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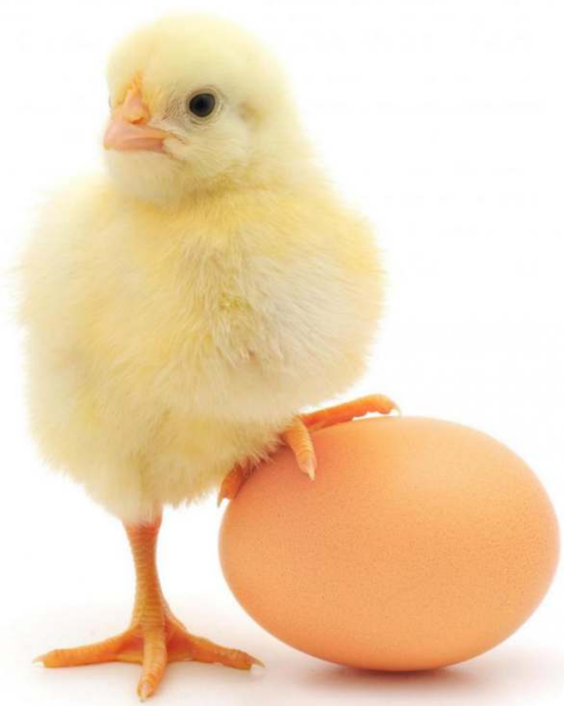

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# Egg Quality Characteristics of Different Varieties of Domesticated Helmeted Guinea Fowl (*Numida meleagris*)

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**Abstract:** A study was conducted to evaluate external and internal egg quality characteristics of the pearl, lavender, royal purple and white varieties of the helmeted guinea fowl kept intensively at Botswana College of Agriculture. A total of 110, 100, 70 and 60 fresh eggs were collected from the four varieties, respectively and subjected to external and internal quality analysis using established procedures. The royal purple had the highest egg weight, egg length, egg width and egg surface area the white variety had the lowest values for all those parameters. Shell thickness differed significantly ($p<0.05$) among the four varieties with values of 0.56±0.008, 0.53±0.013, 0.46±0.008 and 0.42±0.011 for the pearl grey, white, lavender and royal purple varieties, respectively. The royal purple had the highest albumen weight and albumen content and the lowest yolk weight and yolk content while the white variety had the lowest albumin weight and albumin content and the highest yolk content. No significant difference was found among the four varieties in yolk height, yolk width and yolk index. All the four varieties of helmeted guinea fowl produced eggs of acceptable external and internal quality. However, the royal purple had the best egg quality characteristics, followed by the pearl, lavender and lastly the white variety.

**Key words:** Egg quality traits, varieties, guinea fowl

## INTRODUCTION

Guinea fowl production in Botswana is still at its infancy stage but it is viewed as a viable option for the diversification of the country's poultry sector. Over the years, there has been a steady increase in the number of farmers who have ventured into guinea fowl farming in Botswana, particularly in rural areas where most of the peasant and small scale livestock farmers live (Sayila, 2009). Guinea fowls provide an alternative for the rural populace to access protein in the form of meat and eggs and have great potential for revenue generation through sales of live birds and eggs. The economic viability and long term sustainability of individual guinea fowl projects and of the guinea fowl industry in Botswana however, depends on the production of eggs of good external and internal quality.

Varieties of the helmeted guinea fowl found in Botswana include the pearl, lavender, royal purple and the white variety. The performance of different varieties of the helmeted guinea fowl found in Botswana in various traits of economic importance such as growth performance and egg quality traits under different rearing systems remain undocumented. The purpose of this study was therefore to characterize various external and internal egg quality traits in the pearl, lavender, royal purple and the white varieties of the helmeted guinea fowl kept under an intensive management system.

## MATERIALS AND METHODS

**Location and duration of study:** The study was conducted at Botswana College of Agriculture, Content Farm, Sebele, Gaborone, in the Southern part of Botswana from beginning of December 2012 to the end of January 2013. During the study period, environmental temperature averaged 33°C and ranged between 16.4 and 38°C.

**Collection of eggs:** A total of 110, 100, 70 and 60 fresh eggs were collected from the pearl, lavender, royal purple and the white varieties of the domesticated helmeted guinea fowl, respectively. The guinea fowl hens that provided the eggs were of the same age (hatched on the same day through an artificial incubator) and egg collection occurred between 52 and 60 weeks of age. The guinea fowl were housed separately according to strain in guinea fowl houses (intensive production system) made of concrete blocks, chicken wire mesh and corrugated iron roofing with an earth floor. The guinea fowl hens were fed commercial chick starter mash from day old to 4 weeks of age and thereafter fed commercial grower crumbs. Water was provided *ad libitum* throughout the growing and laying period.

