EGG QUALITY AND HATCHABILITY OF KUROILER AND LOCAL GHANAIAN CHICKENS

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ABSTRACT

Chicken production provides animal protein and income for farmers and could thus be considered a livelihood empowerment strategy. In a bid to improve upon local chicken production, Kuroiler – a tropically-adapted improved chicken has been introduced in many countries in sub-Saharan Africa including Ghana. As part of the process of accessing the adaptive and productive potential of Kuroiler chickens in Ghana it is important to characterize their reproductive performance in terms of hatchability and egg quality. In the egg quality test, some Kuroiler and local chicken eggs from chickens of similar age were randomly sampled from farmers in the Forest zone (FZ) and Coastal Savanna zone (CSZ) of Ghana. Participating farmers were selected purposively based on consent and supplied with pre-brooded Kuroiler chickens. The collected eggs were weighed and examined to avoid cracked or damaged and small or oversized ones before incubation. The egg quality of Kuroiler, and those of Forest and Coastal Savannah local chickens were assessed with an electronic vernier caliper and egg analyzer. In the egg hatchability test, only Kuroiler eggs were used. The mean egg weight, albumen height, and Haugh Unit of the Kuroiler eggs were found to be significantly ($p < 0.05$) higher than that of the local chickens except for shell thickness and yolk colour. The total percentage fertility of the Kuroiler eggs was 79 with 67 hatch percentage. Egg fertility of Kuroiler chickens raised in the coastal savannah zone (CSZ), was higher (81%) than those from the forest zone (FZ, 76%) but the hatch percentage was similar (FZ=67.2%; CSZ=66.8%). We concluded that, the introduced Kuroiler chickens could thus be used to enhance egg production among small holder backyard farmers in Ghana and recommend that, they should be made available to chicken farmers.

Keywords: *Animal Protein, Chicken Production, Egg Fertility, Haugh Unit, Shell Thickness*

INTRODUCTION

Chicken production is an economic activity that provides animal protein, income, and sustainable livelihood options to reduce rural poverty (Naazie *et al.*, 2007; Ngongolo *et al.*, 2019). Small holder farmers in Africa mainly keep chickens for their meat and eggs (Ochieng *et al.*, 2013; Melesse, 2014). An egg is a source of nutrients for humans and the developing embryo (chicks) and a potential solution to animal protein shortages, especially in rural Africa (Olawoyin, 2006). In relation to nutrients for the developing embryo, eggs hold the potential for expanding production or getting the next generation of birds (Sun *et al.*, 2019; Liswaniso *et al.*, 2020). Embryonic development has been reported to be dependent on egg quality traits like yolk and albumen weights. These parameters constitute about 90% of the egg weight (Onagbesan *et al.*, 2007; Ahmadi and Rahimi, 2011). Egg fertility and hatchability are major parameters that highly influence the availability of day-old chicks. However, the eggshell thickness is an important factor that affects hatchability. Khan *et al.* (2004) recounted that eggs mostly hatch when their shell thickness ranges between 0.33 and 0.35 mm; but only a few eggs with a shell thickness of less than 0.27 mm will hatch.

The importance of egg quality goes beyond reproduction. This is because eggs are one of the principal sources of income for farmers in the poultry industry. Although the total egg production directly influences profits, the acceptance of the egg by consumers highly depends on its quality. In view of this, Rajkumar *et al*. (2009) linked egg quality to the success of poultry business. Egg weight is known to be the key standard for grading table eggs for the market. Other attributes such as albumen weight, yolk weight, Haugh unit, yolk colour, and shell thickness are very important in determining the market price of an egg.

The Government of Ghana's initiative Rearing for Food and Jobs aims to improve local animal protein production (MoFA, 2019). Chicken production is one of the fastest ways of producing animal protein, but a majority of producers use local chickens. Local chickens are well adapted to the local production conditions but are synonymous with slow growth, few egg numbers and small sized eggs (Moula *et al.*, 2012; Nhleko *et al.,* 2003; Naazie, 2017). The Kuroiler chicken, a tropically adapted dual-purpose improved chicken breed, was developed by Kegg Farms Private Limited from crossing Rhode Island Red, White Leghorn, Barred Plymouth Rock, and two Indian local chickens with some broiler blood infusion (Tadelle and Fasil, 2016).

