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Heritability and Genetic Correlation Between Productive and Biochemical Traits of White Japanese Quail

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Abstract:

Studying heritability and genetic correlation between traits is important to improvement genetic programs and indirect selection, for that, this study was conducted in the poultry field of Animal Production department - College of Agriculture - University of Kirkuk for the period from 28/3/2022 to 15/1/2023, to study heritability and genetic correlation between production and biochemical traits of white Japanese quail. One day hatched white quail chicks were obtained from College of Agriculture - University of Kirkuk, and reared for 35 days until reaching sexual maturity. Then chicks were randomly distributed to 30 families, with a male and a female for each family for two generations. Simple correlation between productive traits and blood biochemical were estimated, and heritability using full sibs method by variance between dam and total variances. The results of the study showed that there was a highly and significant genetic correlation between estrogen hormone in blood serum, egg production and egg mass, while a negative and highly significant genetic correlation was found between estrogen hormone and feed conversion ratio. Heritability values for productive and blood biochemical traits ranged from 0.22 to 0.42 and they considered within mediate heritability. The study recommended to use of selection programs and indirect genetic improvement based on some blood biochemical values (estrogens, total protein and glucose) due to their positive and significant association with productive traits of white Japanese quail.

Key words: Heritability , Simple correlation , white quail , production traits.

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Introduction:

The current characteristic of plumage color of quail was dark brown, but the domestication and selection processes of Japanese quail led to emergence of many strains with different plumage colors [1,2]. The study of [3-5] indicated that the white color of quail is the result of a genetic mutation as a recessive trait given the symbol (wh) and the birds carrying this gene are characterized as white birds stained with some wild-type feathers on head, tail, back and dorsal pelvis, while chest and ventral surface are completely white. They also have discolored legs and feet, while iris and pupils are colored as in wild species. The nap of white Japanese quail chicks is creamy yellow with a few black dots, which will be replaced by wild-type with maturity [6,7]. The melanin pigment is important and responsible for the color of feathers in chickens [8] and presence of this pigment and precise shape of surface of its granules play a role in coloration of feathers, which is an absolute genetic condition. [9] indicated that the oval shape of melanin pigment granules is responsible for appearance of black, gray and brown, but circular or round, appears the red color, while absence of melanin pigment granules leads to appearance of white feathers. On the other hand, [10] indicated that the surface of epidermal cells contains chemical compounds, including melanin and lipochrome, and the ability of these two compounds to absorb light waves was a key factor in showing feathers in different colors by separating components of white light and converting it into different colors. [11] showed in their study on comparing the productive performance and some blood parameters of two strains of Japanese quail, that the concentration of total protein in serum reached 5.94 g/dl, albumin 3.12 g/dl, cholesterol 152.6 mg/dl, and triglycerides 275.4 mg/dl, As for AST and ALT, they were 26.52 and 20.11 IU, respectively. While [12] indicated in his study on productive performance of three strains of Japanese quail, that the total protein in blood serum of white Japanese quail reached 4.44 g/100 ml, albumin 2.36 g/100 ml, and globulin 2.08 g/100 ml, while cholesterol reached 153.44 mg/100 ml. The study conducted by [13] on the effect of sex and strain on blood and biochemical characteristics of white and brown Japanese quails, using 100 quails per strain for 84 days, They concluded that the average blood glucose, cholesterol, total protein, albumin, and globulin were 299.89 mg/dl, 178.83 mg/dl, 40.84 g/l, 17.87 g/l, and 22.97 g/l, respectively, while AST and ALT, were 242.48 and 13.37 IU respectively. [14] in his study on some genetic parameters between body weight and some egg traits for two strains of quail, indicated that the value of heritability of white quail for body weight, egg production, and egg weight was 0.53, 0.43, and 0.39, respectively. While [15] in his thesis to evaluation the genetic and productive traits of three lines of Japanese quail indicated that the value of heritability of white Japanese quail for egg production, egg weight and feed conversion ratio were 0.53, 0.51 and 0.59, respectively, also indicated that there was positive and significant genetic correlation between live body weight and feed conversion ratio, but the genetic correlation was negative and highly significant between body weight and eggs produced, while the correlation was positive and significant between body weight and egg weight. so, our study aimed to study heritability and genetic correlation between production and biochemical traits of white Japanese quail

