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Effect of Egg Weight on Hatchability and Subsequent Performance of Potchefstroom Koekoek Chicks

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ABSTRACT

A study was conducted to determine the effect of Potchefstroom Koekoek chicken egg weight on hatchability and subsequent chick performance. In the first part of the study, a total of 450 Potchefstroom Koekoek eggs were used in a complete randomized design to determine the effect of egg weight on hatchability, embryonic deaths, egg weight loss and hatch weight. The eggs were allocated into three weight-treatments: large (>55 g, A), medium (45-55 g, B) and small (<45 g, C). Hatching yield, hatchability, embryonic deaths, egg weight loss and hatch weight were significantly ($p<0.05$) affected by the weight of the eggs. The large and medium-sized eggs had higher hatching yield (60 and 70%, respectively). The medium-sized eggs had higher ($p<0.05$) hatchability values than both small and large-sized eggs. Medium-sized eggs had lower ($p<0.05$) embryonic deaths (31%) than small (45%) and large (36%) egg sizes. The large-sized eggs had higher hatch-weights than small and medium-sized eggs. The total embryonic deaths, hatching yield and hatchability percentages were optimized within the medium-sized eggs (51 g, $r^2 \simeq 100$). The second part of the study was aimed at determining the effect of Potchefstroom Koekoek egg weights on subsequent chick performance and carcass characteristics. The chicks were fed a growers diet containing 11.97 ME MJ kg^{-1} DM feed of energy and 161 g kg^{-1} CP. Feed and water were given *ad libitum*. All the performance parameters were significantly ($p>0.05$) influenced by egg weight except mortality of the chicks at both starter and finisher phases. The large-sized egg had high ($p<0.05$) weight gain, better ($p<0.05$) daily feed intake (36 and 94 g) and feed conversion ratio (3.0 and 5.1) for both starter and finisher phases, respectively. It can be concluded that for better hatchability medium-sized eggs can be considered. However, if growth performance is of primary importance large-sized eggs can be used.

Key words: Potchefstroom Koekoek, egg weight, hatchability, egg weight loss, chick weight

INTRODUCTION

The global poultry meat production is on the increase, it moved from 69 million tons in 2004 to 94 million tons in 2008, representing a 35% increase (FAO, 2009). This trend is expected to continue. Indigenous chickens play a significant role in this increase as it account to over 85% of livestock found in the rural areas. These chickens are hardy and cheaply reared as scavenger. They are usually on free range during the day and only need small shelter to spend their nights. Their meat and egg tastes are preferred over those of exotic chickens (Roberts, 1999;

Dessie and Ogle, 2001). Indigenous chickens have superior adaptation to endemic diseases and other harsh environmental conditions. There are a number of these chickens found in South Africa, among them is Potchefstroom Koekoek. This breed is one of the most promising breeds, it is second to white leghorn, Fayoumi in terms of hen-housed, egg production per hen and hatchability, respectively. (Grobbelaar *et al*., 2010; Wondmeneh *et al*., 2011). Their feathers are sex-linked, thus making it easier to identified and separate (Fourie and Grobbelaar, 2003). Despites the attributes of this breed of chicken very little work has been done on them. There is evidence that size of eggs has effect on the incubation, embryonic deaths and hatchability of broiler chickens and rock partridges (Caglayan and Inal, 2006). Abiola *et al*. (2008), Enting *et al*. (2007), Tuft and Jensen (1991) and Wayatt *et al*. (1985) reported that egg weight had effects on subsequent chick's performance of broiler chickens. Presently, there is little or limited information on the effect of egg weight on hatchability and growth performance of Potchefstroom Koekoek chickens. Therefore, the objective of the study was to determine the effect of egg weight on hatchability and subsequent growth of indigenous Potchefstroom Koekoek chickens.

MATERIALS AND METHODS

This research was conducted at the experimental farm of the University of Limpopo, South Africa. The farm is situated 10 km North-west of the Turfloop campus of the University of Limpopo. The ambient temperatures around the area are above 30°C during summer and below 25°C in winter, it lies at latitude 27.55 S and longitude 24.77 E. The area receives a mean annual rainfall of less than 400 mm.

