EFFECTS OF PROCESSING ON THE NUTRITIONAL COMPOSITION OF WHITE FOWL EGG (RAW, FRYING AND BOILING)

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 nuts 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. 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 egg 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. 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. 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.

1.1 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. 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 and were domesticated over 3000 years ago, and are known now 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. 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. 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.

1.3 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.

The specific objectives of the study will entail.

- To determine the nutritional composition of boiled chicken egg in terms of its moisture, ash, protein, fats, fiber and carbohydrate contents.
- To determine the nutritional composition of fried chicken eggin terms of its moisture, ash, protein, fats, fiber and carbohydrate contents.
- To compare the nutritional compositions of boiled and fried chicken egg.

MATERIALS AND METHODS

3.1 Materials

Weighing crucible

Soxhlet extractor

Beaker

Filter paper

Bucker funnel

Muffle furnace

Kjeldahlflusk

Muslin cloth

Reagent

Distilled water

N-hexane,

Sulpuric acid

Sodium hydroxide

Hydrochloric acid

Sodium hydroxide

H_2SO_4cristal

3.2 Method of collection of sample

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

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).

3.3 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).

a. Moisture content determination

The AOAC (2002) method no. 945.38 was used. 2g of the sample was weighed into clean, dry and pre weighed crucibles. The crucibles and their contents were dried in the moisture extraction oven at 110^0C for 3 hours. The samples were cool in desiccators and reweighed. The samples were dried in the oven until a constant weight is obtained.

% Moisture content = Initial weight– weight of oven sample X 100

Initial weight of sample

b. Crude fat determination

Method no. 920.39A (AOAC, 2002) was used. 2g of the air dried ground sample was weighed into a filter paper, wrapped carefully and put in the sample holder of the soxhlet extraction apparatus. A clean dry and weighed soxhlet extraction flask will be half filled with N-hexane and the whole apparatus was assembled together, and the flask placed on the heating mantle and heated at 60^0C.

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

% Crude fat = weight of flask + oil – weight of empty flask X100

Initial weight of sample

c. Crude fiber determination

Method No. 942.05 (AOAC, 2002) was used. 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 70^0C 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 preweighed crucible and dried at 120^0C to a constant weight. The crucible with the dry sample were put in a muffle furnace and ashed at 550^0C for 3hrs such that the sample became ash white. Percentage fibre was calculated as followed:

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

d. Crude protein determination

Method no. 955.04C called the Kjeldahl method was used (AOAC, 2002). This method was divided into three namely, digestion, distillation and titration.

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_2SO_4 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 colour (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.

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.

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:

%Crude protein = % Nitrogen X 6.25

e. Ash content determination

The AOAC (2002) method No 942.05 was used. Clean dried crucibles were weighed on an electronic balance and 5g of sample weighed into the crucibles. The samples were dried in the oven until constant weights are obtained. Then, the samples was transferred into the muffle furnace with a pair of tongs and ashed at 550^{0}C 4 hours until a white ash was obtained. The sample was removed from the furnace and cooled in desiccators, and reweighed. The percentage ash was calculated as followed:

$$\% \text{ Ash Content: } \frac{\text{Weight of Ash X 100}}{\text{Weight of sample (after oven drying)}}$$

f. 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, fibre, protein, ash and 100

% Carbohydrate= 100 – (% moisture + % fat + % protein + % fibre + % ash

RESULTS

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. 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. 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.

