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Effects of egg weight on hatchability, chick hatch-weight and subsequent productivity of indigenous Venda chickens in Polokwane, South Africa

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Abstract

A study was conducted to determine the effect of egg weight on hatchability, chick hatch-weight, mortality and subsequent productivity of indigenous Venda chickens. Three hundred and sixty indigenous Venda chicken eggs were collected for a period of a week and selection was done based on the weight of the eggs. A complete randomized design was used, with four treatment weights, each with 90 eggs. The four treatment weights were as follows: below 49 g, between 50 and 59 g, between 60 and 69 g, and above 70 g. Egg weight was positively and strongly correlated with egg hatchability (r^2 = 0.727) and chick hatch-weight (r^2 = 0.953). Heavier-sized eggs hatched chicks had higher mortality rates. Growth rate and live weight of the chickens were optimized at different egg weights of 56 (r^2 = 0.657) and 60 (r^2 = 0.870) g, respectively, for chickens aged 1 to 7 weeks, and egg weights of 61 g (r^2 = 0.514) and 60 g (r^2 = 0.948), respectively, for chickens aged 8 to 13 weeks. It is concluded that indigenous Venda chicken egg weight affects hatchability, hatch-weight, mortality and subsequent productivity of the chickens. It is concluded that production variables were optimized at different egg weights. This means that the selection of eggs for incubation will depend on the parameter in question.

Keywords: Venda chickens, egg weight for optimal productivity, growth, mortality
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Introduction

Indigenous chickens are widely distributed in rural areas of Southern Africa and the world as a whole. They are nutritionally, economically, and culturally very important to rural households (King'ori *et al*., 2007; Mtileni *et al*., 2010). Indigenous Venda chickens are very common in rural areas of Southern Africa. However, productivity of these chickens is generally low and mortality is high, implying that appropriate genetic, nutritional and management interventions are needed to realize their optimal production potential (Okitoi *et al*., 2006; Mbajiorgu *et al*., 2011). Some work on improving productivity of Venda chickens through genetic and nutritional strategies has been done at the University of Limpopo (Mbajiorgu *et al*., 2011; Adesola *et al*., 2012). The influence of egg weight on hatchability, chick hatch-weight and subsequent growth rate and mortality of these chickens is of practical interest to Venda chicken farmers. However, there is evidence that egg weight affects subsequent productivity of layer and broiler chickens (Alders & Spradbrow, 2001; Swatson *et al*., 2001; Rashid *et al*., 2005; King'ori *et al*., 2007). Alabi *et al*. (2012a) reported that hatchability and chick hatch-weight were higher in larger Venda chicken eggs. However, the effect of egg weight on productivity of the progenies was not determined. Alabi *et al*. (2012b), also reported that hatchability and post-hatch performance of Potchefstroom Koekoek chickens were higher in larger eggs. There is, thus, lack of information on the effect of egg weight on subsequent performance of indigenous Venda chickens. Therefore, the objective of this study was to determine the effect of egg weight on hatchability, chick hatch-weight and subsequent productivity of indigenous Venda chickens.

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Materials and Methods

This study was conducted at the University of Limpopo in South Africa. The first part of the study determined the effect of egg weight on hatchability and chick hatch-weight. A total of 360 indigenous Venda chicken eggs were classified into four treatments on the basis of their weight as follows: $W_{<49g}$ (less than 49 g eggs), $W_{50\text{-}59g}$ (50 - 59 g eggs), $W_{60\text{-}69g}$ (60 - 69 g eggs) and $W_{>70g}$ (above 70 g eggs). The eggs came from Venda hens kept indoors at the University of Limpopo Experimental Farm. A completely randomized design was used, having four treatments and five replicates, resulting in a total of 20 units of 18 eggs each. The eggs were incubated and hatched at the University of Limpopo Hatchery Unit. The second part of the study determined the effect of chick weight on feed intake, growth rate, live weight and mortality of the hatched Venda chicks aged 1 - 7 weeks. Hatched chicks were reared on a similar grower diet and housed in enclosed pens, but kept separately according to the initial treatment of the eggs. Feed and water were offered *ad libitum*. The grower diet offered to the chicks contained 880 g DM/kg, 16.8 MJ energy/kg DM, 200 g crude protein/kg DM, 11.5 g lysine/kg DM, and 25 g fat/kg DM. The third part of the study determined the effect of chick weight on feed intake, feed conversion ratio, growth rate, live weight and mortality of the hatched female Venda chickens aged between 8 and 13 weeks. Sixty female Venda chickens, aged 7 weeks, weighing 464 ± 2 g, were used for this part of the study. The chickens were fed the same grower diet used in the second part of the study. The experiment was terminated when the chickens were 13 weeks old, at which age Venda chickens are slaughtered for meat at the University of Limpopo. A complete randomized design with four treatments, according to the initial egg weight treatments, was used. Routine vaccinations and health management practices were followed for all the birds.