**Measurement of external egg quality traits:** The external egg quality traits measured were, egg weight

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(g), egg length (cm), egg width (cm), egg shape index (%), shell weight (g), shell content (%), shell thickness and egg surface area. Egg weight was determined using an electronic scale, while egg length and egg width were determined with an electronic vernier callipers. Shell weight (shell membrane inclusive) was determined by weighing on the electronic scale. Egg shell thickness was determined using a micrometer screw gauge. Accuracy of shell thickness was ensured by measuring shell thickness at the broad end, middle portion and narrow end of the shell and taking the average of the three measurements. Egg shape index was calculated as a ratio of the width to the egg length as follows:

Egg shape index (%) =egg width x 100/egg length

and egg shell content was measured as a ratio of the weight of the egg shell to whole egg weight as follows:

Shell content (%) = shell weight x 100/whole egg weight

**Measurement of Internal egg quality traits:** For internal egg quality traits, individual eggs were carefully broken out on a flat white tile being cautious not to break the membranes that encloses the egg yolk and albumin. Albumin height and yolk height were then measured using vernier calipers and yolk diameter was measured using micrometer screw gauge. The egg yolk and albumen were then carefully separated and the weight of the egg yolk determined using an electronic balance. Albumin weight was calculated by subtracting yolk weight and shell weight from whole egg weight. Other internal egg quality traits were determined using established standard procedures (Reddy *et al.*, 1979; Monira *et al.*, 2003; Fayeye *et al.*, 2005; Olawumiand Ogunlade, 2008).

**Statistical analysis:** The various egg traits of different varieties of the helmeted guinea-fowl were analyzed using General Linear Models of SAS (SAS, 2001) software package and the model included the fixed effect of variety (Pearl grey, lavender, royal purple and white). Results on the effects of guinea-fowl variety on various egg traits are presented as least squares means±SE and means separation was by paired student t-test with Scheffe's adjustment to account for the differences in egg number among the four varieties of helmeted guinea fowl and differences between means were declared significantly different at $P \leq 0.05$.

## RESULTS AND DISCUSSION

Mean values for external quality traits of different varieties of the helmeted guinea fowl are presented in Table 1. Eggs of the royal purple variety were significantly heavier than those of the pearl, lavender and white varieties. There was no significant difference in egg weight between the pearl and lavender varieties (41.42±0.33 vs. 41.60±0.46 g, respectively) but the eggs of the two varieties were significantly heavier than those of the white variety. The royal purple variety produced the heaviest eggs and the white variety produced the lightest eggs (44.78±0.56 vs. 36.03±0.68 g, respectively). The egg weights of the four varieties of helmeted guinea fowl reported in the current study fall within the range of 35.4±2.33 and 46.65±1.79 g reported by Adeyeye (2010) and Song *et al.* (2000), respectively. Significantly higher egg weight in the royal purple than in the pearl variety reported in this study is consistent with Obike *et al.* (2011) who reported slightly higher egg weight in the black (royal purple) than pearl guinea fowl variety (37.91±0.39 vs. 37.67±0.27 g, respectively). Significantly higher egg weight in the pearl than in the white variety (41.42±0.33 vs. 36.03±0.68 g) found in the current study is however contrary to Wilkanowska and Kokoszynski (2010) who reported significantly heavier eggs in the white than in the pearl variety (46.49 vs. 39.14 g, respectively). A strong and positive correlation coefficient has been reported between egg weight and hatchling weight (Abiola, 1999) and between egg weight and offspring quality in birds. Eggs of the royal purple variety are therefore likely to produce the heaviest keets of high quality and eggs of the white variety the lightest keets of poor quality.

There were no significant differences in egg length between the royal purple and lavender and between the pearl and lavender varieties. There was however, a significant difference in egg length between the royal purple and the pearl varieties. Eggs of the white variety were significantly shorter than those of the other three varieties. Of the four varieties, the royal purple had the longest eggs and the white variety had the shortest eggs. There was no significant difference in egg width between the royal purple and pearl varieties but the eggs of the two varieties were significantly wider than those of the lavender and white varieties. The white variety produced eggs with the smallest width of the four varieties of the helmeted guinea fowl. Significantly higher egg length and egg width in the royal purple than in the pearl variety reported in this study is consistent with Obike *et al.* (2011) who reported egg lengths of 47.40±0.27 and 46.84±0.21mm and egg width of 36.83±0.15 and 36.60±0.10mm in the black (royal purple) and pearl varieties, respectively. Contrary to our findings, Wilkanowska and Kokoszynski (2010) reported significantly higher egg length (51.28 vs. 49.40mm) and egg width (39.56 vs. 37.47mm) in the white variety than in the pearl variety. Several studies have reported strong and positive associations between egg weight, egg length and egg width and between egg length and egg width (Nwagu *et al.*, 2010; Apuno *et al.*, 2011 and Obike