Table 1: Effect of Processing on proximate composition of chicken eggs:

Sample	Moisture	Ash	Fiber	Protein	Fats	Carbohydrate
Raw Egg	58.00+ 0.05[a]	1.09+ 0.00[c]	0.90+ 0.03[b]	22.52+ 0.03[a]	1.50+ 0.01[c]	15.99+ 0.03[c]
Cooked Egg	25.80+ 0.07[b]	4.00+ 1.00[a]	1.19+ 0.11[b]	21.52+ 0.00[b]	5.70+ 1.00[b]	41.79+ 0.20[b]
Fried Egg	10.60+ 0.01[c]	3.86+ 0.21[b]	5.30+ 0.05[a]	19.55+ 0.20[c]	8.33+ 0.05[a]	56.22+ 0.03[a]

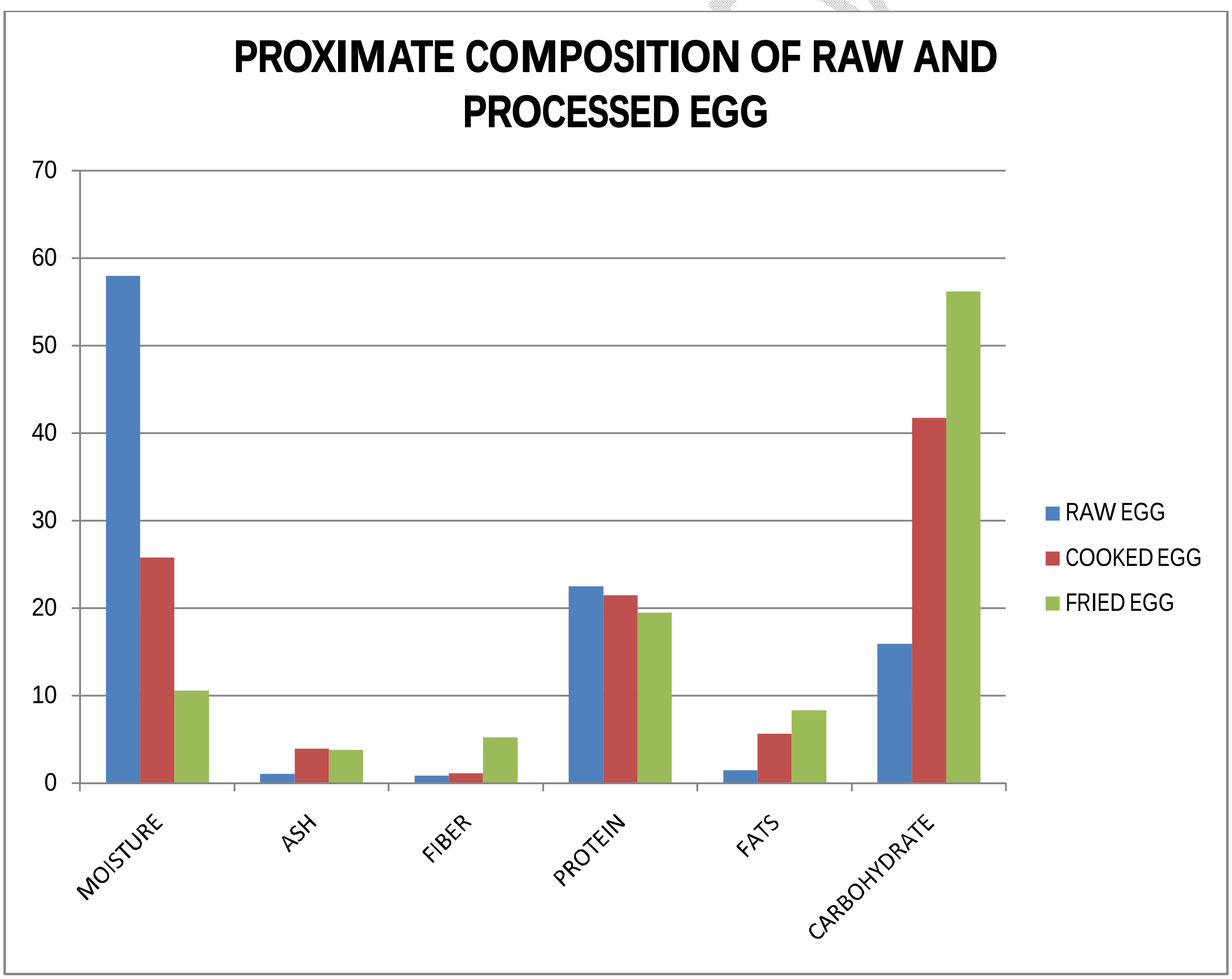

Fig. 1: Effect of processing on proximate composition of chicken eggs:

