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Relationships among egg quality traits in Japanese quails over three generations of selection for egg production

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Target Audience: *Breeders, Farmers, Food processors*

Abstract

The study was carried out to evaluate the relationships among egg quality traits over three generations of selection for egg production. Eggs were obtained at the 9th week from 300, 450 and 320 adult quails in Generation zero (G_0), one (G_1) and two (G_2), respectively. There were significant ($p<0.05$-0.01) positive and negative correlations among egg quality traits as generation of selection increased. The high positive relationships between egg weight and shell weight, shell thickness and albumen weight could be maximized in designing a selection program for egg quality traits in quails.

Key words: Egg, quality, Relationships, Generation, Selection, and Quail.

Description of Problem

Eggs and meat are classified among the most nutritious food; and eggs are rated with milk among the best foods rich in protein, vitamins, essential amino acids, saturated fatty acids, unsaturated fatty acids, phospholipids, iron (Fe) and vitamins (1, 2). Egg quality is a term, which, refers to general standard that define both internal and external egg quality (3, 4). The economic success of a laying flock solely depends on the total number of quality eggs produced. Approximately 7-8 percent of the total number of eggs get broken during transfer of the eggs from the point of production to the consumer, thus high cracked and broken eggs result in serious economical problems both for the producers, dealers and consumers (5). External and internal egg quality traits have also been implicated in serious economic problems for breeders (6, 7, 8) because it affects the improvement programme of future generations of poultry.

Several authors (6, 7, 9) reported different magnitude of relationships between egg quality traits but there is dearth of information on the trend of relationships between these traits over generations of selections for egg number. The aim of this paper is to evaluate the trend of relationships among egg quality traits of Japanese quails over three generations of selection for egg number in the Northern Guinea Savannah of Nigeria.

Material and Methods

Stock, Husbandry and traits Measured

This study was conducted at the Poultry Unit of the Department of Animal Science Experimental Farm, Faculty of Agriculture, Ahmadu Bello University Zaria. Zaria is located in the Northern

Guinea Savannah ecological zone of Nigeria. The area lies between Latitude 11°11'N and Longitude 7°38'E, at an attitude of 686 m above sea level. The climate is relatively dry with a mean annual rainfall of 700-1400 mm, occurring between the month of April and September (10). The birds in the foundation stock and subsequent generation were mated at seven weeks of age. Short term (30 days) selection for egg number was carried out in Generation one and two. Birds with high egg production were selected to be the parents of generations one and two. Eggs were obtained at the 9th week from 300, 450 and 320 birds in the Base population, Generation One and Generation. Two adult quail were kept in individual cages of dimension (35 x 30cm). The mating ratio of 1:2 (male to female) was used for improved fertility (11) such that the male was mated to two female) over three generations. Birds were fed *ad-libitum* on diets of 24% CP, 2904 ME Kcal/Kg throughout the starter phase (from hatch to four weeks), after which they were fed a breeder diet containing 21% CP and 2800 ME Kcal/Kg (12) from the fifth week of age to the end of the experiment in all the three generations.

External and internal quality traits measured were egg weight (g), Egg length (cm), Egg width (cm), Yolk weight (cm), Yolk height (cm), Albumen weight (g), Albumen length (cm), Albumen width (cm) and Shell + membrane weight (cm), External egg measurements were taken and internal quality assessment was carried out using destructive technique (13). Egg shape index was calculated using the method of (14). Yolk index was calculated using the formula of (15) while haugh unit was calculated according to the procedure of Haugh (16).

Data analysis

Phenotypic correlations between traits were evaluated using the correlation procedure of SAS, 9.2 (17). The phenotypic correlations between pairs of traits considered was determined using equation described by (18).

$$r_p = \frac{COV_w + COV_s}{\sqrt{\left(\sigma^2_{w(x)} + \sigma^2_{s(x)}\right)\left(\sigma^2_{w(y)} + \sigma^2_{s(y)}\right)}}$$

$$\text{S.E. (rp)} = \frac{COV_{xy}}{\sigma^2_x.\sigma^2_y}$$

Where; COVw = within sire covariance components, COV_S = sire covariance components σ^2 w (x); σ^2 w(y) = within variance component for traits x and y. σ^2s(x); σ^2s(y) = Sire variance component for traits x and y, respectively.

Results and Discussion

Table 1 shows the phenotypic correlation between external egg qualities in the base population (G_O), Generation One (G_1) and Generation Two (G_2). The phenotypic correlation showed that there was a consistent significant positive relationship between egg weight and shell weight, egg weight and shell thickness, egg width and egg shape and egg width index and shell weight.