The hatchability percentage and hatchling weight were determined within 24 hours after hatching. Feed intake, initial live weight and feed conversion ratio were determined. Mortalities were recorded as they occurred per pen. Effect of egg weight on hatchability, chick hatch-weight, feed intake, growth rate and mortality rate of the chickens were analysed using the General Linear Model procedure of the Statistical Analysis System (SAS, 2008). The means were separated using Duncan's multiple-range test procedures (Duncan, 1955). The responses in intake, feed conversion ratio, growth rate and live weight to egg weight were modelled using the following quadratic equation:

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

where Y= optimum feed intake, feed conversion ratio, growth rate, live weight and mortality rate; a = intercept; b = coefficients of quadratic equation; x = egg weight and $-b_1/2b_2$ = x value for optimum response. The quadratic model was fitted to the experimental data by means of NLIN procedure of SAS (SAS, 2008). The quadratic model was used, because it gave the best fit.

Results and Discussion

Results of the effect of egg weight on hatchability and chick hatch-weight of indigenous Venda chickens are presented in Table 1. Heavier eggs had higher (P <0.05) hatchability values. Similarly, heavier eggs hatched heavier (P <0.05) chicks. These findings are similar to those of Alabi *et al*. (2012a; b) in Venda and Potchefstroom Koekoek chickens, respectively. Constantini & Panella (1984), who found similar results in broiler chickens, concluded that the higher chick hatch-weights are result of higher nutrient content in larger eggs. However, Gonzalez *et al*. (1999) and Abiola *et al*. (2008) found that broiler chicken eggs of medium weight were more suitable for setting in order to obtain higher hatchability.

In the present study, egg weight was positively and strongly correlated (r^2 = 0.729) with egg hatchability (Table 2). Farooq *et al*. (2001) and Narkhede *et al*. (1981) found negative correlations between egg weight and hatchability in crossbred chickens. Thus, in their studies, heavier eggs resulted in lower hatchability. In the present study, egg weight was positively and strongly correlated (r^2 = 0.953) with chick hatch-weight. Narkhede *et al*. (1981) reported a strong and positive correlation (r^2 = 0.93) between egg weight and chick hatch-weight in crossbred chickens (Rhode Island Red X White Leghorn). Tona *et al*. (2002) found similar findings in broiler chickens. However, Asuquo & Okon (1993) observed that egg size within the intermediate weight range of 45 to 56 g hatched heavier chicks than smaller or larger eggs. No biological reasons were suggested for such an observation.

Table 1 Effect of egg weight (g/egg) on egg hatchability (%) and chick hatch-weight (g/chick) of indigenous Venda chickens

Variable	Treatment				SE
	$W_{<49g}$	W_{50-59g}	W_{60-69g}	$W_{>70g}$	
Hatchability	28.1[d]	45.5[c]	48.3[b]	73.9[a]	0.01
Hatch-weight	29.0[d]	31.0[c]	32.0[b]	33.0[a]	0.02

[a, b, c, d]: Means with different superscripts within a row are significantly different (P <0.05).
SE: standard error.

Table 2 Relationships between indigenous Venda chicken egg weight (g/egg) and egg hatchability (%) and chick hatch-weight (g/chick)

Variable	Equation	r^2
Hatchability	Y=-52.239 + 1.639X	0.729
Hatch-weight	Y=20.790 + 0.169X	0.953

r^2: correlation coefficient.