A total of 450 hatching Potchefstroom Koekoek chicken eggs obtained from the Agricultural Research Council (ARC), Irene, Pretoria were used to determine the effect of egg weight on hatchability and subsequent growth performance. The study was divided into two parts. In both parts, a complete randomized design was used. In first part of the study the eggs were classified into three treatment groups as large (>55 g), medium (45-55 g) and small (<45 g), replicated three times (Table 1). A 0.01 g sensitivity level electronic scale (RADWAG) was used to weigh the eggs. Eggs were fumigated with formalin potassium permanganate in a ratio of 1:2 for 15 min before they were placed in an incubator. The eggs were placed in an incubator with the broad end pointing upwards. The temperature and humidity were set at 37.5°C and 52.5%, respectively, for incubation and 37.0°C and 55% for hatching, respectively.

The weights of the eggs were taken at day 7, 14 and 18 of incubation to calculate the weight loss. On the 18th day of incubation, the eggs were candled and those with evidence of living embryos were recorded for the different egg treatments and transferred to the hatcher. The remaining eggs were candled and then broken for microscopic analysis to distinguish the eggs containing dead embryos from the infertile ones. On the day 21, the hatched chicks were counted, weighed and the percentage fertility rate, hatching yield and hatchability were calculated using the formulas described by Sahin *et al*. (2009).

Table 1: Weight of Potchefstroom Koekoek chicken eggs

		Egg weight (g)			
Treatment	No. of eggs	Mean	Minimum	Maximum	SE
A	150	56.44	55.40	59.60	1.94
B	150	50.33	49.40	54.85	1.08
C	150	43.79	42.10	48.10	1.67

SE: Standard error

In the second part of the study, 80 chicks per group were randomly selected from each hatched treatment for subsequent growth trial. Each treatment was divided in four replicates with 20 chicks per replicate, thus a total of 12 floor units (1.5 m^2) were used in total. The experimental diet was isocaloric and isonitrogenous. The diet was composed of the following ingredients: maize (64%), maize gluten meal (11.67%), fish meal (5.00%), soya Hi pro (4.37%), full fat soya (4.91%), Di sodium phosphate (1.33%), DL-methionine (0.20%), L-lysine (0.20%), $CaCO_3$ (8.17%) and vitamin trace element premix (0.15%). The birds were offered feed and water *ad libitum*. The daily lighting program was 24 h.

Data collection: The live weights of birds were taken at hatching and recorded as initial weight. Average live weight per bird was measured at weekly intervals by weighing the chickens in each pen and the total weight was divided by the total number of birds in each pen. These live weights were used to calculate growth rate. Feed conversion ratio per pen was calculated as total feed consumed divided by the weight gain of live birds in that pen. Morality was recorded daily during the study. At day 91 all the birds were slaughtered. Carcass weight, breast meat, drum stick, wings, thigh and fat pads were weighed and recorded.

Statistical analysis: Effects of egg weight on hatchability and subsequent performance of the chicks were analysed using the general linear model procedure of the statistical analysis system (SAS, 2008). The statistical model used was:

$$Y_{ijk} = \mu+T_i+\Sigma_{ijk}$$

where, Y_{ijk} is the overall observation (fertility, embryonic deaths, hatching yield and hatchability, weight gain, feed intake, feed conversion ratio, mortality and carcass characteristics), T_i is effect of different egg weights (small, medium and large) and Σ_{ijk} is residual effect.

Duncan's test for multiple comparisons was used to test the significant difference between treatment means ($p<0.05$). The responses in optimum fertility rate, embryonic deaths hatching yield and hatchability to egg weight were modelled using the following quadratic equation:

$$Y = a+b_1x+b_2x^2$$

where, Y is optimum embryonic deaths, hatching yield and hatchability, a is intersect, b_1 and b_2 is coefficients of quadratic equation, x is egg weight and-b_1/b_2 is x value for optimum egg size.