Materials and Methods:

This study was conducted in the poultry field of Department of Animal Production - College of Agriculture - University of Kirkuk for the period from 3/28/2022 to 1/15/2023, to study heritability and genetic correlation between production and biochemical traits of white Japanese quail. One-day-old chicks were obtained from College of Agriculture, University of Kirkuk, and they reared for 35 days. Electric heaters used to reach temperature for 35 °C during 1st week, then reduced by 2 degrees per week to arrive at optimum temperature. Water and feed were *ad libitum*, and lighting was 24h in the first week, then reduced gradually to 16 hours using 60-watt lamps to ensure that the intensity of lighting reaches all cages. At the end of 5th week of age, they were distributed randomly to 30 families and placed in two battery cages, everyone have 5 floors, each floor have 3 cages with dimensions (30 x 25 x 35 cm) length, width and height, respectively. When the flock reached sexual maturity, the chicks were naturalized by male and female per family. The same breeding and management conditions were repeated during the second generation. The birds were fed on a diet with 24.37% crude protein and 2976 k.cal/kg metabolism energy from one day until the age of 30 days, after which they were fed on a productive diet with 20% crude protein and 2850 k.cal/kg metabolism energy. Feeding continued on this diet until end of experiment and for two generations, as shown in Table (1). The diets were formed according to the nutrients required for birds According to [16]. The simple correlation coefficients between productive and biochemical traits were estimated according to the equation by [17] as follows, and the biochemical measurements of blood were carried out by using spectrophotometer in high graduate laboratory of College of Agriculture at University of Kirkuk.

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{n(\Sigma x^2) - (\Sigma x)^2} \times \sqrt{n(\Sigma y^2) - (\Sigma y)^2}}$$

heritability also estimated using full sibs method by variance between dam and total variances according to the equation reported by [18].

$$h^2D = \frac{4\delta^2 S}{\delta^2 S + \delta^2 D + \delta^2 W}$$

δ^2 D = variance between dam, δ^2 S = variance between sire, δ^2 W = variance between sibs

Table (1) Percentages and chemical composition of experiment diets

Feeds	Starter %	Production %
Yellow corn	41	42.7
Wheat	14	16
Soy bean (48% CP)	36	30
Protein concentration*	5	-
Vit and Minerals	-	2.5
Di-calcium phosphate	0.1	0.5
Vegetarian oil	2	2
Limestone	1.6	6
Nacl	0.3	0.3
Total	100	100
chemical composition**		
Crude protein %	24.37	20
Metabolism energy k.cal/kg	2976	2850
Calcium %	0.87	2.99
Phosphate %	0.46	0.52
Lysine %	1.31	1.00
Methionine %	0.50	0.43
Methionine + cysteine %	0.86	0.74
Fibers %	3.94	3.56

* wafi protein complex (Dutch origin), containing 40% crude protein, 2100 kcal / kg, 5% crude fat, 3.85% lysine, 3.70% methionine, 4.12% methionine + cysteine, 5% calcium, 4.68% phosphorus

** According to [16].

Results and Discussion:

Heritability of production traits:

Table (2) shows the general averages, standard error, minimum, maximum value, and heritability for some productive traits of white Japanese quail. It was clear from table that the general average of the age of the first egg (day), weight of first egg (g), weight of female at laying of first egg (g), egg production (%), egg weight (g), eggs mass (g eggs/bird/day), feed intake (g/bird/day), and feed conversion ratio (g feed/g eggs) reached 43.31, 9.01, 197.57, 92.65, 10.84, 10.03, 20.37, and 2.04, respectively. While heritability for above characteristics were 0.29, 0.39, 0.42, 0.37, 0.31 and 0 .28, 0.38, and 0.22, respectively. The value of heritability were approach to what [19] found for egg production and egg mass, which amounted to 0.34 and 0.26, respectively. It also approach with what found by [20] for egg weight and feed intake which amounted to 0.31 and 0.34, respectively. While heritability values mentioned in Table (2) were higher than estimates of [21] for the age at laying of first egg, weight of female at laying of first egg, weight of first egg, egg production and eggs weight which amounted to 0.20, 0.24, 0.22, 0.26 and 0.21, respectively. While it was higher than what was found by [22] for weight of female at laying of first egg and age at laying of first egg, which amounted to 0.18 and 0.20, respectively. While it was less than what was found by [15] for egg production and feed conversion ratio, which amounted to 0.53 and 0.59, respectively, and also less than what was found by [23] for age at laying of first egg and weight of female at laying first egg, which amounted to 0.37 and 0.58, respectively. It is noted through previous studies that there are variances in values of heritability, and the reason for this due to differences of bird type, strain, method of estimating heritability and the country of study [24].

