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COMPARATIVE ANALYSIS OF THE MINERAL CONTENTS IN THE EGGSHELLS OF GUINEA FOWL (*Numida meleagris*) AND LAYING HENS (*Gallus gallus*)

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ABSTRACT

The study was designed to compare the differences between some mineral elements (Calcium, Phosphorous, Potassium, Magnesium, Zinc, and Sodium) contained in the guinea fowls eggshell (GFE) and commercial layers eggshell (CLE); with a view to assessing the mineral components responsible for the strength of GFE over CLE. Subsamples of the separately dried and grounded eggshells were subjected to mineral analysis by microwave plasma atomic emission spectrometry and colorimetric methods. The results revealed that, with the exception of Zinc, all the mineral elements were relatively high in GFE. Calcium content in the eggshells was 3.61±0.025 and 3.29±0.043g/kg for GFE and CLE respectively. Phosphorus for GFE was 0.24±0.020 mg/g and CLE 0.14±0.010 mg/g. Potassium was 12.58±0.029 and 7.03±0.020 mg/g for GFE and CLE respectively. Magnesium was 22.28±0.730mg/g for GFE and CLE 19.36±0.500 mg/g. Sodium content in the eggshells was 21.81±0.620 and 19.19±0.400mg/g for the GFE and CLE respectively. Zinc was relatively higher in the CLE with a value of 0.39±0.014 mg/g than in GFE with a value of 0.10±0.040 mg/g. It was therefore concluded that other factor which contributed to the unique strength observed in the guinea fowl eggshell is the mineral composition. And it was recommended that if poultry farmers can fortify the diets of the laying hens with useful mineral additives within the range of the bird's requirements for minerals, numbers of egg breakage may be reduced and the final profit realized from the egg sales will also increased.

Keywords: Eggshell, mineral composition, guinea fowl and laying hens

INTRODUCTION

Several researches has been conducted to evaluate the quality of the eggshell in term of its strength. Some of the traits used in the assessment of eggshell quality includes; shell weight, shell thickness, shell percentage, breaking strength and egg specific gravity(Hunton, 2005)

The possibility of minimizing the number of broken or cracked eggs between the times the eggs are laid and when they reach the final consumers is one of the area of interest in the poultry industry. The reason is because, eggshell quality has a major economical impact on commercial egg production. Broken and cracked eggs is one of the causes of economic loss to egg producers. Eggs with damaged shells account for 6.0 to 10.0% of all eggs produced, which leads to great

economic loss (Washburn 1982; Roland *et al* 1988) Eggshell breakage has a direct relationship with the egg shell quality (Hunton, 2005). High eggshell breaking strength and lack of shell defects are essential for protection against penetrating of pathogenic bacterial such as Salmonella spp into the eggs (Swiatkiewicz and Korelski 2008). In other to make significant reductions in the number of eggs lost due to poor shell quality we must first consider the possible factors that are responsible for egg breakage (Gary and Richard,2000). Some of the factors affecting the eggshell quality includes; age of the

birds, environmental temperature, strain, diseases, management and nutrition. Other factor is an increase in egg weight without a corresponding increase in the amount of calcium carbonate deposited in the shells. The hen usually obtain the required calcium from the diet and also from medullary bone reserves. Medullary bone is found in sexually mature, laying hens. It is the primary bone calcium reserve for eggshell formation. For an efficient egg shell quality, calcium and phosphorous must be adequate in the diets of laying hens. For instance, a laying hen requires optimum calcium intake of 4g/day to maintain good shell quality. About 50-60% of dietary calcium is usually used in shell formation.Scott,*et al* (1971), Gary and Richard (2000) reported that shell is about 10 - 11% of the total weight of the egg and it contained about 94% calcium carbonate, 1% calcium phosphate, 1% magnesium carbonate and 4% organic substances therefore, eggshell is a rich source of mineral salts, mainly calcium carbonate. In addition, Burley and Vadehra (1989) reported that, dietary manipulation is the primary means by which poultry farmers can correct deficiency in eggshell quality. To be successful in manipulating the hen's diets, calcium has to be provided as part of the hens's diet in form of calcium carbornate ($CaCO_3$). The $Caco_3$ is usually breakdown in the intestine into its various components after which the calcium is then absorbed into the bloodstream. The calcium is either stored as bone until needed for shell formation or transported to the shell gland for synthesis into eggshell $CaCO_3$.This study was therefore designed to investigateand compare the differences in the mineral content in guinea fowls and commercial layers eggshell. And also to evaluate the possible mineral components responsible for the strength of the guinea fowl eggshell.

