

# EFFECTS OF PROCESSING (BOILING AND FRYING) ON THE NUTRITIONAL COMPOSITION OF WHITE CHICKEN EGGS

The use of fowl is too generalised

## ABSTRACT

Nutritional value of chicken egg is widely accepted but because the egg cannot be consumed raw, various processing methods are utilized. The aim of this study is to determine the effect of processing methods (raw, cooking and frying) on the nutritional composition of chicken egg. The egg samples used in the study were collected from Eke Awka market while the AOAC methods were used in the analysis. The eggs were cooked for 20 minutes at temperature of 100°C and also fried using vegetable oil for 15min. The proximate, mineral and vitamin compositions of the raw and processed egg samples were determined using standard AOAC method. The result revealed that there was no significant ( $p>0.05$ ) difference in fat, total protein and fiber compositions of chicken egg. Processing method affected the moisture content as it decreased from 58.00% in raw egg to 25.80% in cooked egg and 10.60% in fried egg, protein content reduced from 22.52% in raw egg to 21.52% in cooked egg and 8.33% in fried egg respectively. The ash content was increased from 1.09% in raw sample to 3.86% in fried egg and 4.00% in cooked egg. The crude fiber also increased from 0.90% in raw sample to 1.19% in cooked sample and 5.30% in fried samples. The fat content was increased from 1.50% in raw sample to 5.70% in cooked egg and 8.33% in fried egg. Finally, the carbohydrate increased from 15.99% in raw egg to 41.79% in cooked egg and 56.22% in fried egg sample. Calcium decreased from 189.57mg/100g down to 160.72 in fried egg and 29.00mg/100g in cooked egg. Iron was highest in fried egg (3.30mg/100g) while cooked eggs have the lowest value (2.90mg/100g). The magnesium content was reduced by cooking and frying from 240.68mg/100g down to 48.64 in fried and 46.50mg/100g in cooked egg, while Zinc and phosphorus were increased from 11.00 and 0.45mg/100g in raw egg up to 13.10 and 1.16mg/100g for cooked egg and 21.80 and 1.33mg/100g for fried egg. It was also discovered that; Vitamin B2 decreased from 0.68mg/100g down to 0.57 in fried egg and 0.53mg/100g in cooked egg. Vitamin C decreased from 13.11mg/100g down to 5.32 in fried egg and 3.08mg/100g in cooked egg, while vitamin E and D were increased from 17.00 and 0.94mg/100g in raw egg up to 15.74 and 0.95mg/100g for cooked egg and 18.70 and 1.12mg/100g for fried egg. From the tests carried out and the result obtained, it was discovered that chicken egg cooked for 60 minutes at a constant temperature of 100°C gave better results in terms of nutrient retention. Processing treatments showed significant effects on the chemical composition of egg.

## 1. INTRODUCTION

Chickens are the most popular poultry worldwide and are now used for both meat and egg production. The current poultry is a domesticated fowl used for both meat and egg production. This includes birds such as chicken, turkey, duck, goose, ostrich, quail, pheasant, guinea fowl, and peafowl. Chickens are the most popular poultry worldwide irrespective of culture and religion (Aho, 2014). This is because poultry products have very high nutritive values. Chicken meat and eggs are the major protein source for consumers in most of the countries around the world. Chicken meat consumption has been increasing during the last few years due to the rise in health awareness of consumers all over the world. Broilers dominate the world poultry market, consisting of about 70% of the market. Turkeys account for about 8% and other poultry provides 22% of the global market (Roenigk, 2004; USDA, 2016). This indicates that broiler meat continues to be desired over other poultry meats.

### 1.1 Origin of chickens

All commercial chickens are the descendents of the red jungle fowl species (Crawford, 2010; Vaisanen, *et al.*, 2015).

Chickens were originated as jungle fowl in Asia, domesticated over 3000 years ago, and are now known as chicken; *Gallus gallus domesticus* (Romanov and Weigend, 2021). There was a debate on whether the domestic fowl is monophyletic or polyphyletic origin (Crawford, 2010). It was indicated by many research studies that the red jungle fowl is the direct ancestor of the domestic chicken (*Gallus gallus domesticus*) used in commercial production for meat and eggs (Vaisanen, *et al.*, 2015). Fumuhito, *et al.* (2014) reported that *G. g. gallus* of the red jungle fowl is the origin of all domestic breeds. Collias and Collias (2016) reported that the red jungle fowl is the principal and perhaps the sole ancestor of the domestic fowl. Moreover, the use of molecular genetics and micro-satellite techniques provided evidence that the origin of domestic fowl is monophyletic.

Hillel, *et al.*, (2013) evaluated the gene pool of 52 chicken populations from a wide range of origins using the micro-satellite markers technique. They found that the red jungle fowl is the main progenitor of the domestic chickens. Moiseyeva, *et al.*, (2013) investigated the similarity and evolutionary relationships between *G. g. gallus* and different chicken breeds. The authors conducted four experiments on genetic relationships using different estimation criteria including morphological discrete characters, body measurements, biochemical markers, and the activity of

serum esterase-1. They found that the greatest similarity was found between *G. g. gallus* and egg type breeds of Mediterranean roots and/or true Bantam. In addition, Collias and Collais (2016) reported that Leghorn breed is very similar to the red jungle fowl. Therefore, all in all it seems that the domesticated chickens are from one origin.

## **1.2 Objective of the study**

This work was undertaken to determine the effect of processing methods (boiling and frying) on the nutritional value of chicken eggs **while** the specific objectives **are to:**

- Determine the nutritional composition of boiled chicken eggs in terms of its moisture, ash, protein, fats, fiber and carbohydrate contents.
- Determine the nutritional composition of fried chicken eggs in terms of its moisture, ash, protein, fats, fiber and carbohydrate contents, **and**
- Compare the nutritional compositions of boiled and fried chicken eggs.