Since their introduction, impressive growth and egg production performances have been reported under both on-station and on-farm conditions in some parts of Africa (Khan *et al.,* 2013; Adedeji *et. al.,* 2021; Fadhili *et al.,* 2021; Kassa *et. al.,* 2021). In view of the reported production performances, the introduction of the Kuroiler chicken in Ghana is expected to improve the production and income levels of backyard small holder farmers. However, to form the basis of a possible recommendation of the Kuroiler chicken to farmers, it is imperative to test their egg hatchability and quality traits under the existing production conditions. The objective of the current study therefore was to assess the egg hatchability and quality of Kuroiler and local Ghanaian chickens.

MATERIALS AND METHODS

This study was part of a general on-farm research on Kuroiler chickens. A total of 270 farmers were purposively sampled based on

Figure 1: Location of selected farmers

consent to be part of the research and the availability of a poultry structure for the birds or a perimeter fencing for easy data collection where birds are not kept intensively. The selected farmers from two agro-ecological zones in five regions were supplied with ten 5-week-old chickens, each of both sexes (Figure 1).

The study was in two parts, the fertility and hatchability test for only Kuroiler chicken eggs whilst the egg quality test was for both Kuroiler and local chicken eggs. This was due to the unavailability of enough local chicken eggs from the targeted farmers. In the egg quality test, 180 eggs (60 each from Kuroiler, forest, and coastal savannah local chickens) were randomly sampled from farmers in the 5 regions across the 2 ecological zones. The Kuroilers were 35 weeks old at the time of egg collection. The local chickens were between the ages of 34 and 36 weeks based on farmers' records. The eggs were kept at room temperature for 3 days. The egg quality parameters (egg weight, Haugh unit, albumen height, and yolk colour) were measured using an electronic egg analyzer (ORKA Food Technology LLC, 2006) at the Animal Genetics Laboratory, Department of Animal Science, University of Ghana, Legon. Unbroken eggs were first weighed individually after which each was cracked and content gently emptied onto a tray (a component of the egg analyzer) to measure the Haugh unit, albumen height, and yolk colour. The shell thickness of individual eggs was measured with an electronic vernier caliper. This was determined following Aberra *et al.* (2010) by taking the average thicknesses of the large end, the centre, and the narrow end of individual eggs.

The egg quality data generated were subjected to an analysis of variance using GenStat 12 edition VSN International (2009) using the following model:

$$Y_{ij} = \mu + B_i + e_{ij}$$

Where:

Y_{ij} = overall egg quality observed.

μ = overall mean of variables.

B_i = effect due to the chicken genotype (i= Kuroiler, local forest or coastal savannah zone chicken ecotypes).

e_{ij} = random error term.

Where the ANOVA indicated significant genotype effect, the means were separated using Student-Newman-Keuls (SNK) test (Attia *et al.*, 2010).

The fertility and hatchability analyses were conducted using eggs collected from farmers when the Kuroiler hens were 30 weeks old. To ensure the fertility in Kuroiler eggs set for incubation 205 farmers, who were keeping the chickens

Figure 2: A section of labelled Kuroiler eggs set and hatched Kuroiler chicks

intensively and had at least one Kuroiler cockerel within the pullet population, were purposively sampled. Freshly laid eggs, at most 3 days old, were collected within a 3-day period, first weighed and physically examined. Following Adomako *et al*. (2021), very small eggs (<40g), very large eggs (>70g), broken/cracked shells, blood-stained or dirty eggs were discarded. A total of 1,230 eggs carefully labelled, either forest or coastal savannah based on where they were collected from, were set for incubation after 2 days of storage shown in Figure 2.