The significant positive relationships observed between egg weight and egg width, shell weight and shell thickness recorded in the base generation is an indication of pleiotropic effect (19), which implies that these traits are controlled by the same genes. Thus, an increase in egg weight would result in an increase in the egg width as well as other correlated traits (20). Similar observations were reported by (7, 8, and 21) that egg weight is positively correlated with most egg quality traits. Selection for egg weight can thus be used to improve other egg quality traits, which will in turn aid hatchability (7). The non-significant negative correlation obtained between egg weight and egg shape index in this study were unlike the reports of (22) in hen, (23) and (7) in quails. This suggests that the relationship between egg weight and egg shape index may be controlled by environmental factors rather than genetic factors (24).

The significant negative correlation observed between egg length and egg shape index suggested that an increase in one trait would result to a decrease in the other trait in all the three generations. Similar result was reported by (25, 26) in local chickens. The varying magnitude and directions observed between egg quality traits were supported by the findings of (22) in hens and (23, 27, 28, 24) in Japanese quails.

Table 1: Phenotypic correlations of External egg quality traits for Japanese quails over three generations

Generation		EW	EL	EWD	EI	SW	ST
G_0	EW	-					
	EL	0.22	-				
	EWD	0.37*	0.49*	-			
	EI	0.14	-0.54*	0.46*	-		
	SW	0.34*	0.87**	0.86**	-0.05	-	
	ST	0.41*	0.50*	1.00***	0.46*	0.86**	-
G_1	EW	-					
	EL	0.23	-				
	EWD	0.18	0.20	-			
	EI	-0.03	-0.59**	0.67**	-		
	SW	0.27*	0.76*	0.79**	0.08	-	
	ST	0.24	0.21	1.00***	0.66**	0.80**	-
G_2	EW	-					
	EL	0.42*	-				
	EWD	0.34*	0.39*	-			
	EI	-0.05	-0.54*	0.56**	-		
	SW	0.36*	0.22	0.10	-0.24	-	
	ST	0.39*	0.41*	1.00***	0.54*	0.12	-

G0= Base population; G1= Generation 1, G2=Generation 2; EW= Egg weight; EL= Egg length; EWD= egg width; EI= Egg Shape Index; SW= Shell Weight; ST= Shell Thickness

Table 2 shows the phenotypic correlations between internal egg quality traits of Japanese quail in three generations of selection for egg number. The phenotypic correlation between internal egg qualities for the three generations of selection ranged from low to high and differed in magnitude and direction ($p< 0.05-0.01$: $r = - 0.46 - 0.97$).

In this study, only the relationship between albumen length and albumen width as well as yolk width and yolk index maintained consistency in all the three generation of selection which indicated that selection for egg production does not influence the relationships between the two traits and also that these two traits are consistently under the same gene effect. Positive significant correlation between these traits were also reported by other researchers (7, 28) in Japanese quails eggs, (25, 26) in local chickens except for negative correlation reported by (4) for albumen height with albumen width (-0.64), albumen width with haugh unit (-0.64) and yolk width with yolk index (-0.76) in the eggs of Frizzle feather hens. Also a significant negative correlation between the albumen height and the yolk ratio among the internal quality traits of the egg was reported (7). Positive phenotypic correlation was also reported between the internal quality traits except yolk diameter (7). This result indicated that as albumen weight increased, albumen length and yolk weight also increased and as yolk width increased, yolk index which is a ratio of yolk length to yolk width as expressed in percentage also increased, thus increasing the viability and morphological changes in the blastorderm which would later improve survivability of the embryo, hatchability and the future performance of the bird (6, 9)

Table 2: Phenotypic correlations of Internal egg quality traits for Japanese quail by Generation

	Internal traits	AlbW	AlbL	AlbWD	HU	YW	YL	YWD	YI
G_0	AlbW	-							
	AlbL	0.31*	-						
	AlbWD	0.10	0.25*	-					
	HU	0.07	0.19	-0.20	-				
	YW	0.45*	0.23	0.21	-0.10	-			
	YL	0.01	0.07	0.14	-0.08	0.17	-		
	YWD	-0.13	-0.24	0.01	-0.19	-0.09	0.02	-	
	YI	-0.14	-0.26*	-0.04	-0.14	-0.16	-0.21	0.97**	-
G_1	AlbW	-							
	AlbL	0.17	-						
	AlbWD	0.34*	0.40*	-					
	HU	-0.23	0.03	-0.25*	-				
	YW	0.73**	0.18	0.34*	-0.09	-			
	YL	-0.23	0.03	0.04	-0.07	0.03	-		
	YWD	-0.16	-0.21	0.08	-0.11	-0.09	-0.01	-	
	YI	-0.16	-0.23	0.04	-0.13	-0.11	-0.23	0.97**	-
G_2	AlbW	-							
	AlbL	0.39*	-						
	AlbWD	0.18	0.36*	-					
	HU	0.13	-0.24	-0.34*	-				
	YW	0.21	0.19	0.21	-0.07	-			
	YL	0.02	0.13	0.26*	-0.23	0.31*	-		
	YWD	-0.21	-0.42*	-0.08	-0.27*	-0.15	0.04	-	
	YI	-0.21	-0.46*	-0.17	-0.16	-0.26*	-0.28*	0.94**	-

