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Effects of Egg's Weight on Egg Quality Traits of the Potchefstroom Koekoek Chicken Genotype

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Abstract.
Egg is a reproduction tool for chickens and valuable food source for humans. The objective of this study was to examine the effect of egg weight (EW) on egg quality traits such as egg length (EL), egg diameter (ED), yolk weight (YW), albumen weight (AW), shell weight (SW), shell index (SI), yolk ratio (YR), albumen ratio (AR) and shell ratio (SR). Potchefstroom Koekoek layer genotype eggs (n = 200) were used. Pearson correlation and analysis of variance (ANOVA) were used for analysis. Correlation results indicated that egg weight had a statistical significant correlation ($P < 0.05$) with egg quality traits. Egg weight displayed a positive significant correlation with EL (0.82), AW (0.67) and SW (0.62), respectively. The findings suggest that EL, AW and SW might be used to improve EW of Potchefstroom Koekoek chicken genotype. ANOVA results showed that egg weight had a statistical significant difference ($P < 0.05$) with egg quality traits except albumen ratio and yolk ratio ($P > 0.05$). Moreover, the findings revealed that small eggs weight had a longer egg length, yolk weight, shell weight, shell ratio and albumen weight than medium and large eggs. Large eggs had a higher egg diameter and shell index.

Keywords: Albumen weight, egg length, large egg, medium egg, small egg, shell weight

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1. Introduction

Chicken egg is the cheapest source of protein which also contains vitamins and carbohydrates [1]. In egg production enterprise, egg weight is one of the economically important traits which require serious attention to the egg producers [2]. Egg weight is affected by several egg quality traits such as such as egg length, egg diameter, yolk weight, albumen weight, shell weight, shell index, yolk ratio, albumen ratio and shell ratio and other factors including genetic, age, breed or strain of the chicken and nutrition [3]. Transportability of egg is dependent on its shell thickness since eggs with

thin shells are liable to break on transit and thus constitute a great loss to the layer farmer [1]. Hence, the effects of egg weight on egg quality trait and chicken genotype are imperative to the egg industry worldwide [1].

There are also reports on the relationship between egg size and egg quality parameters [4]. However, to the best of our knowledge studies on the effects of egg weight on egg quality traits in South African Potchefstroom Koekoek chicken genotype has not yet been reported on literature. Hence, the objective of this study was to examine the effect of egg weight on egg quality traits such as egg length, egg diameter, yolk weight, albumen weight, shell weight, shell index, yolk ratio, albumen ratio and shell ratio. Thus, this study was designed to examine the effects of egg weight on egg quality traits of Potchefstroom Koekoek layer chicken genotype.

2. Materials and Methods

The research was conducted at the University of Limpopo which is in the Capricorn District Municipality in the Limpopo province of South Africa. Annually, an average temperature of about 24.6 ⍰C is received with a minimum average of 18.9 ⍰C in June, and a maximum average of 28.2 ⍰C in January. In the study area, January is mostly the wettest month with about 420 mm annual rainfall. July is the driest month with only about 2 mm. An average annual relative humidity of about 77.4% [5].

The eggs were weighed and grouped into the following categories: small weight (< 60 g), medium weight (60 to 69 g) and large weight (> 69 g). Egg weight was measured using a sensitive digital weighing balance (Mettler Toledo, PL203 CE) with accuracy of 0.001 g. Egg length and egg width were taken using a Vernier calliper. Egg length, egg weight diameter, yolk weight, albumen weight, shell weight, shell index, shell ratio and albumen ratio were measured and computed as described by Ukwu *et al*. [1].

Statistical Package for Social Sciences [6] version 26 was used for data analysis. Pearson's correlation was used to determine the correlation coefficient between measured traits. Analysis of Variance (ANOVA) was used to determine the effect of egg weight group on egg quality traits. The following model was used for ANOVA.

$$y_{ij} = +T_i + e_{ij}$$

Where; Yij = jth observation in the ith egg weight group, μ = overall mean, Ti = effect of the ith egg weight group (i = small, medium and large) and eij = residual error.