MATERIALS AND METHODS

Sample collection

One crate of eggs of Isa brown laying hen was obtained from a poultry pen within Ahmadu Bello University, Zaria.Whereas a crate of the guinea fowl eggs used for the study was purchased from a poultry farm along Jaji-Kaduna road. The eggs were broken and the shell was washed with clean water to remove adhering albumen, thereafter, the shell was air dried at room temperature. Subsample of the dried eggshell to be analyzed was then labeled, A (Commercial layer) and B (Guinea fowl) and taken to the Multi –User Laboratory in the Department of Chemistry, Ahmadu Bello University, Samaru, Zaria.

Preparation of samples

The air dried samples were grounded to fine powder using a porcelain mortar and pestle. Exactly 0.5g of the powdered samples were separately weighed and transferred into different beakers and to each 7.5ml concentrated HNO_3 and 2.5ml HCl were added and 100ml distilled water was added. The mixture was heated at $120^oC$for 4 hours. About 20ml distilled water was added and the mixture filtered on Wattman40 filter paper into a 50ml capacity volumetric flask and more distilled water was added to make up the 50ml mark.

Determination of some mineral elements contained in the eggshell

The determination of calcium,zinc, potassium, magnesium and sodium were performed using the innovative Agilent 4200 Microwave Plasma-Atomic Emission Spectrometer (MP-AES).The instrument was controlled using Agilent's unique worksheet-based MP Expert software, which runs on the Microsoft® Windows ® 7 operating system and features automated optimization.

Determination of phosphorous in eggshell

Phosphate phosphorous of the samples was determined using HACHDR/890 Colorimeter. Blank solution (10ml) of the filtration was used to bring the reading on the colorimeter to zero. Aliquot (10ml) of sample solution was measured and phosphate standard was added and the reading was taken after 3minutes of color development.

RESULTS AND DISCUSSION

Table 1: Mineral contents in the eggshell of guinea fowl and commercial layer

Parameters	Sample CLE	Sample GFE
Calcium (g/kg)	3.29 ±0.043	3.61 ±0.025
Phosphorous (mg/g)	0.14 ±0.010	0.24 ±0.020
Zinc (mg/g)	0.39 ±0.014	0.10 ±0.040
Potassium (mg/g)	7.03 ±0.020	12.58 ±0.029
Magnesium (mg/g)	19.36 ±0.500	22.28 ±0.730
Sodium (mg/g)	19.19 ±0.400	21.81 ±0.620

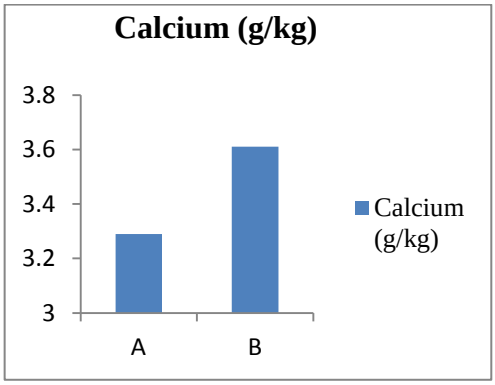
CLE = Commercial layer eggshell, **GFE**= Guinea fowl eggshell