Table 1: External egg quality characteristics of different varieties of the helmeted guinea fowl

| Parameter | Pearl grey | Lavender | Royal purple | white |
|---|---|---|---|---|
| Egg weight (g) | 41.42$^{b}$±0.33 | 41.60$^{b}$±0.46 | 44.78$^{a}$±0.56 | 36.03$^{c}$±0.68 |
| Egg length (cm) | 5.09$^{bc}$±0.02 | 5.14$^{ab}$±0.02 | 5.21$^{a}$±0.03 | 5.01$^{c}$±0.04 |
| Egg width (cm) | 3.88$^{a}$±0.01 | 3.79$^{b}$±0.01 | 3.88$^{a}$±0.02 | 3.68$^{c}$±0.02 |
| Egg shape index | 76.29$^{a}$±0.08 | 73.97$^{b}$±0.36 | 74.77$^{b}$±0.49 | 73.62$^{b}$±0.55 |
| Shell weight (g) | 6.12$^{a}$±0.08 | 5.58$^{b}$±0.08 | 6.09$^{a}$±0.11 | 6.33$^{a}$±0.13 |
| Shell content (%) | 14.66$^{b}$±0.23 | 13.21$^{c}$±0.30 | 13.08$^{c}$±0.37 | 17.44$^{a}$±0.44 |
| Shell thickness (mm) | 0.56$^{a}$±0.008 | 0.46$^{c}$±0.008 | 0.42$^{d}$±0.011 | 0.53$^{b}$±0.013 |
| Egg surface area (cm$^{2}$) | 60.24$^{b}$±0.39 | 60.98$^{b}$±0.39 | 62.44$^{a}$±0.53 | 57.06$^{c}$±0.59 |

Means with different superscripts within a row were significantly different (P<0.05)

Table 2: Internal egg quality characteristics of different varieties of the helmeted guinea fowl

| Parameter | Pearl grey | Lavender | Royal purple | White |
|---|---|---|---|---|
| Albumen weight (g) | 22.90$^{b}$±0.24 | 21.61$^{c}$±0.33 | 24.93$^{a}$±0.41 | 16.43$^{d}$±0.43 |
| Albumen content (%) | 54.71$^{a}$±0.31 | 51.93$^{b}$±0.44 | 55.66$^{a}$±0.54 | 45.10$^{c}$±0.64 |
| Albumen height (mm) | 6.26$^{a}$±0.10 | 5.74$^{b}$±0.10 | 6.14$^{a}$±0.132 | 6.08$^{a}$±0.15 |
| Yolk weight (g) | 12.81$^{c}$±0.14 | 14.51$^{a}$±0.20 | 14.01$^{ab}$±0.24 | 13.40$^{bc}$±0.29 |
| Yolk content (%) | 30.64$^{c}$±0.25 | 34.87$^{b}$±0.36 | 31.26$^{c}$±0.44 | 37.46$^{a}$±0.52 |
| Yolk height (cm) | 1.67±0.009 | 1.67±0.009 | 1.68±0.013 | 1.67±0.014 |
| Yolk width (cm) | 3.72±0.019 | 3.77±0.019 | 3.75±0.026 | 3.74±0.030 |
| Yolk index | 0.4494±0.003 | 0.4432±0.003 | 0.4490±0.004 | 0.4481±0.005 |
| Egg volume (cm$^{3}$) | 45.84$^{a}$±0.40 | 44.38$^{b}$±0.40 | 47.05$^{a}$±0.55 | 40.87$^{c}$±0.62 |
| Haugh Unit | 84.29$^{ab}$±0.71 | 81.40$^{b}$±1.00 | 82.65$^{b}$±1.22 | 86.46$^{a}$±1.45 |

Means with different superscripts within a row were significantly different (P<0.05)

and Azu, 2012) which indicates that the longer and/or wider the egg the higher the egg weight. This is consistent with highest egg length and egg width in the royal purple variety that also produced the heaviest eggs and the lowest egg length and egg width in the white variety that produced the lightest eggs.