RESULTS

Results of the effects of Potchefstroom Koekoek egg weight on hatchability are presented in Table 2. Egg weight had effects ($p<0.05$) on hatching yield, hatchability, embryonic deaths, egg weight loss and chick hatch-weight. The fertility and egg-chick ratio were not affected ($p>0.05$) by the weight of the Potchefstroom Koekoek eggs. The hatching yield of eggs in treatments B and A (74 and 60)%, respectively, were similar ($p>0.05$) and higher ($p<0.05$), than those from treatment C (53%). Percentage hatchability of medium-sized eggs (77%) were higher ($p<0.05$) than those in large-sized eggs (64%). Similarly, larger-sized eggs had higher ($p<0.05$) percentage hatchability than small-sized eggs (55%). Eggs in treatment C had higher ($p<0.05$) embryonic deaths (45%) than those in treatment A (36%) which in turn were higher ($p<0.05$) than those eggs in treatment

Table 2: Effect of Potchefstroom Koekoek chicken egg weight on egg and chick reliability

	Treatment			
Variable	A	B	C	SE
Fertility rate (%)	95	95	96	0.30
Hatching yield (%)	60[a]	74[a]	53[c]	2.56
Hatchability (%)	64[b]	77[a]	55[c]	2.70
Embryonic deaths (%)	36[b]	23[c]	45[a]	1.74
Egg weight loss (g)	24[a]	17[b]	10[c]	1.73
Chick weight (g)	37[a]	32[b]	28[c]	1.09
Egg chick ratio	2	2	2	0.01

[a,b,c]Means in the same row not sharing a common superscript are significantly different ($p<0.05$)

Table 3: Effect of egg weight (g) on optimal embryonic deaths, hatching yield and hatchability percentages

Trait	Formula	r^2 values	Optimum egg weight	Y-value
Total embryonic death (%)	$Y = 728.222+-27.139X-0.264X^2$	0.99	51.42	30.47
Hatching yield (%)	$Y = -1170.444+49.194X-0.486X^2$	0.95	50.60	74.17
Hatchability (%)	$Y = -833.556+35.472X-0.347X^2$	0.99	51.08	72.41

Table 4: Effect of egg weight (g) on subsequent performance of Potchefstroom chicks from one to seven weeks of age

	Treatment			
Variable	A	B	C	SE
Daily weight gain (g bird^{-1})	12[a]	10[b]	8[c]	0.52
Live weight (g bird^{-1})	591[a]	481[b]	388[c]	25.66
Daily feed intake (g bird^{-1})	36[a]	31[b]	28[c]	1.03
Feed conversion ratio	3.0[b]	3.2[ab]	3.6[a]	0.01
Mortality (%)	10	10	11	0.62

[a,b,c]Means in the same row not sharing a common superscript are significantly different ($p<0.05$)

B (31%). Egg weight loss and hatch-weight increased as the egg weight increases. The eggs in treatment A had the highest ($p<0.05$) weight loss and chick hatch-weight 24 and 37 g, respectively, than the eggs in treatment B (17 and 32 g), respectively. Similarly, eggs in treatment B had higher ($p<0.05$) weight loss and chick hatch-weight than those in treatment C (10 and 28) g, respectively. Table 3 revives that the hatching yield, hatchability and embryonic deaths were optimized in eggs weighing approximately 51 g ($r^2 \simeq 100$).

The effects of egg weight on subsequent performance of Potchefstroom Koekoek chicks from one to seven weeks of age are presented in Table 4. Weight of Potchefstroom Koekoek eggs influenced ($p<0.05$) all parameters measured except the mortality percentage. Chickens hatched from large-sized eggs had higher ($p<0.05$) daily live weight gain and live weight at seven weeks than those hatched from medium and small-sized eggs. Those hatched from medium-sized eggs also, had higher ($p<0.05$) daily live weight gain and live weight at seven weeks than those from small-sized eggs. A similar trend was observed with daily intake per bird. Chickens hatched from large-sized eggs had better ($p<0.05$) feed conversion ratio than those hatched from small-sized eggs. However, similar ($p>0.05$) ratio was observed between large and medium-sized eggs.