Table (2) Averages, standard error, and heritability for productive traits of white Japanese quail

Traits	Averages	S.E	Minimum	Maximum	Heritability
Age of the first egg (day)	43.31	0.34	41.00	49.00	0.29
Weight of first egg (g)	9.01	0.17	7.25	11.56	0.39
Weight of female at first egg (g)	197.57	4.37	151.97	241.16	0.42
Egg production (%)	92.65	0.81	81.96	99.10	0.37
Egg weight (g)	10.84	0.09	9.83	11.63	0.31
Egg mass (g egg/bird/day)	10.03	0.11	8.45	11.23	0.28
Feed intake (g/bird)	20.37	0.14	19.18	22.36	0.38
Feed conversion ratio (g feed/ g egg)	2.04	0.02	1.87	2.42	0.22

Heritability of biochemical traits:

Table (3) shows the general averages, standard error, minimum, maximum value, and heritability for some biochemical blood traits of white Japanese quail، including blood glucose (mg/dl), cholesterol (mg/dl), total protein (g/dl), estrogen (ng/ml), AST (IU) and ALT (IU) may It was 395.58, 482.64, 9.22, 2.07, 6.88, and 7.02 respectively. While heritability of blood glucose (mg/dl), cholesterol (mg/dl), total protein (g/dl), estrogen (ng/ml), AST (IU) and ALT (IU) was 0.34 and 0.31, 0.26, 0.35, 0.33, and 0.28 respectively. The results were convergent to what was found by [25] when studying heritability of some blood biochemical characteristics of Japanese quail, as it was 0.26 and 0.34 for cholesterol and total protein, respectively, while it was less than what was found by [26] for cholesterol and total protein amounted to 0.60 and 0.55, respectively, and higher than what found for glucose, whose heritability was 0.25. The genetic variations of blood biochemical traits of white Japanese quail give an indication of their importance to improve the productive traits associated with them significantly by using selection programs and indirect genetic improvement.

Table (3) Averages, standard error and heritability for biochemical traits of white Japanese quail

Traits	Averages	S.E	Minimum	Maximum	Heritability
glucose (mg/dl)	394.58	28.08	50.00	700.00	0.34
cholesterol (mg/dl)	482.64	18.98	203.57	635.71	0.31
total protein (g/dl)	9.22	0.30	6.36	13.20	0.26
estrogen (ng/ml)	2.07	0.01	1.83	2.24	0.35
AST (IU)	6.88	0.23	5.50	9.67	0.33
ALT (IU)	7.02	0.23	4.89	11.52	0.28

Simple correlation between productive traits and biochemical traits:

Table (4) shows the genetic correlation between productive traits biochemical traits of white Japanese quail, its clearly from above table there is a positive genetic correlation between age at first egg (g) and the level of glucose (mg/dl), cholesterol (mg/dl), total protein (gm/dl), estrogen (µgm/ml) and AST enzyme (IU), While the genetic correlation was negative between age at first egg (g) and ALT enzyme (IU). As for the weight at first egg (g), it is noticed from the table there is a positive genetic correlation between the weight at first egg (g) and glucose (mg/dl), cholesterol (mg/dl), total protein (gm/dl) and estrogen (µgm/ml), but the genetic correlation was negative between the weight at first egg (g) and ALT enzyme (IU) while the genetic correlation was positive and significant (P≤0.05) between the weight at first egg (g) and AST enzyme (IU) were amount (0.418). As for female weight at first egg (g), the results of the statistical analysis indicate that there is a positive and significant genetic correlation (P≤0.05) between female weight at first egg (g) and glucose (mg/dl) were (0.391) while the genetic correlation was negative between female weight at first egg (g) and cholesterol (mg/dl), total protein (gm/dl) and ALT (IU) while the genetic correlation was positive between female weight at first egg and estrogen (µgm/ml) and AST (IU). For egg production, we notice a positive genetic correlation between egg production (%) and level of glucose (mg/dl) and cholesterol (mg/dl), , but the genetic correlation was negative between egg production (%) and total protein (gm/dl) and ALT (IU), while the genetic correlation was positive and high significant (P≤0.01) between egg production (%) and estrogen (µgm/ml) as it reached (0.985), while the genetic correlation was positive and significant (P≤0.05) between egg production (%) and AST enzyme (IU) which is (0.381). As for egg weight (g) the genetic correlation was positive between egg weight (g) and the level of glucose (mg/dl), cholesterol (mg/dl), total protein (gm/dl), AST (IU) and ALT (IU), while the genetic correlation was negative between egg weight (g) and level of estrogen in blood serum (µgm/ml).

Table (4): Simple correlation between productive traits and biochemical traits of white Japanese quail

productive traits	biochemical traits					
	Glucose (mg/dl)	Cholesterol (mg/dl)	Total protein (gm/dl)	Estrogen (µgm/ml)	AST (IU)	ALT (IU)
age at first egg (g)	0.243	0.060	0.167	0.046	0.172	0.103-
weight at first egg (g)	0.350	0.267	0.223	0.172	*0.418	0.320-
female weight at first egg (g)	*0.391	0.008-	0.042-	0.034	0.067	0.072-
egg production (%)	0.206	0.096	0.304-	**0.985	*0.381	0.223-
egg weight (g)	0.278	0.101	0.143	0.182-	0.037	0.079
egg mass (gm egg/bird/day)	*0.374	0.131	0.148-	**0.633	0.327	0.118-
feed intake (gm/bird/day)	0.299	0.029-	0.019-	0.063-	0.344	0.036
feed conversion ratio (diets/eggs)	0.257-	0.201-	0.129	**0.722-	0.155-	0.134

Non star indicates non-significant.
* It indicates a genetic correlation at 5 %.
** It indicates a genetic correlation at 1 %.

For egg mass (gm egg/bird/day) it noted from above table there was a positive and significant genetic correlation (P≤0.05) between egg mass and level of glucose (mg/dl) which was (0.374), while the genetic correlation was positive and high significant (P≤0.01) between egg mass and estrogen (µgm/ml) were (0.633), but the genetic correlation was positive between egg mass and cholesterol (mg/dl) and AST (IU), while the genetic correlation was negative between egg mass and between total protein (gm/dl) and ALT (IU). As for the feed intake (gm/bird/day) it is clear from above table there was a positive genetic correlation between feed intake and between glucose (mg/dl), AST (IU) and ALT (IU), while the genetic correlation was negative between feed intake and between cholesterol (mg/dl) , total protein (gm/dl) and estrogen (µgm/ml). For feed conversion ratio (diets/eggs), it is clear through above table that there was a negative correlation between feed conversion ratio and between glucose (mg/dl), cholesterol (mg/dl) and AST (IU), but the genetic correlation was positive between feed conversion ratio and between total protein (gm/dl) and ALT (IU), While the genetic correlation between feed conversion ratio and the level of estrogen in the blood serum was negative and high significant (P≤0.01) reached (0.722-).

