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Correlation Between Egg Weight and Egg Characteristics in Japanese Quail

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Abstract: A study was undertaken to predict the correlation between egg weight and egg characteristics in quail. Data was collected on 102 eggs collected from female quails at 28 weeks. Eggs were numbered, weighed and classified into six egg weight groups: below 9.0g, 9.0-9.5g, 9.6-10.0g, 10.1-10.5g, 10.6-11.0g, and above 11g group. There were 17 eggs per egg weight group. Data was collected on egg weight, shell weight, shell ratio, albumen height, albumen weight, albumen ratio, albumen index, yolk height, yolk diameter, yolk weight, yolk ratio and Haugh Unit. Data collected were analysed using the General Linear Model (GLM) procedure of the Genstat edition 11. The correlation between the various characteristics of egg were determined. The result shows that Albumen diameter, albumen length and albumen width were influenced by size of egg ($p<0.05$). Albumen diameter and albumen length increases with increasing egg size. There was a positive correlation between egg length and albumen (0.448), albumen diameter (0.463), shell surface area ($p<0.01$). Egg width, height, shape index, shell ratio and shell surface area were significantly ($p>0.05$) influenced by the sizes of quail eggs. The egg sizes of above 11g had the best egg length followed by 10.6g-11.0g, 10.1g-10.5g, 9.6g-10.5g, 9.0g-9.5g and below 9.0 g had the least egg length indicating a direct relationship between egg length and egg weight. The positive correlations between the internal and external egg quality traits indicated that the traits can be improved through selection.

Keywords: Correlation, Haugh Unit, Albumen Diameter, Egg Quality, Shell Surface Area

1. Introduction

Quails are highly prolific with shorter generation interval, require less space, feed and capital to start with, have greater resistance to diseases and they can be reared under wide range of climate and farm conditions compared to other species of poultry. Breeding of quails become important because of their meat and eggs. Quails are worldly accepted due to the medicinal value of their meat and eggs. The quality of an egg influences the chick which indirectly influences the meat that is produced. Egg production is an important economic trait in poultry breeding that determines the efficiency of chick production for further rearing for meat. It is influenced by several factors such as nutrition, management, environment etc. External egg quality traits such egg weight, shell weight, shell thickness as well as internal egg quality traits such as albumen and yolk characteristics are very important for the consumers and the egg product industry [1]. A research conducted by Narushin and Romanov [2] revealed that the egg quality traits of an egg is highly influenced by the genotype of the birds, breeding systems, management, nutrition and egg weight. Most poultry breeders and farmers consider weight of the egg very important in determining their choice of birds [3] as it can affect both egg quality and grading [4]. Egg weight is usually the total fraction of albumen, egg yolk and eggshell. Generally, the larger the egg, the larger the yolk and egg albumen and vice versa [5]. Iposu et al [5] reported negative correlations between egg weight and albumen height as well as egg weight and Haugh Unit. Additional conclusions were also reported by Sekeroglu and Altuntas [6] with positive correlations among egg weight and shape index, yolk width, yolk height and albumen index. Despite the current studies on internal and external egg characteristics and their correlation, the researches exploring those features in quails, including phenotypic correlation, remain very scant. Therefore, the objectives of the present study were to evaluate the influence of different egg weight groups on external and internal characteristics and also to determine the correlation among these traits of Japanese quail eggs.

2. Materials and Methods

2.1. Quails and Dgg Collection

The study took place at the Quails Unit of the CSIR-Animal Research Institute, Accra, Ghana, where 102 eggs were collected from female quails at 28 weeks old to be used as the experimental material and transported to the Biotechnology and Molecular Biology laboratory of the CSIR-Animal Research Institute, Accra, Ghana where conditions were optimized for accurate data measurement.

The birds were grouped into 50 each in a cage. Feed and water were given *ad libitum*. They were fed with commercial diet containing 20% CP and 2,750 kcal of ME/kg from a feed company and received 24 hours of light per day. All quails were vaccinated against common diseases during the experimental period. A total number of 102 eggs were collected within 24 hours of lay for the study. Eggs were numbered, weighed and classified into six egg weight groups: below 9.0g, 9.0-9.5g, 9.6-10.0g, 10.1-10.5g, 10.6-11.0g, and above 11g group. There were 17 eggs per egg weight group.

2.2. Egg Measurements

Eggs were weighed using an electronic scale with the accuracy of 0.01g. After breaking and separating egg components, eggshells were washed, air-dried and weighed. For internal egg quality characteristics, a caliper was used to measure the length and width of albumen and yolk.

In addition, parameters of indexes of albumen, yolk and HU were calculated as followed: Albumen index (%) = (albumen height, mm/average of albumen length, mm and albumen width, mm) x 100; Yolk index (%) = (yolk height, mm/yolk diameter, mm) x 100 and Haugh unit = 100 x log(AH + 7.57 – 1.7 x EW0.37), where AH = albumen height (mm) and EW = egg weight (g) [7, 8].