Results of the effects of egg weight on daily weight gain, daily feed intake, feed conversion ratio and mortahty on Potchefstroom Koekoek chickens between eight and 13 weeks and live weight at

Table 5: Effect of egg weight (g) on subsequent performance of Potchefstroom chickens from eight to thirteen weeks of age

	Treatment			
Variable	A	B	C	SE
Daily weight gain (g bird^{-1})	19^{a}	17^{b}	15^{c}	0.47
Live weight (g bird^{-1})	912^{a}	846^{b}	730^{c}	23.51
Daily feed intake (g bird^{-1})	94^{a}	90^{b}	80^{c}	1.80
Feed conversion ratio	5.1^{b}	5.2^{ab}	5.3^{a}	0.06
Mortality (%)	0	0	0	0.00

^{a,b,c}Means in the same row not sharing a common superscript are significantly different ($p<0.05$)

Table 6: Effect of egg weight on subsequent carcass characteristics (g) of Potchefstroom chickens aged thirteen weeks

	Treatment			
Variable	A	B	C	SE
Carcass weight (g)	1040	1142	1119	30.25
Breast meat (g)	249^{a}	240^{b}	235^{b}	2.23
Drum stick (g)	185	175	173	4.16
2 Wings (g)	157	155	153	2.80
Thigh (g)	192^{a}	178^{ab}	164^{b}	4.77
Fat pad (g)	17	17	16	0.15

^{a,b,c}Means in the same row not sharing a common superscript are significantly different ($p<0.05$)

13 week old are presented in Table 5. Chickens hatched from large-sized eggs had higher ($p<0.05$) daily live weight gain, daily feed intake and live weight gain at 13 weeks than those from medium-sized eggs. Similarly, chickens hatched from medium-sized eggs had higher ($p<0.05$) daily live weight gain, daily feed intake and live weight gain at 13 weeks than hatched from small-sized eggs. The feed conversion ratio between eggs hatched from large and medium-sized eggs were similar ($p = 0.05$), however, chickens hatched from large-sized eggs had better feed conversion ratio when compared to those hatched from small-sized eggs. Egg size had no effect ($p>0.05$) on chicken mortality between 8 and 13 weeks of age.

The effects of egg weight on subsequent hatched chicken's carcass characteristics of Potchefstroom Koekoek are presented in Table 6. Egg weight of Potchefstroom Koekoek hen had not effect ($p>0.05$) on the chicken's carcass weight, drum stick, wings and fat pad. However, the breast meat and the thigh weight were influenced ($p<0.05$) by the weight of the eggs. Chickens in treatment A had higher ($p<0.05$) breast meat than those in treatments B and C. However, the breast meat of chickens in treatments B and C were similar ($p>0.05$). The thigh weight of chickens in treatment A was higher ($p<0.05$) than those chickens in treatment C, however, it had similar ($p>0.05$) weight with those in treatment B. The thigh weight of chickens in treatments B and C were similar.

DISCUSSION

Egg weight had an effect on hatchability of Potchefstroom Koekoek eggs. The hatchability percentage ranged between 55-77%, this is similar to those reported by Kingori *et al.* (2010). Medium size eggs had higher hatchability compared to small and large size eggs. The current findings are supported by Wilson (1991), Gonzalez *et al.* (1999), Abiola *et al.* (2008) and Alabi *et al.* (2012) reported that intermediate size eggs of ostrich and chickens have higher hatchability.