## **1.3 Justification (or Importance) of the study**

**The author should give the reader his justification (reasons/benefits for doing this work)**

## **2. MATERIALS AND METHODS**

### **2.1 Materials**

The following materials were used during this study;

Weighing crucible

Soxhlet extractor

Beaker

Filter paper

Bucker funnel

Muffle furnace

Kjeldahlflusk

Muslin cloth

### **2.1.1 Chemicals/Reagents**

**These are chemicals/reagents used in the course of this study;**

Distilled water

N-hexane,

Sulphuric acid

Sodium hydroxide

Hydrochloric acid

Sodium hydroxide

H<sub>2</sub>SO<sub>4</sub>cristal

### **2.2 Methods of collection of sample**

*Gallus gallus* eggs were bought from Eke Awka market in Anambra State, Nigeria. They were transported within one hour in a cooler made from Polyethylene terephthalate (plastic), packed with iced block and were taken to the laboratory while the identification was carried out by my supervisor.

#### **2.2.1 Pre treatment**

The egg samples were separated into two parts. One part was boiled while the second part was fried using vegetable oil as described by Eyo, (2011).

## **3. EXPERIMENTAL SETUP**

**A brief description of the experimental setup to be given here, and if possible, the author should shows the sketches (or diagrams, photographs, etc).**

#### **3.3.1 Proximate analysis**

The determination of the crude protein, moisture, ash and fat contents of the raw and smoked fish were carried out in triplicates in accordance with Association of Analytical Chemist (AOAC, 2002).

#### **3.3.2 Moisture content determination**

The AOAC Method N<sup>o</sup>. 945.38 of year 2002 were used while a sample of 2g was weighed into clean, dry and pre-weighed crucibles. The crucibles and their contents were dried in the moisture extraction oven at 110<sup>o</sup>C for 3 hours. The samples were cooled in desiccators and reweighed. The samples were dried in the oven until a constant weight is obtained and the moisture content determined from:

$$\text{Percentage Moisture content (\%)} = \frac{\{(\text{Initial weight of sample}) - (\text{weight of oven sample})\}}{(\text{Initial weight of sample})} \times 100$$

### 3.3.3 Crude fat determination

Method N<sup>o</sup>. 920.39A from AOAC (2002) was used with a 2g of the air dried ground sample weighed into a filter paper, wrapped carefully and put in the sample holder of the soxhlet extraction apparatus. A clean, dried and half filled weighed soxhlet extraction flask with N-hexane plus the whole assembled apparatus and the flask placed on the heating mantle and heated to 60<sup>o</sup>C.

The fat was extracted for three hours, then, the sample holder disconnected and the extraction flask removed. The percentage fat contained was determined thus:

$$\text{Percentage Crude fat (\%)} = \frac{\{(\text{weight of flask + oil}) - (\text{weight of empty flask})\}}{(\text{Initial weight of sample})} \times 100$$

### 3.3.4 Crude fiber determination

Method N<sup>o</sup>. 942.05 of AOAC (2002) was used while a 2g of defatted sample was weighed into 250 ml beaker containing 200 ml of 0.125M tetraoxosulphate (iv) acid (Sulphuric acid). The mixture was heated in a steam bath at 70<sup>o</sup>C for 2 hours, and then allowed to cool. The cooled mixture was filtered using a muslin cloth over a Buckner funnel. The residue was washed three times with hot water to remove the acid and then put in a beaker containing 100 ml of sodium hydroxide. The mixture was heated as before over a steam bath for 2 hours. The solution was filtered and the residue washed three times with hot water. The final residue obtained were put in clean pre-weighed crucible and dried at 120<sup>o</sup>C to a constant weight. The crucible with the dry sample were put in a muffle furnace and ashed at 550<sup>o</sup>C for 3hrs such that the sample became ash white. Percentage fiber was calculated as followed:

$$\text{Percentage Crude fiber (\%)} = \frac{\{(\text{weight of oven dried sample}) - (\text{weight of ash})\}}{(\text{Initial weight of sample})} \times 100$$

### 3.3.5 Crude protein determination

The Kjeldahl method from AOAC N<sup>o</sup>. 955.04C of year 2002 was used, but this was divided into three namely; digestion, distillation and titration.

#### i) Digestion

Approximately 0.1g of ground sample was weighed into clean dried Kjeldahl flask for digestion, and 0.1g copper tetraoxosulphate (iv) crystals, 0.5g sodium tetraoxosulphate (iv) crystal and 25ml of concentrated H<sub>2</sub>SO<sub>4</sub> acid was added into the flask and some glass beads was added into the flask content as anti-bumping agents. The Kjeldahl flask and its content was transferred to the digesting chamber in a fume cupboard and digested. Digestion continued with constant rotation of the digestion flask until the sample changed color (that is from black to light blue). The digestion flasks were removed from the digesting chamber and allow cooling. The digest was made up to 100ml using distilled water and shaken vigorously to a homogenous solution.

#### ii) Distillation

Out of the homogenous solution of the digest, 5ml was transferred into a distillation flask using a pipette. Then 20ml of 40% sodium hydroxide solution was added carefully down the side of the flask through a funnel.

Then 10ml of 2% boric acid solution was pipette into a receiving flask and two drops of methyl red indicator added. The distillation unit was fitted such that the condenser is connected to the receiving flask with a glass tube, and the condenser cooled with constant supply of cold water from tap. Also, the tip of the glass tube was immersed in the boric acid. The distillation unit is heated on a heating mantle for 35 minutes until the pink solution of the boric acid turned blue and the volume increased to about 100ml by the distillate.

