and Hill, 1981), and new matrices of variances and variations were obtained, from which the heritability of the studied traits and the genetic and phenotypic correlations between them were estimated.

Result and discussion:

The factors affecting body weight at ages of sexual maturity, 90 and 120 days, for Japanese quail in the four generations with added arginine levels selected for high and low immune levels, in addition to the effect of sex are shown in table 1, and 2. The general weight mean of Japanese quail at the ages of sexual maturity 90 and 120 days was (186, 192 and 201) g, respectively. The current study showed a highly significant effect ($P \leq 0.0001$) of the four generations on the weight of birds at sexual maturity, 90 and 120 days. The weight of the birds at sexual maturity was highest in the birds of the base generation (0), when the average reached (189) g. The lowest weight at the age of sexual maturity was in generation (3), when it reached (174) g. The weight of the bird was also at the age of 90, and 120 days, the highest weight in the base generation (198, 209) g, respectively, compared to generation (3), which had the lowest weight (177, 186) g, respectively.

The weight of the bird at the ages of sexual maturity, 90 and 120 days, was significantly affected (P≤0.0001) by the immunological level and the levels of the amino acid arginine that added (Table 2), as the birds achieved the highest weight for the three traits when the amino acid arginine was at a level of 10% more than the actual need recommended and at the low immunogenic level (187, 194 and 205) g, respectively, compared to the other cases. Moreover, there was no effect of interaction between the effect of the generation and the level of added arginine on the three mentioned traits (Table 1). The weight of females at sexual maturity was significantly higher (P≤0.0001) than that of males, reaching (191, 174) g, respectively. The weight of females at the age of 90 and 120 days reached (198, 205) g, while males at the same age reached or their weight is (181 and 193) g, respectively.

The current study agreed with the findings of Bülbül, et al., (2015), who indicated that the addition of arginine at a rate of (0.01%) led to a significant increase in the weight of female quails when they used different concentrations of arginine and lysine in the diets of white quails. And with the study of Ruan, et al., (2020), who used arginine at a rate of 10.9 g/kg (1.09%) in broiler chicken diets, it led to a significant increase in body weight at the age of 30 days (P≤0.001). In a study by the researcher Hussen and Saleh (2019) it was shown that the weight of females in quail

The Japanese quail was significantly higher than the males (208 and 163) g. Also, the weight of females and males differed significantly in the Japanese quail bird, depending on the genetic line used.

The decrease in the weight of birds as generation progress may be due to immune selection conducted on a flock quail birds through the three generations, which proved an inverse relationship with the characteristics of the bird's weight, egg weight, and egg production (Chao and Lee, 2001). The improvement in the weight of the birds for the birds fed the proportion of arginine (10%) and selected for the highest immunity to Newcastle disease antigens. It is due to the ratio of the amino acid arginine used, which led to an increase in weight (Kwak, et al., 1999). In general, it is noted from the results that birds with low or high immunity respond in a manner More to raise the level of the amino acid arginine to 10% more than the need compared to those fed with levels 5% more than the need, as arginine is one of the structural amino acids that help in increasing growth through protein biosynthesis, nitrogen transport and production of polyamines. Lee, et al., (2002). The reason for the decrease in the weight of birds in the three stages is also due to the process of genetic selection for Newcastle disease antigens, as Most, et al., (2011) found that the relationship between the selection of birds for the highest body weight is inverse with the birds' immunity in Chicken.

Table 1: The effect of generation, immune level, and the amino acid arginine on body weight at sexual maturity, at 90 and 120 days (Means ± S.E.)