Similarly, Hassan *et al.* (2005) reported that medium-sized eggs yield at least 75% hatchability compared with 50 to 70% of small and large egg weights. These results are contrary to the observations made by Deeming (1994) who found that hatchability of ostrich eggs decreased with increasing egg weight. De Witt and Schwalbach (2004) also observed that large eggs recorded to have higher hatchability in New Hampshire and Red Rhode Island chicken breeds. The reason for the differences in hatchability might be due to breed differences. Not much information on the subject has been found on indigenous chickens. Chicken egg weight had an effect on weight loss of Potchefstroom Koekoek eggs. Egg weight loss was higher in large sized eggs compared to medium and small ones. Similarly, Hassan *et al.* (2005) reported that egg weight loss occurred in large eggs compared to smaller and medium sized eggs. Contrary to the current findings, Deeming (1994) observed egg weight loss to be less from large ostrich eggs than from small and medium eggs. Deeming (1995) indicated that egg weight loss less than 10% or over 20% of their initial mass were not likely to hatch, this was probable the reason the medium-sized with 17% weight loss had higher hatchability. Elsayed *et al.* (2009) study revealed that chick weigh loss percentage at pull out were no influenced by temperature and breed differences, however, the present study reveals higher weight loss in chicks hatched from bigger eggs. This difference might be because they were not observing the weight differences in the eggs used. Chicken egg weight had an effect on embryonic deaths of Potchefstroom Koekoek eggs. Average embryonic deaths from the treatment groups varied from an average of 23-45% and it was determined to be 37%. However, Caglayan *et al.* (2008) reported that the average embryonic mortality from the groups differed between 11.25-28.57% and it was calculated to be 14.56% in rock Partridges. The values from the current study are found to be higher than 14.56 and 21.23% values found in rock Partridges (Caglayan *et al.*, 2008; Kirikci *et al.*, 2006). Chicken egg weight had an effect on chick weight of Potchefstroom Koekoek eggs. Average chick weight in the current study has been recorded to be 32.3 g. Similarly, Caglayan and Inal (2006) observed that chick weight increased with the increasing egg weight. Chicken egg weight had no effect on fertility rate and egg chick ratio of Potchefstroom Koekoek eggs. The total embryonic deaths, hatching yield and hatchability percent were optimized within the medium-sized egg (Approximately, 51 g). There was no information found on optimum egg size for these parameters.

There is a positive relationship between egg weight and chick-hatched weight (g). In the current findings, large-sized eggs had higher chick-hatched weight compared to medium and small size eggs. These results are similar to the observations made by Abiola *et al.* (2008) and Abiola (1999) who reported that a close correlation between egg and initial chick weights. In contrast, Sinclair *et al.* (1990) and Pinchasov (1991) indicated that there is a decrease in correlation between egg weight and initial chicken weight with the advancement of age of the chick. Smaller chicks hatched from smaller eggs while large chicks hatched from large sized eggs. The Potchefstroom Koekoek maintained their size categories up to the end of seven week period (starter phase). Daily feed intake increased with the increasing egg weight. The daily feed intake ranged between 28-36 g bird^{-1} and the best feed conversion ratio was recorded in chicks hatched from large-sized eggs. These results are similar to the findings of Abiola *et al.* (2008) who observed that daily feed intake of broiler chickens increased with increase in the weight of chicks, the values were recorded to be 30.75-50.08 g bird^{-1}. Daily weight gain was influenced by egg weight of Potchefstroom Koekoek chicks aged between eight and thirteen weeks. At the end of thirteen weeks, large chickens maintained the advantage of their initially higher egg weight. Results recorded for large chicks on weight gain are higher compared to medium and small chicks. There is a direct

relationship between feed intake and chick weight of Potchefstroom Koekoek chickens. It is common knowledge, the higher the size of an animal the higher the intake in order to maintain the body processes and productivity, thus it is expected that the larger chicken will require higher feed intake. This is in agreement with the findings of Patek *et al.* (2003) they observed that the initial chick weights were affected by hatching egg weight, with superiority of chicks from jumbo eggs, compared to those from small, medium and large eggs. They went further to say, small eggs produced smaller offspring with smaller body weight at 42 day of age compared to those from the larger eggs. The feed conversion ratio was influenced by the egg weight, the reason for this is not known. Egg weight did not affect mortality of Potchefstroom Koekoek chickens between one and seven weeks of age nor did it affect them between eight and thirteen weeks of age. Large chickens were superior to the small and medium in terms of breast meat. However, there were differences in carcass weight and results observed on other parameters did not show any particular trend. The current results are in contrast with the findings of Abiola *et al.* (2008) who reported that dressing percentage of large chicks were higher compared to the small and medium chicks. Egg weight has been observed to be an important factor on pre-hatch and post-hatch performance of Potchefstroom Koekoek.

CONCLUSION

Hatchability and post-hatch performance of Potchefstroom Koekoek were influenced by egg weights. However, it can be recommended that for better hatchabiity percentages, hatching yields and lower embryonic deaths medium size eggs can be suitable. If performance and carcass traits are of high importance, large eggs can be considered.

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