#### iii) Titration

Ten milliliters of the distillate was titrated against 0.1N hydrochloric acid to a colorless end point. A blank solution was also titrated to get any trace of nitrogen in the blank. All the titre volumes were recorded. The percentage crude protein was calculated as follows:

$$\% \text{Crude protein} = \% \text{Nitrogen} \times 6.25$$

### 3.3.6 Ash content determination

The AOAC (2002) method N<sup>o</sup>. 942.05 was used where clean dried crucibles were weighed on an electronic balance and 5g of samples weighed into the crucibles. The samples were dried in the

oven until constant weights are obtained. Then, the samples were transferred into the muffle furnace with a pair of tongs and ashed at 550°C for 4 hours until white ash were obtained. The sample was removed from the furnace and cooled in desiccators, and reweighed. The percentage ash was calculated using;

$$\text{Percentage Ash Content (\%)} = \frac{\text{(Weight of Ash)}}{\text{(Weight of sample after oven drying)}} \times 100$$

### 3.3.7 Carbohydrate content determination

The carbohydrate content of the sample was obtained by difference, that is, as the difference between the total summations of percentage moisture, fat, fiber, protein, ash and 100, thus:

$$\text{Percentage carbohydrate (\%)} = 100 - (\% \text{ moisture} + \% \text{ fat} + \% \text{ protein} + \% \text{ fibre} + \% \text{ ash})$$

## 4. RESULTS AND DISCUSSION

### 4.1 RESULTS

#### 4.1.1 Effect of processing on proximate composition of chicken eggs

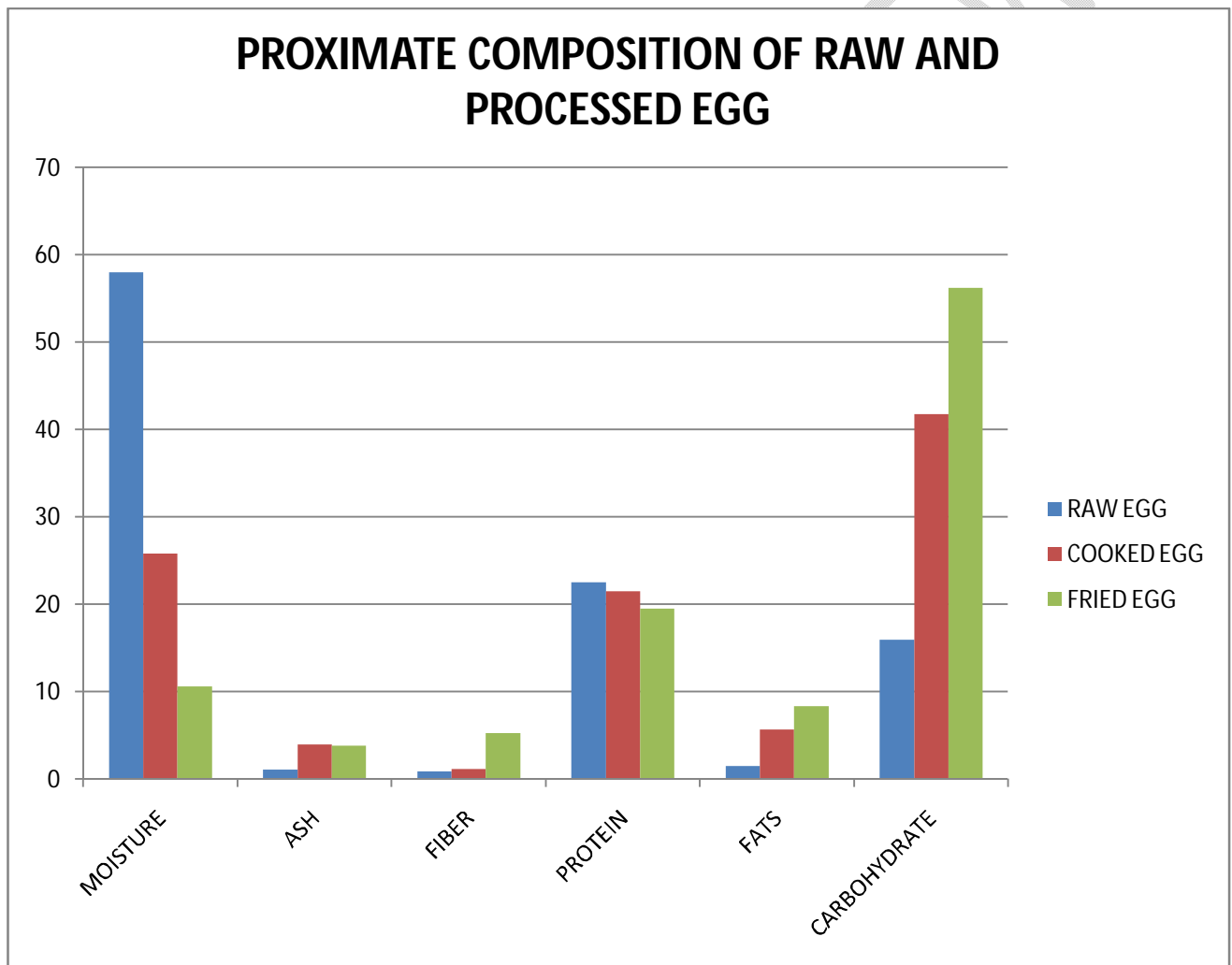
Result on the effect of processing on proximate composition of chicken eggs is presented in Table 1. From this table, the result revealed that, there was no significant difference ( $p > 0.05$ ) in fat, total protein and fiber compositions of chicken egg but, processing methods affected the moisture content as it decreased from 58.00% in raw egg to 25.80% in cooked egg and 10.60% in fried egg, protein content reduced from 22.52% in raw egg to 21.52% in cooked egg and 8.33% in fried egg respectively. The ash content was also increased from 1.09% in raw sample to 3.86% in fried egg and 4.00% in cooked egg. The crude fiber increased from 0.90% in raw sample to 1.19% in cooked sample and 5.30% in fried samples. The fat content was increased from 1.50% in raw sample to 5.70% in cooked egg and 8.33% in fried egg while, the carbohydrate increased from 15.99% in raw egg to 41.79% in cooked egg and 56.22% in fried egg sample respectively.