Eggs of the pearl variety had significantly higher egg shape index than those of the other three varieties. There were however, no significant differences in egg shape indices between the lavender, royal purple and white varieties of the helmeted guinea fowl. Significantly higher egg shape indices in the pearl than in the royal purple (76.29±0.08 and 74.77±0.49%, respectively) and in the pearl than in the white variety (76.29±0.08 and 73.62±0.55%, respectively) reported in the present study are contrary to Obike *et al.* (2011) and Wikanowska and Kokoszynski (2010) who reported similar egg shape indices between the royal purple and pearl (78.14±0.52 and 78.46±0.54%, respectively) and between the pearl and white varieties (75.85 and 77.14%, respectively), respectively. Contrary to our present findings, Ahmed *et al.* (2009) also reported significantly higher egg shape index in the lavender than in the pearl varieties (78.72±0.05 vs. 76.37±1.17%, respectively). Significantly higher egg shape index in the pearl than in the other three varieties is however consistent with Bednarczyk (1991) who noted that egg shape in poultry is characteristic for specific line and/or even for specific individuals.

There were no significant differences in absolute egg shell weight between the pearl, royal purple and white varieties (6.12±0.08, 6.09±0.11 and 6.33±0.13g, respectively) of the helmeted guinea. The egg shell weights of the three varieties were however significantly higher than that of the lavender variety. The white variety had the highest absolute shell weight and the lavender variety had the lowest absolute shell weight. Similar shell weight between the pearl and royal purple varieties reported in the current study is consistent with Obike *et al.* (2011) who reported similar shell weights between the pearl and black (royal purple) varieties (7.27±0.30 and 7.12±0.32g, respectively). Slightly higher shell weight in the white than in the pearl variety is consistent with Wilkanowska and Kokoszynski (2010) who reported significantly higher shell weight in white than in the pearl varieties (7.16 vs. 6.18g, respectively). The shell content (expressed as a proportion of shell weight to total egg weight) was significantly higher in the white variety than in any of the other three varieties. The shell content of the pearl was also significantly higher than those of the lavender and royal purple varieties. There was however no significant difference in egg shells content between the lavender and royal purple varieties. Significantly higher egg shell content in the white than in the pearl variety reported in the present study in not consistent with Wilkanowska and Kokoszynski (2010) who reported slightly lower egg shell content in the white than in the pearl variety (15.40 versus 15.76%, respectively). Significantly higher egg shell content in the pearl than in the lavender variety is also contrary to Ahmed *et al.* (2009) who reported superior egg shell content in the lavender than in the pearl variety (13.16±0.007 vs. 12.12±0.04%, respectively).

The egg shell thickness differed significantly among the four helmeted guinea fowl varieties. The egg shell was thickest in the pearl (0.56±0.008mm), followed by white

(0.53±0.013mm), lavender (0.46±0.008mm) and royal purple varieties (0.42±0.011). Significantly higher egg shell thickness in the pearl than in the white variety and in the pearl than in the lavender variety are contrary to Wikanowska and Kokoszynski (2010) and Ahmed *et al.* (2009), respectively, who both reported lower shell thickness in the pearl than in the white or lavender varieties. Higher shell thickness in the pearl than in the royal purple variety is consistent with Obike *et al.* (2011) who reported egg shell thickness of 0.43±0.04 and 0.41±0.21mm in the pearl and black (royal purple) varieties, respectively. The egg shell thickness for the different varieties of the helmeted guinea fowl ranged from 0.42±0.011 to 0.56±0.008mm which were all above the critical egg shell thickness of 0.33mm below which the risks of egg breakage and entry by micro-organisms is increased (Chineke, 2001).

The egg surface area was significantly higher in the royal purple than in the other three varieties and the white variety had the lowest egg surface area. The egg surface area for the four varieties of helmeted guinea fowl reported in this study fall within the range of 56.2±0.49 and 68.9±0.58cm$^2$ reported by Nowaczewski *et al.* (2008) for the domestic and French guinea fowls, respectively. Nowaczewski *et al.* (2008) reported a highly significant and positive correlation coefficient of 0.989 between egg weight and egg surface area which means the larger the egg the larger the surface area which is consistent with the largest egg surface area in the royal purple and the smallest surface area in the white variety found in the current study.

