ANALYSIS OF THE PHYSICO-MORPHOLOGICAL AND FUNCTIONAL ATTRIBUTES OF GUINEA FOWL (*Numida meleagris*) EGGS

***Ojo, T.S., Mbakwe, C. C., Gaddafi, S., Lamido M. and Haruna S.**
Department of Animal Science, Federal University, Dutsin-Ma, P.M.B. 5001 Dutsin-Ma, Katsina State, Nigeria
*Corresponding author: temiphuns@gmail.com; +2348061308314

ABSTRACT
Guinea fowl (Numida meleagris) eggs are a valuable poultry product recognized for their unique qualities, such as a thicker, harder shell, high nutrient content, and functional properties. This study examined the impact of storage time on the physical, morphological, and functional properties of Guinea fowl eggs. A total of 100 freshly laid eggs were divided into five storage treatments (0, 4, 8, 12, and 16 days) and analyzed for physio-morphological and functional changes using established methods. The results revealed that egg size and shape remained stable across all treatments, with medium size and oval shape consistently observed. However, storage led to minor morphological changes, including shell darkening (T3-T5) and structural defects such as pimpled eggs, cracks, and calcium-coated surfaces, with the highest occurrence of calcium-coated eggs in T2 (++). Storage significantly (P<0.05) reduced foaming capacity (T1: 16.00 vs. T5: 13.50), indicating protein degradation, particularly affecting ovalbumin and ovomucin. Conversely, foaming stability, emulsifying activity, emulsifying stability, and swelling capacity were not significantly (P>0.05) affected by storage. In conclusion, while Guinea fowl eggs are robust against most storage-related changes, prolonged storage reduces their foaming capacity.
Keywords: Guinea fowl eggs, Functional attributes, Storage, Morphological attributes.

Introduction

The guinea fowl (*Numida meleagris*) egg is a distinctive and valuable product highly regarded by both consumers and industries for its unique qualities (Terra-Long, 2022). Unlike chicken eggs, guinea fowl eggs are smaller and longer, with a thicker, harder shell that provides exceptional durability. This toughness significantly reduces the likelihood of cracking during handling and transportation, making them ideal for more rigorous storage and distribution conditions. The eggs are typically grayish-brown in color, with a natural speckled appearance that adds to their aesthetic appeal. They generally weigh between 40 and 50 grams, slightly lighter than most chicken eggs (Cheng, 2020). These characteristics, combined with their resilience and unique appearance, make guinea fowl eggs a favoured choice in both culinary and industrial applications

Guinea fowl eggs are a nutrient-dense food, rich in essential fatty acids, vitamins, minerals, and high-quality proteins, with a higher albumen-to-yolk ratio compared to chicken eggs (Onyenweaku, 2018). Their exceptional functional properties and health benefits are largely attributed to their high antioxidant content, which supports overall nutrition and promotes well-being (Kuesten and Hu, 2020). Although guinea fowl are acknowledged as a valuable poultry species, they have received significantly less research attention compared to chickens, particularly in the area of egg studies. While chicken eggs dominate research efforts, guinea fowl eggs possess unique characteristics that warrant more focused investigation (Fajemilehin, 2014).

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the Livestock Teaching and Research Farm, Department of Animal Science, Federal University Dutsin-Ma, Katsina State, Nigeria.

Sources of Egg

A total of one hundred (100) freshly laid Guinea fowl eggs were procured from Yelwa Farm, Tsanyawa Local Government area of Kano State.

Experimental Design

A total of 100 guinea fowl eggs were divided into five storage groups at random: 0, 4, 8, 12, and 16 based on weight in a completely randomized design in treatments designated as T1, T2, T3, T4, and T5.

Data Collection

Determination of Physio-Morphological properties of Egg

Detailed visual observations were used to evaluate the morphological and physical characteristics of Guinea fowl eggs from each storage group. This allowed for the assessment of any changes that occurred during the study period.

Determination of Functional Properties of Egg

The functional properties of eggs, including emulsifying activity (EA), emulsifying stability (ES), foaming capacity (FC), foam stability (FS), and swelling capacity (SC), were determined using established methods with slight modifications. Emulsifying activities: Following the method by Sanusi *et al.* (2021), an egg sample, 10 ml of distilled water, and 10 ml of soybean oil were mixed in a calibrated centrifuge tube. The mixture was centrifuged at 2,000 rpm for 5 minutes. EA was calculated as the percentage ratio of emulsion height to total mixture height. For Emulsifying stability, the emulsion was heated at 80°C for 30 minutes, cooled under tap water for 15 minutes, and the emulsified layer's height was similarly expressed as a percentage of the total mixture height.