From the results (Table 1), Calcium content of the eggshell was relatively high for both guinea fowl and layers, when compared with the other minerals contained in the eggshell. However highest value was recorded for guinea fowl eggshell. This is in consonance with the findings of Burley and Vadehra (1989), Adeyeye (2009), these authors reported that calcium is the major mineral element in the eggshell and that its value may range between 95- 97%.Figures 1,2,3 4, 5 and 6 shows the comparative analysis of the various eggshell components(calcium, phosphorous, zinc, potassium, magnesium and sodium). Results of this study showed that guinea fowl egg shell is relatively high in all the mineral elements analyzed except zinc, This could be part of the reasons why guinea fowl eggshell is strong. It is also possible that the high value (22.28mg/g) of magnesium content recorded for the guinea fowl eggshell has positive role in the structural strength of eggshell. This observation conform to the report by Brooks, (1955)who hypothesized that, the level of magnesium in form of magnesium carbornate usually increase the structural strength of the mamillary layer of the eggshell. The results of this study is also in agreement with the findings of other researchers such as Petersen and Tyler (1966),Gary and Richard (2000), Ahmed and Singh (2009), who reported that guinea fowl egg shells are stronger and thicker than egg shells from the domestic hen. However, the observed hardness observed in guinea fowl eggshell may also be linked with the smaller size (40-45g) of the eggs when compared with the chicken eggs (55-60g).This observation agreed with the report by Gary and Richard (2000) and Fani *et al*. (2014), they reported that smaller eggs often has stronger shells than larger ones, because the capacity of calcium deposition by the hens is limited, hence the same amount of calcium is spread over a larger area. Genetic makeup of the birds may also be responsible for the observed differences in the eggshell of guinea fowl and layers. It is also possible that that the guinea fowls eggs spend longer time within the shell gland during the eggshell formation leading to more calcium deposition and consequently stronger eggshell. This observation is in line with the findings of Gary and Richard (2000), who reported the occurrence of thin shell due to the shortness of the time that the egg spent in the ovary. However, the value 0.39 and 0.10mg/g recorded for zinc in chicken and guinea fowl egg shell respectively may be due to the modification of the commercial diet fed to the laying hens used for the study. This is an indication that eggshell of the commercial layers can be fortified with mineral elements to improve the strength of the eggshell. This is in consonance with the findings of Inal *et al.* (2001), and Fermandes *et al.* (2008). The report by Mabe *et al* (2003), Lim

and Paik (2003) and Zamani *et al.* (2005), is also in agreement with this observation, these authors reported the need to fortify layers diet with zinc because, zinc is one of the micro minerals which have direct effects on the mechanical properties of eggshell, due to its effects on calcite crystal formation.

COMPARATIVE ANALYSIS OF THE MINERAL ELEMENTS CONTAINED IN THE EGGSHELL OF GUINEA FOWL AND LAYING HENS

Figure1



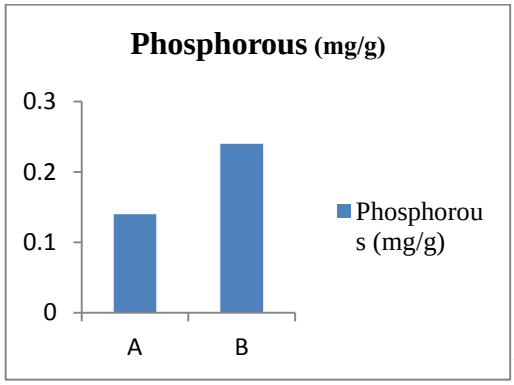
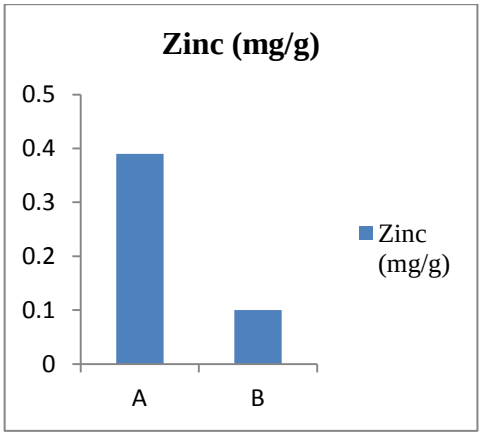