The absolute albumen weight differed significantly among the four helmeted guinea fowl varieties as shown in Table 2. The royal purple had the highest albumen weight (24.93±0.41g), followed by pearl (22.90±0.24g), lavender (21.61±0.33g) and white varieties (16.43±0.43g). There was however no significant difference in albumen content (expressed as a proportion of albumen weight to total egg weight) between the royal purple and pearl varieties. The albumen content of the royal purple and pearl varieties were however significantly higher than those of the lavender and white varieties. The royal purple had the highest albumen content (55.66±0.54%) and the white variety had the lowest albumen content (45.10±0.64%). Significantly higher albumen weight and albumin content in the pearl than in the lavender variety is consistent with Ahmed *et al.* (2009). Significantly higher albumen weight and albumen content in the pearl than in the white variety found in the present study is however contrary to Wilkanowska and Kokoszynski (2010) who reported significantly higher albumen weight and albumin content in the white than in the pearl variety. Higher albumen content in the royal purple than in the pearl variety is however in line with Obike *et al.* (2011) who reported a slightly higher albumen weight in the black (royal purple) than in the pearl variety (17.48±0.30 vs. 17.38±0.20g, respectively).

There were no significant differences in absolute yolk weight between the royal purple and lavender, between the royal purple and the white varieties and between the pearl and white varieties. The yolk weight of the lavender (14.51±0.20g) was however significantly higher than those of the white (13.40±0.29g) and pearl (12.81±0.14g) varieties. The yolk content of the white variety (37.46±0.52%) was significantly higher than those of the other three varieties. There was no significant difference in yolk content between royal purple and pearl (31.26±0.44 and 30.64±0.25%, respectively) varieties. The yolk content of the lavender (34.87±0.36%) was however significantly higher than those of the royal purple and pearl varieties. Significantly higher yolk weight and yolk content in the lavender than in the pearl variety is consistent with Ahmed *et al.* (2009) who reported superior yolk weight and yolk weight percentage in the lavender than in the pearl variety. Similar yolk weight between the royal purple and the pearl and between the pearl and white varieties reported in the present study are consistent with Obike *et al.* (2011) and Wilkanowska and Kokoszynski (2010), respectively. Wilkanowska and Kokoszynski (2010) however, reported significantly higher yolk content in the pearl than in the white variety while we report the exact opposite in the current study. There were no significant differences between the four helmeted guinea fowl varieties in yolk height, yolk width and yolk index. Obike *et al.* (2011) also reported non-significant differences in yolk height, yolk width and yolk index between the black (royal purple) and pearl varieties. Wilkanowska and Kokoszynski (2010) however reported significantly higher yolk height, yolk width and yolk index in the white than in the pearl variety. Udoh *et al.* (2012) reported non-significant differences in yolk width, yolk height and yolk index between the naked neck, frizzled and normal feathered Nigerian local chickens. The yolk indices for the four varieties of the helmeted guinea fowl were within the acceptable range of 0.33 and 0.50 required of good quality eggs (Ihekoronye and Ngoddy, 1985). Higher absolute albumen weight and albumen content and lower yolk content in the royal purple than in the other three varieties indicate that eggs of the royal purple variety might be the healthiest with the highest total protein content and the lowest fat content.

There was no significant difference in egg volume between the royal purple and pearl varieties (47.05$^a$±0.55 and 45.84$^a$±0.40, respectively). The egg volumes of the two varieties were however significantly higher than those of the lavender and white varieties. The royal purple had the highest egg volume (47.05$^a$±0.55) and the white variety had the lowest egg volume (40.87±0.62). According to Obike and Azu (2012), egg length and egg width determine the volume and holding capacity of an egg which in turn gives an indication of egg weight. Of the four varieties, the royal purple had the highest egg length and egg width and consequently the highest egg volume while the white variety had the lowest egg length and egg width which in turn resulted in the lowest egg volume.

There were no significant differences in haugh unit between white and pearl varieties and between the pearl, lavender and royal purple varieties. The haugh unit of the white variety (86.46±1.45) was however significantly higher than those of the royal purple (82.65±1.22) and lavender (81.40±1.00) varieties. Haugh unit determines the albumen quality and a higher haugh unit means better albumen quality (Akhtar *et al.*, 2007). The white variety of helmeted guinea therefore produced eggs of the highest albumen quality while there were no differences among the other three varieties in albumen quality. Differences in haugh unit among some varieties of the helmeted guinea fowl are consistent with Udoh *et al.* (2012) who reported different haugh unit values for different strains of Nigerian local chickens.

**Conclusion:** All the four varieties of helmeted guinea fowl produced eggs of acceptable external and internal quality. However, royal purple had the highest egg weight, egg length, egg width, egg surface area, egg volume, albumin weight and albumen content and the lowest yolk weight and yolk content. The white variety had the lowest egg weight, egg length, egg width, egg surface area, egg volume, albumin weight and albumin content and the highest yolk content. The royal purple therefore had the best egg quality characteristics, followed by the pearl, lavender and lastly the white variety. The royal purple is likely to produce to produce heavy and high quality keets while the white variety is likely to produce light and poor quality keets.

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