Table 3 Effect of indigenous Venda chicken egg weight on dry matter intake (g/bird/day), growth rate (g/bird/day), feed conversion ratio (FCR) (g DM feed/g weight gain), live weight (g/bird) and mortality between 1 - 7 weeks of age

Variable	Treatments				SE
	$W_{<49g}$	W_{50-59g}	W_{60-69g}	$W_{>70g}$	
Intake	57.4[a]	49.0[b]	48.0[b]	34.0[c]	1.58
Growth rate	6.6[ab]	6.7[a]	6.3[b]	6.5[ab]	0.11
Feed conversion ratio	8.7[a]	7.3[b]	7.6[b]	5.2[c]	0.28
Live weight	470.6[b]	582.0[a]	480.6[b]	507.2[ab]	26.02
Mortality	0.0[d]	2.5[c]	8.9[a]	7.7[ab]	2.47

[a, b, c, d] Means with different superscripts within a row are significantly different (P <0.05).
SE: standard error.

Results of the effect of egg weight on feed intake, growth rate, feed conversion ratio, live weight and mortality of indigenous Venda chickens aged 1 to 7 weeks are presented in Table 3. Chick weight had a significant (P <0.05) effect on feed intake, growth rate, live weight and mortality of the chickens. Chickens hatched from smaller eggs had higher (P <0.05) intakes than those hatched from heavier eggs. Petek *et al.* (2003) found similar results in quails. However, Vieira & Moran (1998) found no differences in intake due to differences in broiler chicken egg weights. In the present study, chicks hatched from heavier eggs had better (lower) (P <0.05) feed conversion ratios (Tables 3 and 4). This is similar to the findings of Petek *et al.* (2003) in quails. However, De Witt & Schwalbach (2004) found that feed conversion ratio was better in chicks hatched from medium New Hampshire and Rhode Island Red eggs than in those hatched from larger eggs. Venda chicks hatched from heavier eggs had higher (P <0.05) mortality rates (Tables 3 and 4). This is similar to the findings of Alabi *et al*. (2012b) in Potchefstroom Koekoek chicken eggs. Growth rate and live

weight of Venda chickens aged between 1 and 7 weeks were optimized at different egg weights of 56 and 60 g, respectively (Table 5).

Table 4 Relationships between indigenous Venda chicken egg weight (g/egg) and feed intake (g/kg), feed conversion ratio (g/DM feed/g weight gain) and mortality of indigenous Venda chickens aged 1 - 7 weeks

Variable	Equation	r^2
Feed intake	Y = 97.668-0.819X	0.691
Feed conversion ratio	Y = 14.209-0.113X	0.584
Mortality	Y = -20.960+0.417X	0.943

r^2: correlation coefficient.

Table 5 Venda chicken egg weight (g/egg) for subsequent optimal growth rate (g/bird/day) and live weight (g/bird) of the chicks between 1 and 7 weeks of age

Variable	Equation	r^2	Egg weight	Optimal Y level
Growth rate	$Y = 1.681+0.178X-0.002X^2$	0.657	56	6.7
Live weight	$Y=-2644.390+107.605X-.898X^2$	0.870	60	579.1

r^2: regression coefficient; X: egg weight.

Egg weight did not affect (P >0.05) subsequent dry matter intake, growth rate, feed conversion ratio, metabolisable energy, nitrogen retention and live weight of female indigenous Venda chickens between 8 and 13 weeks old (Table 6). Vieira & Moran (1998) observed similar results in broiler chickens. However, Petek *et al*. (2003) found that older broiler chickens hatched from heavier eggs had higher growth rates. These authors explained their results in terms of higher intakes.

Table 6 Effect of Venda chicken egg weight on subsequent intake (g/bird/day), growth rate (g/bird/day), feed conversion ratio (FCR) (g DM feed g/weight gain), metabolisable energy (ME) (MJ/kg DM), nitrogen retention (g/bird/day) and live weight (g/bird aged 13 weeks) of female chickens between 8 and 13 weeks of age

Variable	Treatment				SE
	$W_{<49g}$	W_{50-59g}	W_{60-69g}	$W_{>70g}$	
Intake	93	98	106	94	5.56
Growth rate	1.8	2.1	1.8	2.0	0.12
Feed conversion ratio	5.0	4.9	6.7	4.8	0.68
Metabolisable energy	11.8	12.0	11.9	11.7	0.71
N retention	0.59	0.63	0.78	0.41	0.251
Live weight	1085	1192	1144	1102	55.45

SE: standard error.

Conclusion

It is concluded that indigenous Venda chicken egg weight affected hatchability, hatch-weight, mortality and subsequent productivity of the chickens. However, these variables were optimized at different egg weights. This has implications on selection of eggs for incubation.

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