Factors	BWSM (g)		BW90D		BW120D	
	No.	Means ± S.E.	No.	Means ± S.E.	No.	Means ± S.E.
Overall mean	1062	186 ± 0.53	1011	192 ± 0.59	1000	201 ± 0.66
Generation (G):						
0	311	189 ± 0.80 a	310	198 ± 0.86 a	302	209 ± 1.04 a
1	271	183 ± 0.86 b	249	189 ± 0.96 b	246	199 ± 1.15 b
2	247	185 ± 0.89 b	237	190 ± 0.98 b	237	199 ± 1.17 b
3	233	174 ± 0.92 c	215	177 ± 1.03 c	215	186 ± 1.23 c
Immunity level (I):						
1 Control (-) (CN)	174	183 ± 1.07 bc	165	187 ± 1.19 c	162	195 ± 1.43 c
1Control (+) (CP)	179	182 ± 1.06 c	170	187 ± 1.17 c	166	191 ± 1.41 c
2 High Immune (2H)	182	177 ± 1.05 d	178	184 ± 1.14 d	177	195 ± 1.36 c
2 Low Immune (2L)	175	182 ± 1.07 c	164	189 ± 1.18 bc	163	200 ± 1.42 b
3 High Immune (3H)	172	186 ± 1.07 ab	161	192 ± 1.20 ab	160	203 ± 1.44 ab
3 Low Immune (3L)	180	187 ± 1.05 a	173	194 ± 1.15 a	172	205 ± 1.39 a
Gender:						
Female	687	191 ± 0.53 a	636	198 ± 0.74 a	625	205 ± 0.87 a
Male	375	194 ± 0.72 b	375	181 ± 0.69 b	375	198 ± 0.87 b

BWSM=Body weight at sexual maturity; BW90D=Body weight at 90 days; BW120D=Body weight at 120 days.

Table 2: Mean squares and test of significance for factors affecting body weight at sexual maturity, 90 days and 120 days in quail.

Factors	BWSM (g)		BW90D (g)		BW120D (g)	
	d.f.	Means squares	d.f.	Means squares	d.f.	Means squares
Generation (G)	3	9562.64**	3	18601.32***	3	21842.47***
Immunity level (I)	5	2552.82**	5	2044.94***	5	4781.79***
Gender	1	72969.6**	1	60853.13***	1	33887.62***
Interaction (G*I)	15	169.72	15	181.25	15	250.89
Residual	1037	195.83	986	226.35	975	323.98

** $p<0.01$. BWSM=Body weight at sexual maturity; BW90D=Body weight at 90 days; BW120D=Body weight at 120 days.

Estimates of the genetic equivalent of body weight at the ages of sexual maturity, 90, and 120 days were 0.20, 0.02, and 0.06, respectively (Table 3). The study also showed the presence of positive and high genetic correlations (0.9061) between The weight of the bird at the age of 90 days or the weight at the age of 120 days, and a high and positive morphology (0.9058) between the weight of the bird at the age of sexual maturity and the weight at the age of 90 days (Table 3)

The heritability of the weight of birds at the age of sexual maturity (0.20) is similar to what was found by (Sezer, 2007), who used in his experiment the Japanese quail to study the genetic equivalent of the age of sexual maturity and weekly weight, as the genetic equivalent of the age of sexual maturity was 0.24, And less than what (Özsoy & Aktan, 2011) found from the estimate of the genotypic equivalent of body weight for female Japanese quail at the age of sexual maturity (0.58), and what was recorded by Khaldari, et al. (2011) that the estimates of the genotypic equivalent of the weight of the Japanese quail bird differed according to the sex of the bird, as the genotyped equivalent of the weight of males at the age of sexual maturity was 0.85, while for females it was 0.73.

Table 3: Genetic parameters for the body weight at sexual maturity, 90 days and 120 days in quail.

Traits	BWSM	BW90D	BW120D
BWSM	0.20	0.43	0.13
BW90D	0.91	0.02	0.91
BW120D	0.74	0.83	0.06

The values on, above, and below the diagonal are estimates of heritability, genetic and phenotypic correlation among traits respectively. ** $p<0.01$. BWSM=Body weight at sexual maturity; BW90D=Body weight at 90 days; BW120D=Body weight at 120 days.

Conclusion:

We can conclude that adding 10% of L-arginine more then quail needing according to the NRC increase the body weight for the quail with low immune to Newcastle disease.

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