Figure2

Figure 3



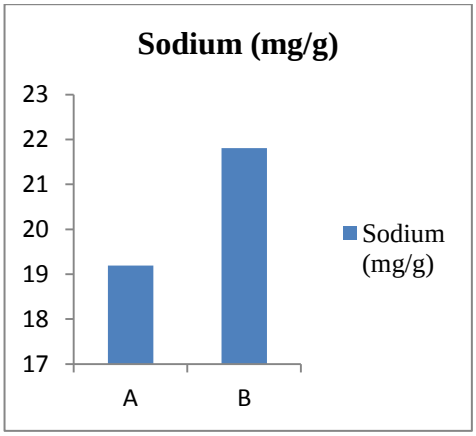
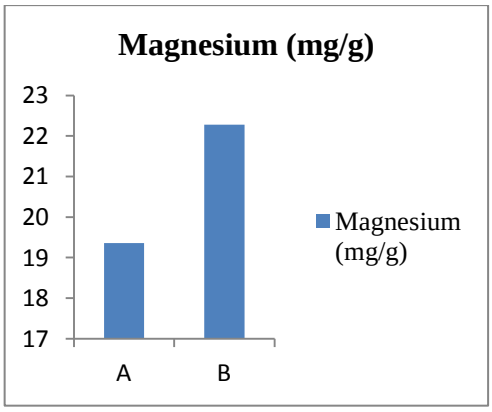


Figure 4

Figure 5



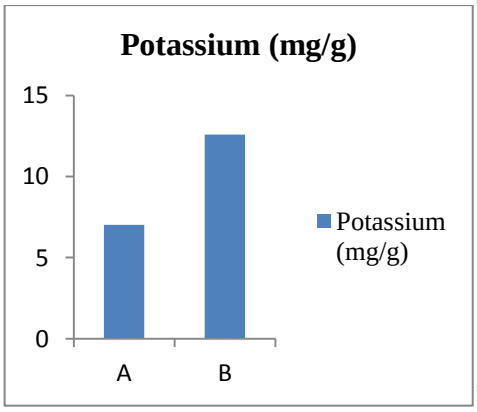


Figure 6

A = Commercial layer eggshell (CLE), B = Guinea fowl eggshell (GFE)

CONCLUSION AND RECOMMENDATION

Results of this study revealed that, other factors which may be responsible for the variations between the eggshell strength of guinea fowl and laying hens is the mineral composition of the eggshell. It was therefore concluded that, the uniqueness of guinea fowl eggshell is due to higher calcium, Phophorus, magnesium, and sodium contents. Based on the findings of this study;

- Calcium content in the guinea fowl eggshell and chicken is 3.61g/kg and 3.29 mg/kg respectively
- Phosphorus content in the eggshell is 0.24 and 0.14 mg/g respectively for the guinea fowl and chickens
- Potassium values in the eggshellis 12.58mg./g and 7.03mg/g for the guinea fowl and chickens respectively
- Magnesium content in the eggshell used for this study was 22.28mg/g and 19.36mg/g for the guinea fowl and chickens respectively.
- Sodium contained in the eggshell was 21.81 and 19.19mg/g for the guinea fowl and chickens respectively.
- However, the values (0.39 and 0.10 mg/g) of zinc recorded for the chickens and guinea fowl eggshell is an indication that diets can be fortified with valuable mineral additives to improve the strength of the eggshell of the commercial layers.

RECOMMENDATIONS

Further research is recommended to determine the effects of the various mineral additives in the diets of commercial layers, with the goal of improving the strength of the eggshell and consequently reducing egg breakage and boost the profits from egg sales.

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