It notice clearly from table (4) there was a positive and significant genetic correlation between the level of glucose in the blood and between female weight at first egg and egg mass. [27] indicated that the increase in the female weight is caused by consumption of more feed and this results in the bird's access to more carbohydrates and leads to digestion and converting it into glucose in the intestine and absorbing it and thus caused increasing its level in blood, It also results from the increase of body weight to a decrease in physical activity, which reduces the amounts of energy consumed and the accumulation of glucose in the blood. Moreover, the production of eggs (%) requires to availability of enough nutrients to meet the needs of higher production and that nutrients include carbohydrates and fats to be used in providing energy needed for ovulation, and if there is not enough stock of stored energy, this may negatively affect to production of eggs significantly. It was also shown from table (4) above a positive and high significant correlation between egg production (%) and the level of estrogen in the blood serum, and that reason for this may be due to what [24] indicated, with existence of a positive and significant correlation between the level estrogen in the blood and egg production rate, as estrogen works to stimulate the activity of liver to yolk process (Vitelllogenesis) and enhance growth of oviduct and helps to formation Ovalbumine, Conalbumine and Lysozyme. Also, the high concentration of estrogen in blood has a pre-ovulation role, as it leads to high concentration of the luteinizing hormone (LH), which provides a greater response to vesicles with effect of this hormone, and this confirms the main estrogen role in ovulation as well as the role of estrogen in increasing receptors of follicle stimulating hormone (FSH) in target tissue, which leads to mature ovarian vesicles [28,29]. Therefore, the relationship between estrogen hormone in blood and egg production was important because it gives an indication that can be used in selection programs and indirect genetic improvement. It is also noticed from above table that the increase in egg production leads to metabolic stress, and this is evident through positive and significant genetic correlation between AST enzyme and level of egg production, and this may explain to the high liver activity and increase in its meticulous activity to meet the needs of egg manufacturing and formation of yolk continuously and this gives an indication of the relationship between egg production and the level of AST enzyme concentration in liver that can be used in indirect selection in poultry [30].

Recommendations:

Using indirectly genetic improvement and selection programs dependent on some biochemical traits in serum blood (estrogen and glucose) because of their positive and significant correlation with production traits of white Japanese quail.

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مجلة جامعة كركوك للعلوم الزراعية

المكافئ والارتباط الوراثي بين الصفات الانتاجية والصفات الكيموحيوية لطائر السمان الياباني الابيض

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- تاريخ استلام البحث 2023/08/09 وتاريخ قبول البحث 2023/08/20
- البحث مستل من اطروحة دكتوراه للباحث الاول

الملخص:

أجريت هذه الدراسة في حقل الطيور الداجنة التابع لقسم الإنتاج الحيواني – كلية الزراعة – جامعة كركوك للمدة من 2022/3/28 لغاية 2023/1/15، لدراسة بعض المعالم الوراثية وهي المكافئ الوراثي والارتباط الوراثي بين الصفات الانتاجية والصفات الكيموحيوية لطائر السمان الياباني الابيض، تم الحصول على الافراخ بعمر يوم واحد من كلية الزراعة بجامعة كركوك وتم تربيتها لمدة 35 يوماً لحين الوصول الى عمر النضج الجنسي ثم وزعت عشوائيا الى 30 عائلة وبواقع ذكر وانثى لكل عائلة ثم وأُعيدت ظروف التربية والإدارة نفسها لجيل اخر. تم تقدير معاملات الارتباط البسيط بين الصفات الانتاجية مع القيم الحيوية في الدم وكما تم تقدير المكافئ الوراثي بطريقة الاخوة الاشقاء الكاملة (Full Sibs) باستعمال تباينات الامهات والتباينات الكلية. اوضحت نتائج التجربة وجود ارتباط وراثي عالي المعنوية بين هرمون الاستروجين في مصل الدم وبين انتاج البيض وكتلة البيض فيما وجد ارتباط وراثي سالب وعالي المعنوية بين هرمون الاستروجين وبين معامل التحويل الغذائي. قيم المكافئ الوراثي للصفات الانتاجية وصفات الدم الكيموحيوية للدم تراوحت ما بين 0.22 الى 0.42 وتعتبر ضمن المكافئات الوراثية المتوسطة. اوصت الدراسة باستعمال برامج الانتخاب والتحسين الوراثي الغير مباشر بالاعتماد على بعض قيم الدم الكيموحيوية (هرمون الاستروجين والبروتين الكلي والكلوكوز) لارتباطها بشكل ايجابي ومعنوي مع الصفات الانتاجية لطائر السمان الياباني الابيض.

الكلمات المفتاحية: المكافئ الوراثي ، الارتباط البسيط ، السمان الياباني ، الصفات الانتاجية.