G_0= Base population; G_1= Generation 1, G_2=Generation 2; AlbW= Albumen weight; AlbL= Albumen Length; AlbWD= albumen width; HU= haugh Unit; YW= Yolk Weight; YL= Yolk Length; YWD= Yolk Width; YI= Yolk Index

The phenotypic correlation between external and internal egg quality traits for Japanese quails over three generations of selection for egg number is shown in Table 3. It was understood that there was an increase in the relationship between egg weight and albumen weight in G_0 and G_1. This implies that these traits increased together as generation of selection increased. This is similar to the result of (7) who reported an increase in some egg qualities of Japanese quail when the external and internal qualities were correlated. The statistically significant increase in the other traits except for the egg shape index and the haugh unit as reported by (7) was in contrast with the results obtained in this study for correlation between egg external and internal qualities. Similarly significant positive correlation was between albumen length and shell thickness and haugh and shell thickness are in harmony with (25) and (4). The non-significant correlation between albumen width and egg weight obtained in this study contradicts the significant correlation reported among some egg quality traits in local chickens by (26, 4). This could be due to the fact that genotype influences these traits and that the traits that are moderately to highly correlated can be inherited together and could be controlled by the same sets of genes (29, 30, 19). The varying magnitude and directions observed between egg external and internal quality traits were supported by the findings of several authors (22) in hen, (23, 27, 28, 24) in Japanese quails while the differences observed between the results obtained in this experiment with other researchers may be as a result of differences in the selection design and artificial selection which the present study was subjected as compared to some of these other researches (24, 12).

Table 3: Phenotypic correlations between External and Internal egg quality traits for Japanese quails

	Internal traits	**External traits**					
		EW	**EL**	**EWDT**	**EI**	**SW**	**ST**
G_0	Alb W	0.43*	0.14	0.22	0.05	0.21	0.23
	Alb L	0.04	0.06	0.27*	0.20	0.19	0.26*
	Alb WDT	0.11	0.01	-0.08	-0.10	-0.04	-0.07
	HU	-0.34*	0.85**	0.28*	-0.59**	0.66**	0.26*
	YW	1.00	0.25*	0.44*	0.18	0.40*	0.48*
	YL	0.12	0.12	-0.12	-0.22	-0.11	0.00
	YWDT	0.06	-0.01	-0.08	-0.06	-0.08	-0.05
	YI	0.03	-0.03	-0.05	-0.02	-0.05	-0.04
G_1	Alb W	0.77**	0.26*	0.12	-0.11	0.24	0.16
	Alb L	0.17	0.05	0.10	0.03	0.10	0.11
	Alb WDT	0.36*	-0.05	0.03	0.06	-0.12	0.05
	HU	-0.39*	0.76**	0.08	-0.51*	0.53*	0.06
	YW	0.94**	0.22	0.15	-0.05	0.24	0.20
	YL	0.03	0.09	-0.01	-0.08	0.05	-0.01
	YWDT	-0.18	-0.15	0.12	0.27*	0.04	0.18
	YI	-0.18	-0.18	0.18	0.29*	0.01	0.17
G_2	Alb W	0.49*	0.22	0.11	-0.10	0.16	0.13
	Alb L	0.37*	0.33*	0.14	-0.16	0.43*	0.15
	Alb WDT	0.27*	0.22	0.05	-0.15	0.29*	0.06
	HU	0.03	0.26*	0.03	-0.22	-0.08	0.03
	YW	0.49*	0.15	0.16	0.03	0.29*	0.18
	YL	0.21	0.05	-0.06	-0.07	0.15	-0.04
	YWDT	-0.30*	-0.30*	0.03	0.27*	-0.87**	0.00
	YI	-0.36*	-0.30*	0.03	0.27*	-0.90**	0.01

G_0= Base population; G_1= Generation 1, G_2=Generation 2; EW= Egg weight; EL= Egg length; EWD= egg width; EI= Egg Shape Index; SW= Shell Weight; ST= Shell Thickness; AlbW= Albumen weight; AlbL= Albumen Length; AlbWD= albumen width; HU= haugh Unit; YW= Yolk Weight; YL= Yolk Length; YWD= Yolk Width; YI= Yolk Index

Conclusion and Applications

1. The interrelationships that exist among internal and external egg quality traits in this study could be maximized in improving for egg quality traits in quails as selection for egg number increases.
2. The breeders could utilise the information from this study to reduce the traits of interest in developing the breeding programme especially traits which have negative correlations with egg weight.
3. The research would aid the breeder in determining the tools for improvement other than selection to fast track the improvement program.

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