**Table 1: Effect of Processing on Proximate Composition of Chicken Eggs**

Sample	Moisture (%)	Ash (%)	Fiber (%)	Protein (%)	Fats (%)	Carbohydrate (%)
Raw Egg	58.00+ 0.05 <sup>a</sup>	1.09+ 0.00 <sup>c</sup>	0.90+ 0.03 <sup>b</sup>	22.52+ 0.03 <sup>a</sup>	1.50+ 0.01 <sup>c</sup>	15.99+ 0.03 <sup>c</sup>
Cooked Egg	25.80+ 0.07 <sup>b</sup>	4.00+ 1.00 <sup>a</sup>	1.19+ 0.11 <sup>b</sup>	21.52+ 0.00 <sup>b</sup>	5.70+ 1.00 <sup>b</sup>	41.79+ 0.20 <sup>b</sup>

**Fried Egg**      10.60+ 0.01<sup>c</sup>    3.86+ 0.21<sup>b</sup>    5.30+ 0.05<sup>a</sup>    19.55+ 0.20<sup>c</sup>    8.33+ 0.05<sup>a</sup>    56.22+ 0.03<sup>a</sup>

- 1) This Table needs more explanation, for example; what is the meaning of 58.00+ 0.05<sup>a</sup>, etc?
- 2) Like this, how is it plotted or shown on the bar chart?
- 3) Equally, what are; a, b. and c what for? These should be well known or meaningful to any reader.
- 4) All units in the table should be indicated as shown.
- 5) Author to give clearer more/explanation of what (p>0.05) means to readers



**Fig. 1: Effect of Processing on Proximate Composition of Chicken Eggs**

The Y – axis is what unit, temoerature, %, mm, kg, etc? This is required from the author

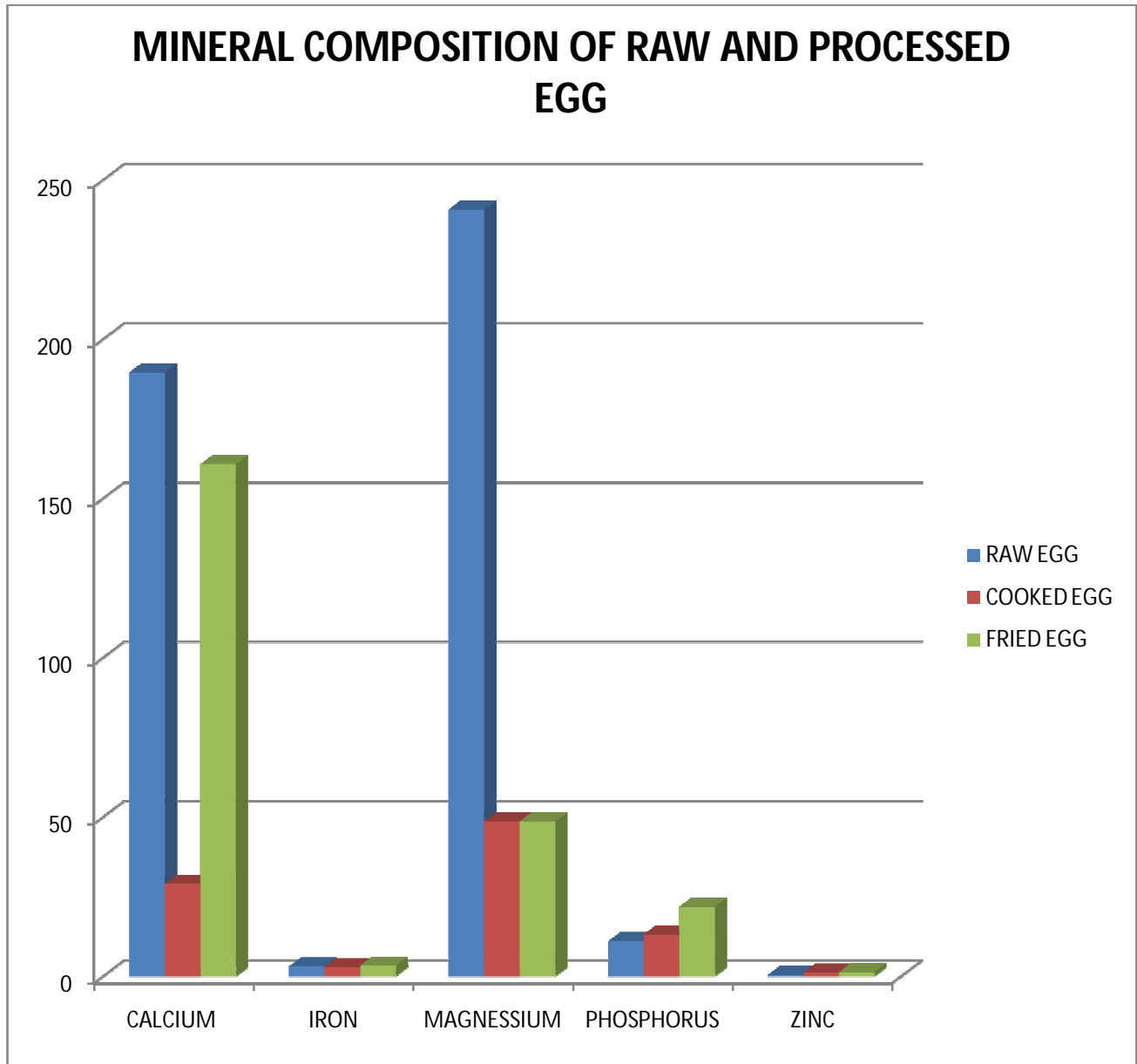
#### **4.1.2 Effect of processing on mineral composition of chicken eggs**

The result for the effect of processing on the mineral composition of egg is presented in Table 2. The results of Mineral analysis revealed that zinc and phosphorus were significantly higher ( $p < 0.05$ ) in processed samples than in raw chicken eggs. Calcium decreased from 189.57mg/100g down to 160.72mg/100g in fried egg and 29.00mg/100g in cooked egg. Iron was highest in fried egg (3.30mg/100g) while cooked egg has the lowest value of 2.90mg/100g. The magnesium content was reduced due to frying and cooking from 240.68mg/100g down to 48.64 in fried and 46.50mg/100g in cooked egg. Zinc and phosphorus were increased from 11.00 and 0.45mg/100g in raw egg up to 13.10 and 1.16mg/100g for cooked egg and 21.80 and 1.33mg/100g for fried egg.