Foaming capacity: Adapted from Coffman and Garcia (1997), FC was determined by whipping an egg mixed with 50 ml of water at 30°C in a graduated cylinder. The volume of foam after 30 seconds of whipping was measured, and FC was calculated using the formula: Foaming Capacity=

$$\frac{\text{Volume before whippingVolume of foam after whipping - Volume before whipping}}{\text{Volume before whipping}}$$

Foaming stability was measured as the percentage of initial foam volume retained after 1 hour. Swelling Capacity: To determine SC, an egg was added to a graduated cylinder with 10 ml of distilled water and topped up to 50 ml. The cylinder was sealed, inverted to mix, left to settle for 2 minutes, then inverted again and allowed to stand for 8 minutes. SC was expressed based on the resulting volume changes

Data Analysis

The data obtained in this study was analyzed using GenStat software version 2015. The treatment means was analyzed using analysis of variance and separated using Duncan Multiple Range Test.

RESULTS AND DISCUSSION

Table 1 presents findings from the physical and morphological defect assessment of Guinea fowl eggs. Egg size remained consistently medium across treatments, highlighting the species' tendency to lay medium-sized eggs, unaffected by storage time (Rayan *et a*l., 2022). Similarly, egg shape remained stable, with all eggs maintaining an oval shape regardless of storage conditions (Attard *et al*., 2018). Eggshell color changed slightly with storage as T1 and T2 retained their brown color, while T3, T4, and T5 showed darker shells, likely due to oxidation or environmental factors like humidity (Orellana, 2023). Pimpled eggs were observed in all treatments except T2, with a higher occurrence in T3 (++), possibly linked to storage conditions causing calcification irregularities (Hamid, 2022). Haemorrhagic eggs appeared only in T2 (+), potentially caused by vascular damage from specific storage conditions (Mukhtar *et al*., 2023). Cracks were present in T1, T4, and T5 (+) but absent in T2 and T3, possibly due to handling or environmental factors affecting the shell integrity. Calcium-coated eggs were most prominent in T2 (++), mildly present in T3 (+), and absent in T1, T4, and T5, potentially due to mineral deposits forming under specific conditions (Vaquette *et al*., 2023).

Table 1: Effect of storage time on physical and morphological changes of Guinea fowl egg

Parameters	T1	T2	T3	T4	T5
Egg size	Medium size	Medium size	Medium size	Medium size	Medium
Egg Shape	Oval	Oval	Oval	Oval	Oval
Shell colour	Brown	Brown	Slightly dark brown	Slightly dark brown	Slightly dark brown
Pimple egg	+	-	++	+	+
Haemorrhagic egg	-	+	-	-	-
Cracks	+	-	-	+	+
Calcium coated egg	-	++	+	-	-

Key: - = absent, + = mild presence and ++ = highly presence

The effect of storage time on Guinea fowl egg functional properties is showed in Table 2**. Foaming capacity** showed significant (P<0.05) differences, with T1 having the highest value (16.00), while T5 was the lowest (insert the value). The decline in foaming capacity with storage suggests protein degradation, reducing the ability to trap air (Chi and Ma, 2023). **Foaming stability** showed no significant differences (P>0.05), indicating storage does not affect foam retention over time (Ho *et al*., 2019). **Emulsifying activity** declined slightly with storage but differences were not significant, suggesting eggs retain emulsification capacity for blending water and oil phases

(Tian *et al*., 2024). **Emulsifying stability** (approx. 3.5) remained consistent across treatments, showing robustness of yolk components to storage effects (Hennebelle *et al*., 2024). **Swelling capacity** decreased from 2.40 (T1) to 1.85 (T5), reflecting protein hydration loss with extended storage, though differences were not statistically significant (Chi *et al*., 2024)

Table 2: Effect of storage time on functional properties of Guinea fowl eggs

Parameters	T1	T2	T3	T4	T5	SEM	LOS
FC	16.00[a]	14.75[ab]	15.50[a]	15.70[a]	13.50[b]	0.679	*
FS	9.50	9.30	9.05	9.25	9.10	0.319	NS
EA	15.90	15.35	15.65	15.00	14.80	1.029	NS
ES	3.500	3.200	3.300	3.500	3.500	0.452	NS
SC	2.400	2.150	2.00	1.950	1.850	0.207	NS

FC = Foaming capacity, FS = Foaming stability, EA = Emulsifying Activity, ES = Emulsifying stability, SC = Swelling capacity

CONCLUSION

The size and shape of Guinea fowl eggs remain stable over time, but storage conditions may cause some morphological changes, such as shell colour darkening and structural defects like pimples, cracks, and calcium coating.