3. Results and Discussion

3.1. Descriptive statistics

The current study was conducted to determine the effect of egg weight on egg quality traits of the Potchefstroom Koekoek layer genotype. Descriptive statistics of egg quality traits (egg length, egg diameter, yolk weight, albumen weight, shell weight, shell index, yolk ratio, albumen ratio and shell ratio) in different egg weight groups (small, medium and large) are presented in Table 1. The summary indicated that small egg group had higher mean numerical value of yolk ratio (3.02) than the other egg weight groups, medium egg group had a higher mean numerical values in egg weight diameter (4.44 cm), yolk weight (1.85 g), albumen weight (3.50 g), shell weight (0.90 g), shell ratio (1.44) and albumen ratio (5.60) while large egg group had a longer numerical value of egg length (5.73 cm) than the other egg weight groups. Our descriptive statistics findings are similar with the study of Abanikannda *et al*. [7] on Harco chicken layer genotype. However, these results are higher than of Ukwu *et al*. [1] on Isa Brown layer genotype of Nigeria. This variation might be due to genotype differences between Potchefstroom Koekoek layer and Isa Brown layer.

3.2. Phenotypic correlation between measured traits

The study firstly focused on the relationships between egg weight and egg quality traits of Potchefstroom Koekoek layer genotype as presented in Table 2. The results indicated that EW had a highly statistical significant positive correlation ($P < 0.01$) with EL ($r = 0.82$), AW ($r = 0.67$) and SW ($r = 0.62$) while EW had a statistically positive significant correlation ($P < 0.05$) with EWD ($r = 0.40$), YW ($r = 0.33$), SR ($r = 0.27$) and AR ($r = 0.31$) while negatively statistical correlation with SI ($r = -0.44$) and YR ($r = -0.48$), respectively. Positive significant ($P < 0.01$) correlation were found between egg weight diameter and albumen weight and albumen ratio, while a positive significant ($P < 0.05$) correlation was observed between egg weight diameter and yolk weight, shell weight and shell index. However, high negative significant ($P < 0.01$) correlation observed between egg weight diameter and yolk ratio. Positive correlations were found between yolk weight and shell weight, shell ratio ($P < 0.01$) and yolk ratio ($P < 0.05$). Moreover, moderate negative significant ($P < 0.05$) correlation was observed between yolk weight and shell index, albumen ratio.

The correlation between albumen weight and shell weight, albumen ratio was highly positive significant ($P < 0.01$) and low significant ($P < 0.05$) with shell index in the study. However, high negative significant ($P < 0.05$) between albumen weight and yolk ratio

Table 1: Descriptive statistics of egg quality traits in different egg weight groups.

Traits	Egg weight group	N	Min	Max	Mean	Std. Error	SD	CV (%)
Egg length (cm)	Small	60	5.26	5.54	5.41	0.11	0.89	0.79
	Medium	60	5.26	5.54	5.41	0.11	0.89	0.79
	Large	23	5.47	5.73	5.69	0.10	0.48	0.23
Egg weight diameter	Small	60	4.11	4.51	4.31	0.15	1.19	1.43
(cm)	Medium	60	4.29	4.50	4.44	0.05	0.44	0.20
	Large	23	4.23	4.40	4.24	0.07	0.36	0.13
Yolk weight (g)	Small	60	15.10	17.90	16.75	0.10	0.84	0.71
	Medium	60	17.80	19.10	18.52	0.06	0.54	0.29
	Large	23	17.60	19.10	17.67	0.06	0.31	0.10
Albumen weight (g)	Small	60	26.90	36.40	31.81	0.42	3.28	10.77
	Medium	60	30.80	36.90	34.99	0.17	1.38	1.90
	Large	23	30.80	34.30	33.32	0.12	0.58	0.33
Shell weight (g)	Small	60	6.70	8.30	7.37	0.07	0.55	0.30
	Medium	60	7.80	9.40	8.98	0.05	0.39	0.16
	Large	23	7.80	9.40	8.14	0.05	0.28	0.07
Shell index (%)	Small	60	78.16	83.57	79.63	0.24	1.85	3.45
	Medium	60	76.82	80.04	77.96	0.18	1.44	2.08
	Large	23	74.26	78.43	74.55	0.20	0.99	0.99
Shell ratio (%)	Small	60	11.39	13.97	13.18	0.11	0.85	0.72
	Medium	60	13.45	14.97	14.37	0.08	0.65	0.43
	Large	23	13.71	14.97	13.76	0.05	0.26	0.06
Albumen ratio (%)	Small	60	53.16	60.97	56.66	0.36	2.85	8.13
	Medium	60	54.51	58.39	55.97	0.21	1.66	2.78
	Large	23	54.51	56.51	56.34	0.11	0.56	0.31
Yolk ratio	Small	60	26.09	33.60	30.15	0.32	2.54	6.49
	Medium	60	28.16	31.68	29.64	0.13	1.04	1.08
	Large	23	29.78	31.68	29.89	0.08	0.41	0.16