**Table 2: Effect of Processing on Mineral composition of Chicken Eggs**

Sample	Calcium (Mg/100g)	Iron (Mg/100g)	Magnesium (Mg/100g)	Phosphorus (Mg/100g)	Zinc (Mg/100g)
Raw Egg	189.57+ 1.00 <sup>a</sup>	3.10+ 0.00 <sup>b</sup>	240.68+ 2.00 <sup>a</sup>	11.00+ 0.02 <sup>a</sup>	0.45+ 0.02 <sup>c</sup>
Cooked Egg	29.00+ 0.02 <sup>c</sup>	2.90+ 0.22 <sup>c</sup>	48.50+ 0.00 <sup>b</sup>	13.10+ 0.11 <sup>b</sup>	1.16+ 0.02 <sup>b</sup>
Fried Egg	160.72+ 0.00 <sup>b</sup>	3.30+ 0.05 <sup>a</sup>	48.64+ 0.07 <sup>b</sup>	21.80+ 0.03 <sup>a</sup>	1.33+ 0.01 <sup>a</sup>

- 1) This table also needs more explanation, for example; what is the meaning of 189.57+ 1.00<sup>a</sup>, etc?
- 2) Like this, how is it plotted or shown on the bar chart?
- 3) Equally, what are; a, b, and c what for? These should be well known or meaningful to any reader.
- 4) All units in the table should be indicated as shown.
- 5) More explanation/interpretation of ( $p < 0.05$ )



**Fig.2: Effect of Processing on Mineral Composition of Chicken Eggs**

Units are depicted on the Y axis and not with the title, .i.e. the height of each bar represent what; temperature, Mg/100g, %, mg, °C, km, etc?

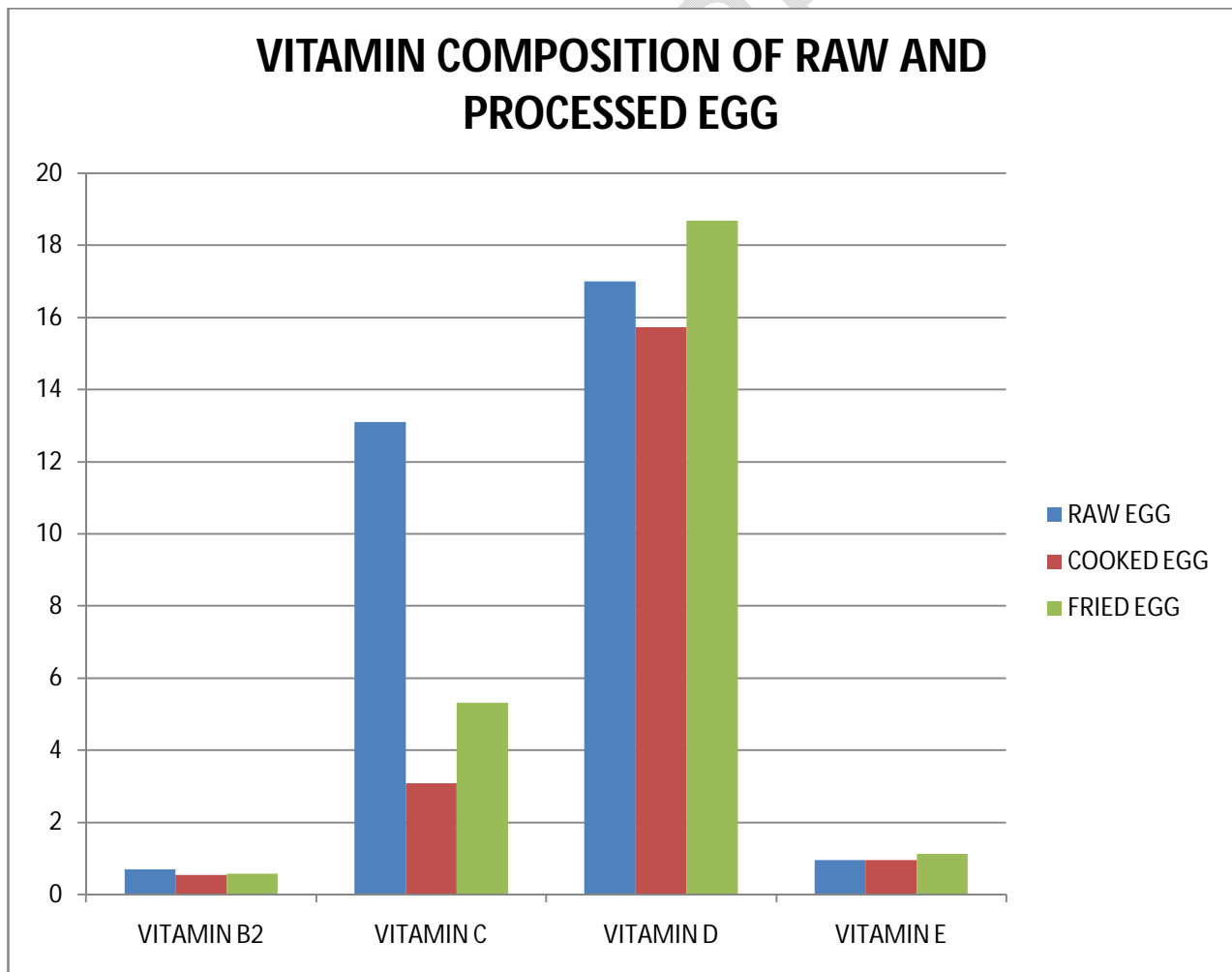
#### **4.1.3 Effect of processing on vitamin composition of chicken eggs**