Foaming capacity (FC) decreases significantly with prolonged storage, suggesting a decline in the functionality of proteins like ovalbumin and ovomucin, which are essential for foam formation. This may reduce the eggs' effectiveness in applications requiring high foaming properties.

In contrast, foaming stability, emulsifying activity, emulsifying stability, and swelling capacity are not significantly affected by storage. This indicates that the eggs retain their functional integrity for most culinary and industrial purposes, even after extended storage

REFERENCES

Attard, M. R., Sherratt, E., McDonald, P., Young, I., Vidal-García, M., & Wroe, S. (2018). A new, three-dimensional geometric morphometric approach to assess egg shape. *PeerJ*, *6*, e5052.

Cheng, H. W., & Jiang, S. (2020). Genetics and genomics of behavioral and welfare traits in poultry species. In *Advances in poultry genetics and genomics* (pp. 221-262). Burleigh Dodds Science Publishing.

Chi, Y., & Ma, Z. (2023). Egg White Protein Functionality. In *Handbook of Egg Science and Technology* (pp. 133-160). CRC Press.

Chi, Y., Ma, Z., Wang, R., & Chi, Y. (2024). A comprehensive review on freeze-induced deterioration of frozen egg yolks: Freezing behaviors, gelation mechanisms, and control techniques. *Comprehensive Reviews in Food Science and Food Safety*, *23*(5), e70019.

Coffman and Garcia (1997). Foaming capacities (FC) and Stabilities (FS) using the method, *Characterization of Guinea Fowl Eggs* Food Chemistry, 2015.

Fajemilehin, S. O. K. (2014). *Morphological and Genetic Characterization of Domesticated Guinea Fowl in Sokoto State, Nigeria* (Doctoral dissertation).

Hamid, M. S. (2022). *Effect of Sea-shell Based Calcium Carbonate Supplement (Cockle) on the Egg Quality of Japanese Quail (Coturnix coturnix japonica)* (Doctoral dissertation, Chittagong Veterinary and Animal Sciences University Chittagong–4225, Bangladesh).

Hennebelle, M., Villeneuve, P., Durand, E., Lecomte, J., Van Duynhoven, J., Meynier, A., & Berton-Carabin, C. (2024). Lipid oxidation in emulsions: New insights from the past two decades. *Progress in Lipid Research*, 101275.

Ho, T. M., Le, T. H. A., Yan, A., Bhandari, B. R., & Bansal, N. (2019). Foaming properties and foam structure of milk during storage. *Food research international*, *116*, 379-386.

Kuesten, C., & Hu, C. (2020). Functional foods and protein supplementation. *Handbook of eating and drinking: Interdisciplinary perspectives*, 941-964.

Mukhtar, K., Nabi, B. G., Ansar, S., Bhat, Z. F., Aadil, R. M., & Khaneghah, A. M. (2023). Mycotoxins and consumers' awareness: Recent progress and future challenges. *Toxicon*, 107227.

Onyenweaku, E. O., Ene-Obong, H. N., Williams, I. O., & Nwaehujor, C. O. (2018). Comparison of nutritional composition of bird egg varieties found in Southern Nigeria: A preliminary study. *Food and Nutrition Sciences*, *9*(7), 868-879.

Orellana Galindo, L. (2023). *Effect of Eggshell Translucency and Color on Broiler Egg Hatchability and Chick Quality and its Relationship with Other Eggshell Quality Parameters* (Master's thesis).

Rayan, G. N., Mansour, A., & Fathi, M. M. (2022). Comparative study of egg and meat quality of guinea fowl under different tropical regions: a review. *Brazilian Journal of Poultry Science*, *24*(04), eRBCA-2022.

Sanusi, A. Z., Jibia, Z. S., Garba, M. G., Salisu, U. S., Usman, H. B., Gaddafi, S., ... & Mikailu, M. M. (2021). Determination of functional properties of fresh and powdered whole egg. *Nigerian Journal of Animal Production*, 934-937.

Terra-Long, M. (2022). Ascaridia galli: Diagnosis, alternative treatments and influence on cytokine expression, microbiota, egg quality and digestibility.

Tian, Y., Lv, X., Oh, D. H., Kassem, J. M., Salama, M., & Fu, X. (2024). Emulsifying properties of egg proteins: Influencing factors, modification techniques, and applications. *Comprehensive Reviews in Food Science and Food Safety*, *23*(5), e70004.

Vaquette, C., Ivanovski, S., Hamlet, S. M., & Hutmacher, D. W. (2013). Effect of culture conditions and calcium phosphate coating on ectopic bone formation. *Biomaterials*, *34*(22), 5538-5551.