2.3. Statistical Analysis

Data collected were analysed using the General Linear Model (GLM) procedure of the Genstat Edition 11 according to the following model: Yik = μ + Wi + eik; where: Yik is the phenotypic value of the traits (egg weight, shell weight, shell ratio, albumen height, albumen weight, albumen ratio, albumen index, yolk height, yolk diameter, yolk weight, yolk ratio, and HU); μ is the overall mean; Wi is the effect of the egg weight groups (1, 2, 3, 4, 5, 6); and eik is the random error. The differences and their significance among egg weight groups were done by using Turkey's test at 95% levels of Probability.

3. Results and Discussion

3.1. Effects of Egg Size on Internal Egg Characteristics

Albumen diameter, albumen length and albumen width were influenced by size of egg (p<0.05). Albumen diameter and albumen length increases with increasing egg size. Eggs above 11g had the widest albumen diameter and those eggs of size of 9.0g had the least albumen diameter. Albumen height, Yolk index, Albumen index, Yolk diameter, and Yolk height were not significantly influenced by the size of eggs. There was a positive correlation between egg length and albumen (0.448), albumen diameter (0.463), shell surface area (p<0.01). The significant and positive correlations indicated that the longer egg length had a positive effect on egg weight. Albumen length is highly correlated to egg length. This implies selection for egg length will automatically select for Albumen length. Egg width is positively correlated to albumen length. This indicates that improvement of albumen height, yolk height and yolk width will result in a better yolk index. Dependent on this result, egg freshness will be improved since yolk index determines egg freshness.

There was a highly significant negative correlation between yolk index and yolk diameter while a negative correlation between albumen index and albumen length was recorded. The physical qualities of quails' eggs play a very critical role in embryonic development. According to the finding of [9] Haugh unit was not influenced by egg size in quails. However, they reported of significant effect on larger eggs on yolk height, yolk diameter, yolk weight, albumen height and albumen weight than the small eggs.

Duman *et al* [10] reported significantly positive correlation between egg shape index and egg surface area. However, [11]reported non-significant correlation negative correlation shape index and egg surface area. However, egg weight has significant (p<0.01) influence on shell ratio, unit surface shell weight (p>0.05).

3.2. Effects of Egg Size on External Egg Characteristics

The result on the influence of egg size on external and internal egg characteristics is shown in table 1 above. Egg width, height, shape index, shell ratio and shell surface area were significantly (p>0.05) influenced by the sizes of quail eggs.

The egg sizes of above 11g had the best egg length followed by 10.6g-11.0g, 10.1g-10.5g, 9.6g-10.5g, 9.0g-9.5g and below 9.0 g had the least egg length indicating a direct relationship between egg length and egg weight. Higher egg weights correspond with higher egg length values. It further implies that, selection for better egg weight will automatically result in selection for egg length. Egg weight has a highly significant positive correlation with egg height (0.686) as shown in Table 2. This indicates that increases in egg weight will lead to increases in the length. From Table 1 and 2 a similar result was obtained for the relationship between egg weight and width of the egg. Selection for better egg weight will invariably select eggs with better length and width.

Egg width and shell surface area were influenced by the weight of egg ($p<0.05$). Egg width increases with increasing egg weight. There was a highly significant positive correlation between egg weight and egg width (0.730) and shell surface area (1.00). This may be due to the fact that egg yolk occupies the egg width area, thereby translating to heavier egg weight. Similar findings were reported by Monira *et al* [12] that egg weight significantly affect egg length and width. Also, the current result supports the report of [13]. These authors reported a correlation coefficient of 0.78 and 0.84 between egg weight with egg length and egg width, respectively. Based on the correlations, they concluded that egg length and egg width were better predictors of egg weight when compared to egg shape index.

The findings determined in this study are also in agreement with the reports of [14], they found highly significant correlations between the egg weight with egg length and egg width. Also, [15] reported significant correlations between egg weight with egg length and egg width.

However, shell ratio and unit surface shell weight were not significantly ($p>0.05$) influenced by egg weight. The result further shows that there was positive-non-significant correlation between shell thickness and egg weight and egg width. The findings of current study differ from that of Nwagu *et al*. [16]; Obike and Azu [17] who reported of highly significant correlation between egg weight and egg width in chicken and Guinea fowl. There was non-significant negative correlation between egg weight and shape index (-0.014).

Egg weight had no significant effect on Haugh unit, shape index, shell thickness and shell weight.