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 ($p<0.05$) higher in processed samples than in raw chicken eggs. 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 egg has 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. 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 (Mg/100g)

Sample	Calcium	Iron	Magnesium	Phosphorus	Zinc
Raw Egg	**189.57**+ 1.00[a]	**3.10**+ 0.00[b]	**240.68**+ 2.00[a]	11.00+ 0.02[a]	0.45+ 0.02[c]
Cooked Egg	**29.00**+ 0.02[c]	**2.90**+ 0.22[c]	**48.50**+ 0.00[b]	13.10+ 0.11[b]	1.16+ 0.02[b]
Fried Egg	**160.72**+ 0.00[b]	3.30+ 0.05[a]	**48.64**+ 0.07[b]	21.80+ 0.03[a]	1.33+ 0.01[a]

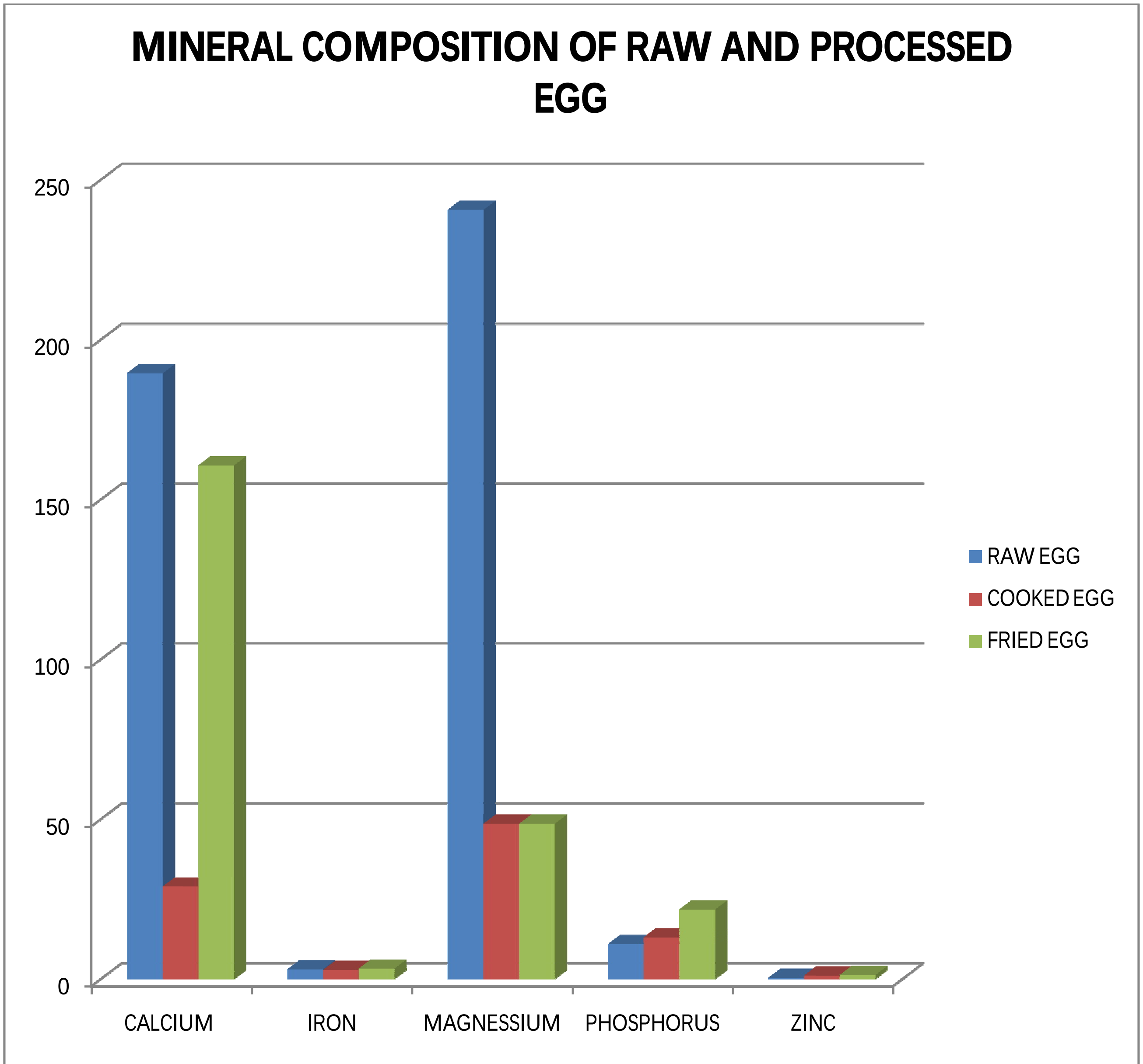

Fig.2: Effect of Processing on mineral composition of chicken eggs (Mg/100g)

Effect of processing on vitamin composition of chicken eggs:

The result for the effect of processing on the vitamin composition of egg is presented in Table 3. The results showed that vitamin B_2, and C were significantly ($p<0.05$) higher in raw chicken egg than processed chicken eggs. Vitamin B_2 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 (Mg/100g)

Sample	**Vitamin $_{B2}$**	**Vitamin C**	**Vitamin D**	**Vitamin E**
Raw Egg	0.68+ 0.07^{a}	13.11+ 0.07^{a}	17.00+ 0.07^{a}	0.94+ 0.07^{a}
Cooked Egg	0.53+ 0.07^{a}	3.08+ 0.07^{a}	15.74+ 0.07^{a}	0.95+ 0.07^{a}
Fried Egg	0.57+ 0.07^{a}	5.32+ 0.07^{a}	18.70+ 0.07^{a}	1.12+ 0.07^{a}