N = sample size; Max = maximum; Min = minimum; SD = standard deviation, Std. Error = Standard error of means; CV = coefficient of variation.

was found. This revealed that as albumen weight increases the yolk ratio decreases. Negative significant correlation between shell weight and shell index ($P < 0.05$) and yolk ratio ($P < 0.01$) was found in the study, although high positive correlation was observed between shell weight and shell ratio ($P < 0.01$). The correlation between shell index and shell ratio ($P < 0.01$), yolk ratio ($P < 0.05$) were negative significant in the study. Even though, positive significant ($P < 0.01$) correlation was found between shell index and albumen ratio. Negative significant ($P < 0.01$) correlation between shell ratio and albumen ratio was observed in the study, while low positive significant ($P < 0.05$)

Table 2: Phenotypic correlations between egg weight and egg quality traits.

Egg traits	EW	EL	EWD	YW	AW	SW	SI	SR	AR
EL	0.82**								
EWD	0.40*	0.47*							
YW	0.33*	0.57**	0.13^{ns}						
AW	0.67**	0.60**	0.89**	-0.02^{ns}					
SW	0.62**	0.92**	0.46*	0.57**	0.52**				
SI	-0.44*	-0.56**	0.47*	-0.44*	0.24*	-0.50**			
SR	0.27*	0.67**	-0.07^{ns}	0.54**	-0.03^{ns}	0.83**	-0.74**		
AR	0.31*	0.04^{ns}	0.65**	-0.59**	0.78**	-0.07^{ns}	0.57**	-.525**	
YR	-0.48*	-0.34*	-0.72**	0.45*	-0.89**	-0.28*	-0.34*	0.17*	-0.93**

*= Correlation is significant at the 0.05 level, **= Correlation is significant at the 0.01 level, EL= Egg length; EWD= Egg weight diameter; YW= Yolk weight; AW= Albumen weight; SW= Shell weight; Shell index; SR= Shell ratio; AR= Albumen ratio; YR= Yolk ratio.

was found between shell ratio and yolk ratio. Moreover, negative significant ($P < 0.01$) correlation was observed between albumen ratio and yolk ratio. These findings are in agreement with the report of Ukwu *et al*. [1] who reported that egg weight had a highly statistical significant correlation ($P < 0.01$) with egg length ($r = 0.773$), egg diameter ($r = 0.888$) and shell weight ($r = 0.680$), and concluded that increasing egg length, egg diameter and shell weight might increase egg weight of Isa Brown layer genotype of Nigeria. Aktan [8] and Alkan *et al*. [9] reported that egg weight has a statistical positive correlation with albumen weight. However, Alkan *et al*. [10] reported that egg weight has a statistical significant correlation with shell weight, yolk weight and albumen weight. Our findings suggest that increasing egg length, albumen weight and shell weight might also improve egg weight of Potchefstroom Koekoek. Therefore, egg length, albumen weight and shell weight might be employed in the selection criteria during breeding to improve egg weight.