The result **obtained** for the effect of processing on the vitamin composition of egg is presented in Table 3. The results showed that vitamin B<sub>2</sub>, and C were significantly higher ( $p < 0.05$ ) in raw chicken egg than processed chicken eggs. Vitamin B<sub>2</sub> decreased from 0.68mg/100g down to 0.57 in fried egg and 0.53mg/100g in cooked egg. Vitamin C decreased from 13.11mg/100g down to

5.32 in fried egg and 3.08mg/100g in cooked egg, while vitamin E and D were increased from 17.00 and 0.94mg/100g in raw egg up to 15.74 and 0.95mg/100g for cooked egg and 18.70 and 1.12mg/100g for fried egg.

**Table 3: Effect of Processing on Vitamin Composition of Chicken Eggs**

Sample	Vitamin B <sub>2</sub> (Mg/100g)	Vitamin C (Mg/100g)	Vitamin D (Mg/100g)	Vitamin E (Mg/100g)
Raw Egg	0.68+ 0.07 <sup>a</sup>	13.11+ 0.07 <sup>a</sup>	17.00+ 0.07 <sup>a</sup>	0.94+ 0.07 <sup>a</sup>
Cooked Egg	0.53+ 0.07 <sup>a</sup>	3.08+ 0.07 <sup>a</sup>	15.74+ 0.07 <sup>a</sup>	0.95+ 0.07 <sup>a</sup>
Fried Egg	0.57+ 0.07 <sup>a</sup>	5.32+ 0.07 <sup>a</sup>	18.70+ 0.07 <sup>a</sup>	1.12+ 0.07 <sup>a</sup>



**Fig.3: Effect of Processing on vitamin composition of chicken eggs**

## 4.2 DISCUSSION

The nutrient composition in this study revealed that chicken eggs contain protein, fiber, ash, fats/oil as well as carbohydrate as shown in Table 1. Our result suggests that chicken eggs could serve as better sources of dietary carbohydrate, protein and lipids. The chicken egg contains crude protein value which is higher than protein content of most food items consumed in Nigeria, but lower than soybean (29.78% DW) and T. peanut (31.00% DW) (Akindahunsi and Salawu, 2005).

From this study, moisture content value of processed chicken eggs was relatively low, which implies that, the low content would therefore hinder the growth of spoilage microorganisms and enhance shelf life (Ruberto and Baratta, (2000). However, high amount of protein is essential for animal growth and increased milk production (Tangka, 2003). Animal proteins are a source of food nutrient especially for the less privileged population in developing countries including Nigeria. Proteins are one of the macromolecule and it is an alternate energy source when other energy sources are in short supply. They are building block units and food protein is needed to make vital hormones, important brain chemicals, antibodies, digestive enzymes, and necessary elements for the manufacture of DNA. Some proteins are involved in structural support, while others are involved in bodily movement, or in defense against germs (Bailey, 2008). Chicken egg can thus be considered a good source of protein because they provide more than 12% of caloric value from protein. Therefore, the protein content of the chicken egg will go a long way in meeting the protein requirement of the local people.

High temperature treatments might have rendered the high digestibility of proteins during processing, however, Alajaji [2001] reported that, the 23.64% protein in chicken egg showed non-significant effect of cooking treatments on protein content of chicken eggs. Processing of chicken eggs decreased their fat and ash contents, while leaching effect of the fats in the cooking broth at higher temperature is responsible for lower fat content in processed chicken eggs, which also confirm that; fat serves as store house of energy during embryo development. These results are in accordance with the reports of Alajaji [2001].

Chicken eggs had ash value of 3.24% and this is a reflection of the mineral contents preserved in the food. The ash content compared favorably well with the values reported for *Vernonia colorate* (2.86%) and *Moringa oleifera* (2.09%) (Lockeett, et al., 2000) and lower than that of some leafy vegetables commonly consumed in Nigeria such as *Talinum triangulare* (20.05%)

This result therefore suggests a high deposit of mineral elements in chicken eggs. Ash is a non organic compound containing mineral compound of food and nutritionally it aids in the metabolism of other organic compounds such as fat and carbohydrate (McWilliam, 1978). It has been shown by Ebun-Oluwa and Alade (2007) that, Carbohydrates are essential for the maintenance of life in both plants and animals and also provide raw materials for many industries.

Carbohydrates produced by plants are one of the three main energy sources in food, along with protein and fat. When animals eat plants, energy stored as carbohydrates is released by the process of respiration, a chemical reaction between glucose and oxygen to produce energy, carbon dioxide, and water. Glucose is also used by animal cells in the production of other substances needed for growth (Westman, 2002).

\*\*Mineral content of walnut as summarized in Table 2 depicted a significant reduction of minerals in cooked chicken egg\*\*. The minerals leached from the chicken egg into the water during cooking treatments. Interestingly, cooking increased zinc and phosphorus in chicken eggs. The analysis indicated that zinc, and phosphorus were significantly ( $p < 0.05$ ) higher in processed eggs than in raw chicken eggs, this suggested that raw chicken eggs are richer in minerals than chicken eggs which is in tandem with Tunsaringkarn, et al., (2018). High zinc content in chicken eggs could be responsible for strengthening of the immune system, increase brain activity and stabilization of the nervous system. High phosphorus and iron in quail eggs could stimulate sexual potency and increase haemoglobin level in the body. While potassium and sodium help in regulating blood pressure and aging.