The total number of egg set (nES) was recorded. Candling was done on the 18th day of incubation to separate the fertile eggs for 3 additional days of incubation. The total number was recorded as the number of fertile eggs (nFE). After the 21 days of incubation, the total number of chicks was counted as the number of eggs hatched (nEH). The percentage fertility (F%) and hatchability (H%) were calculated as follows:

$$F\% = \frac{(nFE)}{nES} \times 100$$

$$H\% = \left(\frac{nEH}{nES}\right) \times 100$$

Where:
F% = Percentage fertility
H% = Percentage hatchability
nFE = Number of fertile eggs
nEH = Number of eggs hatched
nES = Number of egg set

RESULTS

The mean egg weight of Kuroiler chickens was significantly ($p < 0.05$) heavier than that of the local chicken ecotypes. Between the two local chicken ecotypes, the forest zone chickens had heavier eggs. The mean albumen height and Haugh Unit of eggs produced by Kuroiler chickens were also significantly ($p < 0.05$) different from that of the local chicken ecotypes. Table 1 shows the means and standard deviation of the various egg quality parameters analysed. The albumen height and Haugh unit of eggs of forest zone local chickens were significantly ($p < 0.05$) better than that of the coastal savannah zone. However, the shell thickness and yolk colour of the experimental eggs were not significantly different from each other.

The percentage egg fertility of the incubated Kuroiler eggs was 79 with 67% of egg hatch. Fertility was higher (81%) in Kuroiler eggs raised in the coastal savannah zone (CSZ) than

Table 1: Egg quality trait parameters of experimental chickens (N=180)

Parameters	Range	Means and standard deviation			P-values
		Kuroiler (Ku)	Forest (Fo)	Coastal Savannah (CS)	
EWt (g)	32.2 - 101.8	$88.8^{a}\pm9.42$	$58.7^{b}\pm9.9$	$52.5^{c}\pm10.3$	<0.001
AH (mm)	2.1 - 5.5	$3.94^{a}\pm0.68$	$3.54^{a}\pm0.93$	$3.1^{b}\pm0.52$	<0.001
ST (mm)	0.24 - 0.48	0.39±0.05	0.38±0.04	0.38±0.04	0.592
YC	1.0 - 11.0	5.8±2.01	6.27±2.26	6.43±2.79	0.565
HU	43.30 - 97.60	$77.3^{a}\pm9.85$	$73.4^{a}\pm9.05$	$66.4^{b}\pm11.7$	<0.001

Within rows means followed by different superscripts are significantly ($p \leq 0.05$) different.

Table 2: Fertility and hatchability of Kuroiler eggs by ecological zone

Parameters	Ecological Zone		Total
	Forest	Coastal	
Number of Egg Set	643	587	1230
Number of Fertile Eggs	491	478	969
Number of Eggs Hatch	432	392	824
Percentage Fertility	76%	81%	79%
Percentage Hatchability	67.2%	66.8%	67%

those from the forest zone (76%) but the hatch percentage was similar (FZ=67.2%; CSZ = 66.8%). Table 2 shows the results on the fertility and hatchability of Kuroiler eggs by agro-ecological zone.

DISCUSSION

Egg quality parameters (egg weight, albumen height, and Haugh unit) of Kuroiler chickens analysed in this study were higher compared to the results of Osei-Amponsah *et. al.* (2014) for local chicken ecotypes of Ghana. Egg weight results in this study are also higher compared to the ones reported by Hagan *et al.* (2013). A mean weight of 45.2 g, which is lighter than the weights recorded in this study, was reported for scavenging local chickens in Ethiopia (Yonas *et al.* 2019). Egg weights of Kuroiler chickens recorded in this study were however heavier than those of Sasso, Koekoek, and local chickens as reported by Assefa *et al.* (2019).