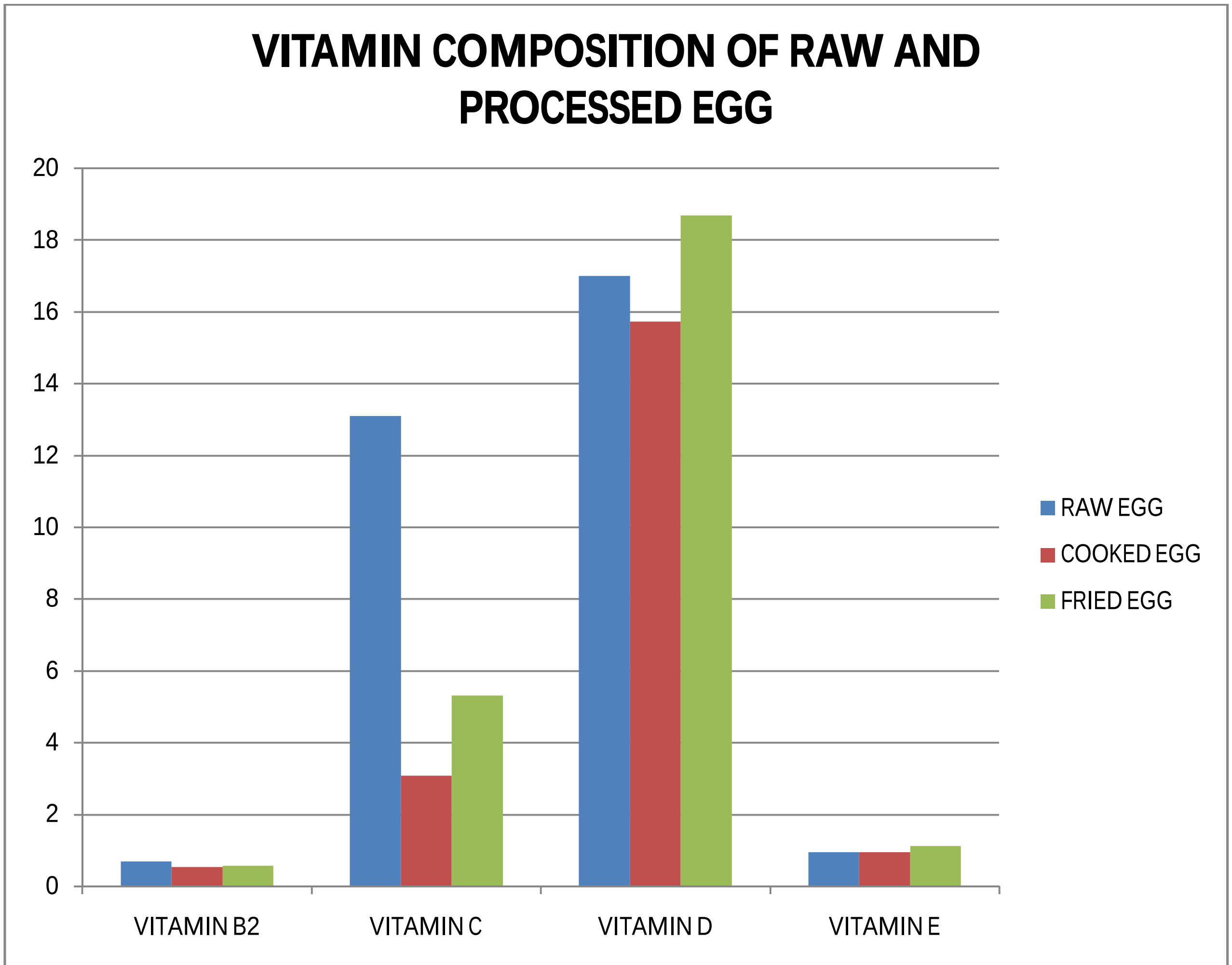

Fig.3: Effect of Processing on vitamin composition of chicken eggs (Mg/100g)

5.1 Discussion

The nutrient composition in this study revealed that chicken egg contained protein, fiber, ash, fats/oil as well as carbohydrate as shown in Table 1. Our result suggests that chicken egg could serve as better sources of dietary carbohydrate, protein and lipids. The chicken egg contained 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).

The moisture content value of processed chicken egg was relatively low. The low moisture content would therefore hinder the growth of spoilage microorganisms and enhance shelf life (Ruberto and Baratta, 2000). 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 23.64percent protein in chicken egg that showed non-significant effect of cooking treatments on protein content of chicken egg. Processing of chicken egg decreased the fat and ash content. Leaching effect of fats into the cooking broth at higher temperature is responsible for lower fat content in processed chicken egg. Also, as fat serves as store house of energy during embryo development. The results are in accordance to the reports of Alajaji [2001].

Chicken egg had ash value of 3.24% and the ash content is a reflection of the mineral contents preserved in the food. The ash content compare favorably 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%)

The result therefore suggests a high deposit of mineral elements in chicken egg. 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 (Mc William 1978).Carbohydrates are essential for the maintenance of life in both plants and animals and also provide raw materials for many industries (Ebun-Oluwa and Alade, 2007).

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 egg. 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.

5.2 Conclusion

The variations in composition of raw and processed chicken egg analyzed could be attributed to differences in effect 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.

5.3 Recommendations

It is recommended that, people should be eating egg in order to meet up the recommended daily intake of vitamins.

b. It is also recommended that, consumption of cooked egg should be strongly encouraged because cooking leads to a considerable loss in ascorbic acid contents.

c. Further studies are needed on chicken egg to determine the microbial quality of the chicken egg.

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