The results in Table 3 showed the effect of processing on the vitamin content of chicken egg. The data obtained showed that heat significantly affect the water soluble vitamins by reducing the concentrations of vitamin C and B2. The cooked and fried chicken egg still contained appreciable concentrations of the water soluble vitamins while cooking significantly reduced the contents of the vitamins in the chicken egg. The Vitamins B-Complexes in foods has been associated with antioxidant activity and therapeutic effects including maintenance and protection of skin and teeth as well as the prevention of scurvy. However, vitamins, as reported by Okiei, et al., (2009) must be supplied daily with a recommended allowance of 60 mg. Although Tosun and Yücecan (2007) suggested it is present in appreciable quantities in other food sources such as

green vegetables and potatoes, Kadar (2002) reported it is easily deactivated by heat and exposure to the atmosphere, because of its strong reducing properties. Thus, their presence in chicken egg that do not require heating is preferred. Folic acid is itself not biologically active, but its biological importance is due to tetrahydrofolate and other derivatives after its conversion to dihydrofolic acid in the liver.

## 5. CONCLUSIONS AND RECOMMENDATIONS

### 5.1 Conclusions

The variations in composition of raw and processed chicken eggs analyzed in this study, could be attributed to the differences in the effects of heat. The results from current study reveal that chicken egg is nutritionally rich in protein, mineral and fats. This study shows that egg are rich in nutrients and that their utilization should be strongly recommended for good health. The result revealed that there was no significant ( $p>0.05$ ) difference in fat, total protein and fiber compositions of chicken egg. The results of Mineral analysis revealed that zinc and phosphorus were significantly ( $p<0.05$ ) higher in processed samples than in raw chicken eggs. The results showed that vitamin B2, and C were significantly ( $p<0.05$ ) higher in raw chicken egg than processed chicken eggs. This study suggests that cooked eggs are more nutritious than fried chicken eggs and as such should be given preference and wider acceptability. The processing methods applied in the present investigation resulted in reduction of water soluble vitamin content of egg. The study clearly showed that cooking of eggs is the better processing method as its still retained higher concentration of the water soluble vitamin which are destroyed by heat.

### 5.2 Recommendations

Based on the results from this study, it is recommended that;

- a) People should be eating egg in order to meet up the recommended daily intake of vitamins.
- b) Consumption of boiled eggs should be strongly encouraged because boiling leads to a considerable loss in ascorbic acid contents.
- c) Further studies are undertaken on chicken eggs so as to determine their microbial quality.

## REFERENCES

- Adler-Nissen, J. (2016). Enzymic hydrolysis of proteins for increased solubility. *J. Agric. Food Chem.* **24**:1090-1093.
- AHO, P. (2014). Challenges and opportunities for marketing poultry products in developed and developing countries. *Presented on behalf of The American Soybean Association in Romania and Turkey*, June 1-16, 2004.
- Aho, P. (2021). The World's Commercial Chicken Meat and Egg Industries. *In: Commercial Chicken Meat and Egg production*. Fifth edition. (Ed. Bell, D. D., and Weaver W. D.). *Kluwer Academic Publishers, the Netherlands*, pp: 3-17.
- Bradley. (2018). Discovery of water-soluble anticancer agents (edotides) from a Vegetable found in Benin City, Nigeria. *Exp. Biol. Med.*, **228**: 293-298.
- Bush, K. L. and Strobeck, C. (2013). Phylogenetic relationships of the phasianidae reveals possible nonpheasant. pp' 10 - 21
- Collias, N. and Collias, E. (2016). Social organization of a red jungle fowl, *Gallus gallus*, population related to evolution theory. *The Association of the study of animal behaviour*, pp: 1337-1345.
- Cowell, D. (2016). Red Junglefowl (*Gallus gallus*). *gbwf.org* PP:1-3.
- Crawford, R. D. (2020). Poultry Biology: Origin and History of Poultry Species. *In: Poultry Breeding and Genetics* (Ed. Crawford, R.D.). *Elsevier Science Publishing Company, Amsterdam and New York*, pp: 1-42.
- Di Maso, M., Talamini, R., Bosetti, C., Montella, M., Zucchetto, A., Libra, M., Negri, E., Levi, F., La Vecchia, C. and Franceschi, S. (2013). Red meat and cancer risk in a network of case-control studies focusing on cooking practices. *Ann. Oncol.* **24**:3107-3112.
- Dunnington, E. A., Stallard, L. C., Hillel, J. and Siegel, P. B. (2014). Genetic diversity among commercial chicken populations estimated from DNA fingerprints. *Poultry Science* 73:1218-1225.
- Fillion, L. and Henry, C. (2018). Nutrient losses and gains during frying: a review. *Int. J. Food Sci. Nutr.* **49**:157-168.

- Fumihito, A., Miyake, T., Sumi, S., Takada, M., Ohno, S. and Kondo, N. (2014). One subspecies of the red jungle fowl (*Gallus gallus gallus*) suffices as the matriarchic ancestor of all domestic breeds. *Proc.*
- Gokoglu N, Yerlikaya P, Cengiz E (2014). Effects of cooking methods on the proximate composition and mineral contents of rainbow trout (*Oncorhynchus mykiss*). *Food Chem.* **84**:19-22.
- Henneberg and Stohmann, (2014). Evaluating forage quality by visual appraisal, pH, and dry matter content. Pennsylvania State University Department of Dairy and Animal Science and Cooperative Extension.
- Hillel, J., Groenen, M. A., Tixier-Boichard, M., Korol, A. B., David, L., Kirzhner, V. M., Burke, T., Barre-Dirie, A., Crooijmans, R. P., Elo, K., Feldman, M.W., Freidlin, P. J., Maki-Tanila, A., Oortwijn, M., Thomson, P., Vignal, A., Wimmers, K. And Weigend, S. (2013). Biodiversity of 52 chicken populations assessed by microsatellite typing of DNA.
- Hunton, P. (2020). Industrial breeding and selection. *In: Poultry Breeding and Genetics*, (Ed. Crawford R.D.). *Elsevier Science Publishing Company, Amsterdam and New York*, pp: 985-1028.
- Li, D., Ng, A. and Sinclair AJ. (2018). Contribution of meat fat to dietary arachidonic acid. *Lipids* **33(4)**:437–440.
- Lindqvist, C. E. S., Schutz, K. E. and Jensen, P. (2012). Red jungle fowl have more contra freeloading than white leghorn layers: effect of food deprivation and consequences for information gain. *Behaviour* **139**: 1195-1209.
- Malik, A., Aremu, A., Bayode, G. and Ibrahim, B. (2011). A nutritional and organoleptic assessment of the meat of the giant African land snail (*Archachatina marginata Swaison*) compared to the meat of other livestock. *Livest. Res. Rural Dev.* **23**:60-67.
- McCleary, T. and Prosky, P. (2012). Detection and Removal of L-Dopa in *Mucuna*. In Food and Feed from *Mucuna*: Current Issues and the Way Forward. *International Cover Crops Clearinghouse, Honduras*, p. 142-162
- Moiseyeva, I. G., Romanov, M. N., Nikiforov, A. A., Sevastyanova, A. A. and Semyenova, S. K. (2013). Evolutionary relationships of red jungle fowl and chicken breeds. *Genetics, Selection, Evolution* **35**: 403-423.