3.3. Effects of egg weight on egg quality traits

The current study also focused on the effect of egg weight into egg quality traits (Table 3). The egg length of small, medium and large egg weight groups was significantly ($P > 0.05$) different. Numerically, the large egg weight group had the highest egg length (5.70 cm) while small had the lowest egg length (5.41 cm). Egg weight diameter of the different egg weight groups differ significantly ($P < 0.05$). However, the medium egg weight group had the highest egg weight diameter (4.44 cm) while, large weight group had the lowest egg weight diameter (4.24 cm). Yolk weight for small, medium

and large egg groups were 16.74, 18.52 and 17.67 g respectively. Egg yolk weight from the three groups differ significantly ($P < 0.05$). However, medium egg weight group had the better yolk weight (18.52 g) than eggs in the other groups. Mean albumen weight indices were 31.76, 34.99 and 33.32 g for small, medium and large egg weight groups respectively. Albumen indices among the different egg weight groups differ significantly ($P < 0.05$). However, the small egg weight group had the lowest albumen weight (31.76 g) compared to other groups. The egg shell weight of small, medium and large egg weight groups was significantly ($P < 0.05$) different and were observed to be 7.37, 8.98 and 8.14 g respectively.

Table 3: Effect of egg weight on egg quality traits of Potchefstroom Koekoek layer genotype.

Egg traits		Egg weight groups	
	Small	Medium	Large
Egg length (cm)	5.41 ± 0.12^{b}	5.69 ± 0.12^{a}	5.70 ± 0.12^{a}
Egg weight diameter (cm)	4.30 ± 0.15^{b}	4.44 ± 0.15^{a}	4.24 ± 0.15^{c}
Yolk weight (g)	1.67 ± 0.11^{c}	18.52 ± 0.11^{a}	17.67 ± 0.11^{b}
Albumen weight (g)	3.18 ± 0.42^{c}	34.99 ± 0.42^{a}	33.32 ± 0.42^{b}
Shell weight (g)	7.37 ± 0.07^{c}	8.98 ± 0.07^{a}	8.14 ± 0.07^{b}
Shell index (%)	79.59 ± 0.26^{a}	77.96 ± 0.26^{b}	74.55 ± 0.26^{c}
Shell ratio	13.19 ± 0.11^{c}	14.37 ± 0.11^{a}	13.76 ± 0.11^{b}
Albumen ratio	56.62 ± 0.37^{a}	55.97 ± 0.37^{a}	56.34 ± 0.37^{a}
Yolk ratio	30.18 ± 0.32^{a}	29.64 ± 0.32^{a}	29.89 ± 0.32^{a}

a, b, c: means in the same row with different superscripts are significantly ($P < 0.05$) different.
SEM: standard error of the mean.

The egg shell index indices of small, medium and large egg weight groups were significantly ($P < 0.05$) different. The small egg weight group had the highest shell index (79.59 %) while the large weight group had the lowest index (74.55 %), but statistically significant. The shell ratio of the egg weight groups was significantly ($P < 0.05$) different, with numerical values of 13.19, 14.37 and 13.76 for small, medium and large respectively. The medium egg weight group had the better mean shell ratio (14.37), while the small egg weight group had the lowest mean shell ratio (13.19). The albumen ratio of small, medium and large egg weight groups did not differ significantly ($P > 0.05$). Numerically, the small egg weight group had the highest albumen ratio (56.62) while medium had the lowest mean albumen ratio (55.97) but statistical insignificant. The yolk ratio indices for small, medium and large egg weight groups were 30.18, 29.64 and 29.89, respectively. Egg from the three groups were not significantly ($P > 0.05$) affected by yolk ratio. However, eggs from the small egg weight group had better mean yolk ratio (30.18) than other groups. Our results are in agreement with the study of Alkan *et al*. [11] who

reported that egg quality traits are affected by the egg weight in Partridge (*Alectoris chukas*). However, Sekeroglu and Altuntas [12] also reported that egg weight influences the egg characteristics in laying hens. The findings of our study are in disagreement with the study of Alkan *et al*. [11] who reported that albumen weight improve as the egg weight increase. This variation might be due to bird variation since Khan [13] indicated that bird breed has an effect of egg quality traits.