Table 1. *Influence of Egg Weight on Internal and External Egg Characteristics.*

	9.0g	9.0-9.5g	9.6-10.0g	10.1-10.5g	10.6-11.0g	Above 11g	SEM	*p*-value
Internal Characteristics								
Alb index	11.97^{a}	12.50^{a}	13.17^{a}	11.88^{a}	12.82^{a}	12.85^{a}	1.009	0.934
Alb. Diameter	26.04^{a}	27.45^{ab}	27.70^{ab}	28.19^{abc}	29.49^{bc}	30.30^{c}	0.610	<.001
Alb. Height	3.676^{a}	4.032^{a}	4.274^{a}	3.710^{a}	4.057^{a}	4.385^{a}	0.222	0.147
Alb. Length	35.75^{a}	37.25^{ab}	37.38^{ab}	38.47^{abc}	40.14^{bc}	42.15^{c}	0.985	<.001
Yolk Diameter	21.15^{a}	21.55^{a}	21.36^{a}	21.33^{a}	23.05^{a}	22.22^{a}	0.636	0.267
Yolk index	41.62^{a}	39.34^{a}	38.69^{a}	40.06^{a}	37.02^{a}	41.63^{a}	1.468	0.206
Yolk height	8.77^{a}	8.36^{a}	8.24^{a}	8.52^{a}	8.31^{a}	9.22^{a}	0.273	0.111
HU	52.2^{a}	56.7^{a}	58.5^{a}	51.4^{a}	54.2^{a}	58.2^{a}	02.77	0.303
External Characteristics								
Shape Index	70.83^{a}	67.94^{a}	70.25^{a}	69.73^{a}	71.20^{a}	69.60^{a}	0.782	0.064
Shell Ratio	10.10^{a}	9.72^{a}	8.88^{a}	7.93^{a}	6.92^{a}	7.90^{a}	0.789	0.046
Shell thickness	0.242^{a}	0.296^{a}	0.318^{a}	0.252^{a}	0.332^{a}	0.292^{a}	0.0306	0.251
Shell weight	0.878^{a}	0.902^{a}	0.871^{a}	0.813^{a}	0.748^{a}	0.926^{a}	0.0797	0.646
Unit Sur S. W	0.0435^{a}	0.0426^{a}	0.0394^{a}	0.0356^{a}	0.0315^{a}	0.0367^{a}	0.0035	0.150
Egg height	28.73^{a}	30.01^{b}	30.14^{b}	30.83^{b}	30.82^{b}	32.09^{c}	0.275	<.001
Egg weight	8.70	9.28	9.80	10.25	10.81^{a}	11.68	0.0523	<.001
Egg width	20.327^{d}	20.308^{a}	21.165^{b}	21.487^{bc}	21.933^{cd}	22.318^{d}	0.1563	<.001
Shell surf A.	20.176	21.192	22.062	22.833	23.770^{a}	25.180	0.0854	<.001

Table 2. *Correlation Coefficients of Egg Characteristics.*

	EH	EW	ST	SW	AH	YH	YD	AL	AD	SI	SHA	USSW	SR	AI	YI	HU
EH	.686**	.730**	.138	-.012	.156	.145	.148	.448**	.463**	-.014	1.000**	-.213*	-.275**	.042	.008	.068
EW		.466**	.137	.029	.133	.038	.174*	.414**	.390**	-.543**	.687**	-.112	-.155	-.030	-.100	.089
ST			.060	.130	.174*	.121	.149	.355**	.382**	.485**	.733**	-.014	-.060	.062	.002	.028
SW				-.066	-.088	-.078	.024	.048	.127	-.077	.139	-.097	-.106	-.160	-.075	-.102
AH					-.209*	.152	.019	.036	-.120	.102	-.013	.977**	.960**	-.310**	.135	-.212*
YH						.093	-.078	.142	.109	.035	.154	-.227*	-.231**	.749**	.083	.978**
YD							.020	.031	-.074	.057	.143	.121	.111	.014	.827**	.088
AL								.185*	.135	-.046	.149	-.021	-.033	-.150	-.505**	-.104
AD									.638**	-.090	.449**	-.071	-.104	-.254**	-.135	.109
SI										-.034	.462**	-.226*	-.258**	-.265**	-.204*	.067
SHA											-.012	.110	.112	.091	.094	-.061
USSW												-.215*	-.276**	.041	.006	.065
SR													.998**	-.289**	.138	-.215*
AI														-.280**	.138	-.214*
YI															.090	.714**
HU																.093

EG=egg height, EW= egg width, ST=Shell thickness, SW=Shell weight, AH=Albumen Height, YH=Yolk height, YD=Yolk diameter, AL=Albumen length, AD=Albumen Diameter, SI=Shape Index, SHA=Shell Surface Area, USSW= Unit surface shell weight, SR=Shell Ratio, AI=Albumen Index, YI=Yolk Index, HU=Haugh Unit *$p<0.05$; **$p<0.01$

4. Conclusions

The positive correlations between the internal and external egg quality traits indicate that the traits can be improved through selection.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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