- Murphy, R., Marks, B. and Marcy, J. (2018). Apparent specific heat of chicken breast patties and their constituent proteins by differential scanning calorimetry. *J. Food Sci.* **63**:88-91.
- Mutilangi, W., Panyam, D. and Kilara, A. (2016). Functional Properties of Hydrolysates from Proteolysis of Heat denatured Whey Protein Isolate. *J. Food Sci.* **61**:270-275.
- Okezie, M. A. (2010). *n*-3 enrichment of chicken meat using fish oil: alternative substitution with rapeseed and linseed oils. *Poult Sci* 78(3):356–365.
- Oluwaniyi, O., Dosumu, O. and Awolola, G. (2010). Effect of local processing methods (boiling, frying and roasting) on the amino acid composition of four marine fishes commonly consumed in Nigeria. *Food Chem.* **123**:1000-1006.
- Oz F, Kaban, G. and Kaya, M. (2017). Effects of cooking methods on the formation of heterocyclic aromatic amines of two different species trout. *Food Chem.* **104**:67-72.
- Roenigk, W. P. (2019). World poultry consumption. *Poultry Science* **78**: 722-728.
- Romanov, M. N. and Weigend, S. (2021). Analysis of genetic relationships between various populations of domestic and jungle fowl using microsatellite markers. *Poultry Science* **80**: 1057-1063.
- Seuss-Baum, D. B. (2009). Experimental procedures for determining destruction kinetics of food components. *Food Technol* **34**(2):51–55.
- Siegel, P. B. and Dunnington, E. A. (2020). Behavioral genetics. *In: Poultry Breeding and Genetics* (Ed. Crawford R.D.). *Elsevier Science Publishing Company, Amsterdam and New York*, pp: 877-896.
- Sinha, R., Chow, W. H, Kulldorff , M., Denobile, J., Butler, J., Garcia-Closas, M., Weil, R., Hoover, R. N. and Rothman, N. (2019). Well-done, grilled red meat increases the risk of colorectal adenomas. *Cancer Res.* **59**:4320-4324.
- Sinha, R., Kulldorff, M., Curtin, J., Brown, C. C., Alavanja, M. C. R., Swanson, C. A. (2018). Fried, well-done red meat and risk of lung cancer in women (United States). *Cancer Causes Control* **9**:621-630.
- Skog, K., Steineck, G., Augustsson, K. J. and Gerstad, M. (2015). Effect of cooking temperature on the formation of heterocyclic amines in fried meat products and pan residues. *Carcinogenesis* **16**:861-867.

- Sosa-Morales, M. E., Orzuna-Esp Ritu, R. and V Lez-Ruiz, J. F. (2016). Mass, thermal and quality aspects of deep-fat frying of pork meat. *J. Food Eng.* **77**:731-738.
- Tasevska, N., Sinha, R., Kipnis, V., Subar, A. F., Leitzmann, M.F., Hollenbeck, A.R., Caporaso, N.E., Schatzkin, A. and Cross, A. J. (2019). A prospective study of meat, cooking methods, meat mutagens, heme iron, and lung cancer risks. *Am. J. Clin. Nutr.* **89**:1884-1894.
- USDA/ ITIS (2016). *Gallus sonneratii* (Temminck, 1813), Taxonomy and Nomenclature. ITIS standard report page. Taxonomic Serial No. 176088 (Itis.usda.gov).
- Vaisanen, J. and Jensen, P. (2014). Responses of young red jungle fowl (*Gallus gallus*) and white leghorn layers to familiar and unfamiliar social stimuli. *Poultry Science* **83**: 335-343.
- Vaisanen, J., Hakansson, J. and Jensen, P. (2015). Social interactions in red junglefowl (*Gallus gallus*) and white leghorn layers in stable groups and after re-grouping. *British Poultry Science* **46** (2): 156-168.
- Winegarden, M.W., Lowe, B., Kastelic, J., Kline, E. A., Plagge, A.R., Shearer, P. S. (2012). Physical changes of connective tissues of beef during heating, b. *J. Food Sci.* **17**:172-184.
- Wong, D., Cheng, K. W. and Wang, M. (2012). Inhibition of heterocyclic amine formation by water-soluble vitamins in Maillard reaction model systems and beef patties. *Food Chem.* **133**:760-766.
- Yu, T. H, Wu, C. M. and Ho, C.T. (2013). Volatile compounds of deep-oil fried, microwave-heated and oven-baked garlic slices. *J. Agric. Food Chem.* **41**:800-805.
- Zhang, Y., Zeng, Q. X. and Zhu, Z. W. (2011). Effect of ultrasonic treatment on the activities of endogenous transglutaminase and proteinases in tilapia (*sarotherodon nilotica*) surimi during gel formation. *J. Food Process Eng.* **34**:1695-1713.