4. Conclusions

The study was carried out to investigate the effect of egg weight on egg quality traits of Potchefstroom Koekoek as indigenous chicken layer chicken. Our study firstly determined the relationship between egg weight and egg quality traits, and indicated that egg weight is statistically significant correlated with egg length, albumen weight and shell weight. ANOVA findings recognised that there is a statistically significant differences among egg weight groups viz small, medium and large on all measured egg quality traits except albumen ratio and yolk ratio. The study might be helpful to chicken farmers focusing on egg production during selection to improve egg weight in breeding. Further studies need to be done on effect of egg weight on egg quality traits in bigger sample size of Potchefstroom Koekoek eggs or different chicken layer breeds.

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References

[1] Ukwu HO, Ezihe CO, Asaa SK, Anyogo ME. Effect of egg weight on external and internal egg quality traits of Isa Brown egg layer chickens in Nigeria. Journal of Animal Science and Veterinary Medicine. 2017;2(4):126–32.

[2] Ahmadi F, Rahimi F. Factors affecting quality and quantity of egg production in laying hens: A review. World Appl Sci J. 2011;12(3):372–84.

[3] Alkan S, Kemal K, Askin G, Taki K, Murat B. Effects of selection for body weight and egg production on egg quality traits in Japanese Quails (Coturnix coturnix japonica)

of different lines and relationships between these traits. Kafkas Univ Vet Fak Derg. 2010;16:239–44.

[4] Sarica M, Önder H, Yamak U. Determining the most effective variables for egg quality traits of five hen genotypes. Int J Agric Biol. 2012;14(2):235–40.

[5] Tyasi TL, Mathye ND, Danguru LW, Rashijane LT, Mokoena K, Makgowo KM, et al. Correlation and path analysis of body weight and biometric traits of Nguni cattle breed. J Adv Vet Anim Res. 2020;7(1):148–55.

[6] IBM SPSS. 2019. SPSS Release 26.0 Statistical packet program, SPSS for Windows. SPSS Inc., Chicago, IL, USA. Turkoglu, M., Sarica.

[7] Abanikannda O, Olutogun O, Leigh AO, Ajayi LA. Statistical modeling of egg weight and egg dimensions in commercial layers. Int J Poult Sci. 2007;6(1):59–63.

[8] Aktan S. Determining storage related egg quality changes via digital image analysis. S Afr J Anim Sci. 2004;34(2). https://doi.org/10.4314/sajas.v34i2.3808.

[9] Alkan S, Karsli T, Galiç A, Karabağ K. Determination of phenotypic correlations between internal and external quality traits of guinea fowl eggs. Kafkas Univ Vet Fak Derg. 2013;19(5):861–7.

[10] Alkan S, Kemal K, Askin G, Taki K, Murat B. Effects of selection for body weight and egg production on egg quality traits in Japanese Quails (Coturnix coturnix japonica) of different lines and relationships between these traits. Kafkas Univ Vet Fak Derg. 2010;16(2):239–44.

[11] Alkan S, Aşkın G, Taki K, Karabağ K. Effects of egg weight on egg quality traits in partridge (*Alectoris Chukar*). J Appl Anim Res. 2015;43(4):450–6.

[12] Sekeroglu A, Altuntas E. Effects of egg weight on egg quality characteristics. J Sci Food Agric. 2009;89(3):379–83.

[13] Khan M, Khatun M, Kibria A; M.K.I. Khan; M.J. Khatun; A.K.M.G. Kibria. Study the quality of eggs of different genotypes of chicken under scavenging system at Bangladesh. Pak J Biol Sci. 2004;7(12):2163–6.