The observed variations might be because of differences in the time of egg lay, age of laying chickens, number of eggs evaluated, chicken genotype, and environmental conditions. The egg weight is a trait influenced by both the environment/management and the genetic make-up of laying birds. Heavy chicken breeds lay heavy eggs compared to lighter ones (Duraisamy, 2011). All the birds in this study were under farmer-management, hence a relatively similar poultry management practice. The superiority of Kuroiler eggs to those of the local chickens used in this study, however, is expected since Kuroilers have gone through some formal selection processes for improvement in growth and egg production performance over time (Tadelle and Fasil, 2016). The local chicken ecotypes, on the other hand, have not been subjected to any formal selection for improvement in commercial traits (Kayang *et al.*, 2015; Tabler and Wells, 2019).

The Albumen height and Haugh unit both have a positive and significant relationship with egg weight (Moula *et al.*, 2013; Osei-Amponsah *et al.*, 2014; Bekele *et al.*, 2022). The Kuroiler eggs in this study were significantly ($p < 0.05$) superior to the eggs of local chickens in terms of average Albumen height and Haugh unit, just as their mean egg weight was. These parameters were lower than that recorded for Local chickens in Ethiopia including Sasso and Koekoeck under traditional management systems (Desalew, 2015; Assefa *et al.* 2019). The mean Haugh unit of the eggs used in this study ranged from 66.4 to 77.3. According to the egg classification of the United States Department of Agriculture (2000), the higher the value of the Haugh unit, the better the quality of eggs [**AA** (100 to 72), **A** (71 to 60), **B** (59 to 30) and **C** (below 29)]. Therefore, eggs from all genotypes in this study are classified as **AA** or **A**.

The shell thickness and yolk colour of the eggs under study were not significantly ($p > 0.05$) different across genotypes. It has been reported that the variations in breed as well as chicken dietary quality influence the shell thickness of an egg (Fayeye *et al.* 2005). This is such that, various breeds of chicken may vary in the ability to absorb calcium by the shell gland. Furthermore, the calcium content or availability in layer diets could vary from farm to farm. The similarity in shell thickness in this study might be due to the lack of variation in the birds' ability to absorb calcium or a possible similarity in the calcium content in the diet the chickens were fed. The Kuroiler chickens could therefore be said to have the ability to lay heavy eggs with good shell thickness to withstand breakages. Yolk colour recorded in this study was lighter than the reports of Desalew (2015) and Assefa *et al.* (2019) and this can be attributed to genetic and environmental variations.

According to Hawken (2013) the average hatchability performance of a hatchery should be around 85 percent. However, the percentage hatchability of the incubated Kuroiler eggs in this study was 67. A higher hatchability of 87.8% for local chickens in the forest, and savannah zones were reported by Osei-Amponsah *et al.* (2009) with fewer eggs. Considerably lower hatchability percentages were recorded for light ecotype local chicken in Nigeria (61%) and White Fulani local chicken (48%) (Fayeye *et al.*, 2005; Ndofor-Foleng *et al.*, 2015). The egg hatchability is reported to be affected by the environment (egg physiology, egg size, bird nutrition, handling of eggs) the chicken breed and their interaction (Peters *et al.*, 2004). The current egg hatch results could not be solely associated with the genetic make-up of the Kuroiler chickens. Since the eggs were collected and transported from different farmers and locations, the hatchability results might have been affected by environmental factors such as poor handling or storage of eggs before incubation.

CONCLUSIONS AND RECOMMENDATIONS

The introduced Kuroiler chickens could be used to enhance egg production among the predominant small holder backyard chicken farmer population in Ghana based on their ability to produce quality eggs. These small holder farmers should be supported with lower capacity community level incubation facilities for constant supply of quality day-old chicks. The Kuroiler chickens are therefore recommended for small scale backyard poultry producers in both the forest and coastal savannah zones of Ghana. The reproductive performance of Kuroiler chickens and the hatchability of their eggs by local chickens should be further studied to assess their suitability among farmers who depend on the broodiness in local chickens, particularly where artificial incubation facilities are non-existent.

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