DETERMINATION OF THE PROXIMATE COMPOSITION OF JAPANESE QUAIL EGG AND RHODE ISLAND RED EGG AT VARIOUS HEATING PERIODS

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ABSTRACT

The work reported the proximate composition of cooked Japanese quail (*Coturnix japonica*) egg (QE) at 63^{o}C and that of Rhodes Island red egg (RE) at 100^{o}C water for 10, 15, 25, 30, 60, 90 and 120 min. The ash, carbohydrate, lipid, protein and moisture contents were determined according to AOAC procedures. The ash content of QE increased from 2.40% at 2 min heating up to 6.78% at 30 min, and then significantly decreased to 3.49% at 90 min. The ash content for RE increased after 10 min heating period from 1.01% to 2.39% after 90 min; and decreased to 2.30% at 120 min. The fresh QE contained 11.03% fat. This decreased on heating to 4.71% at 90 min. However fat in RE increased from 9.10% in the fresh RE to a maximum of 9.60% at 30 min heating and beyond. Protein content of fresh QE was 15.65%, while the fresh RE contained 12.40%. Protein in QE decreased with heating time. Significant decrease was recorded at 30 min heating (6.26%) and beyond. For RE protein increased to 12.71% at 10 min, 12.90% at 15 min to 25 min; and 13.39% at 30 min. The percentage carbohydrate in the fresh QE was 0.61%. This increased from the 2 to 10 min heating (7.01%); and decreased to 25.52% after 90 min heating. Fresh RE had low carbohydrate (0.9%), and drastically decreased on heating. The optimum contents of protein, fat and carbohydrate of QE will be attained when boiled for 10 min and 25 min for RE This study is imperative for understanding the optimum heating periods to obtain maximum nutritional contents of the eggs.

Keywords: Egg, nutritional contents, optimum, Quail, Rhodes Island red

INTRODUCTION

Eggs constituted an important part of human diets for centuries because of its high quality protein [1], vitamins, minerals and fatty acids [2]. They are known to supply the best proteins besides milk [3]. Egg is always recognized as a food of high nutritional quality for humans [4-7].

Popular birds for egg consumption are chicken, duck, quail, roe and caviar, but the egg most often consumed by humans is the chicken egg [8]. The Rhode Island Red is a breed of chicken (*Gallus gallus domesticus*) raised for meat and eggs [9]. The Japanese quail (*Coturnix japonica)* - about 20 cm from beak to tail - is also a popular source of meat and eggs in various parts of the world including Nigeria. The quail can lay up to 350 eggs of 10 – 12 g annually, which is twenty times its body weight [10, 11].

Oluwafemi and Udeh [12] stated that quail egg contains minerals and vitamins and that their nutritional value is three to four times greater than chicken eggs. However, of concern to nutritionists is the effect of processing on the inherent nutritional values of foods. Heat is by far the most destructive of all processing methods. Heating temperature and duration of heating has depleting effect on the nutritional values of foods [13, 14].

The cooking of eggs changes the structure of the constituent proteins and other nutrients. Overheating depletes inherent nutritional benefits. In egg, the most affected of the amino acids are lysine and threonin. Large losses on egg quality can occur depending on the duration and the degree of heat [15].

According to Mark *et al.* [16], when an egg is heated the resulting effect is increase in the fat, ash and protein contents and decrease in moisture and carbohydrate content. Furthermore, it was reported that proteins are not lost during cooking as easily as vitamins, though cooking at high temperature will denature proteins found in egg [17, 18].

There is dearth of information concerning the effects of cooking duration on the nutritional qualities of Rhode Island Red egg and quail egg. Therefore, the aim of this study is to assess the effect of heating period on the proximate composition of Japanese Quail egg and Rhode Island Red egg. This is relevant in having optimal nutritional values of eggs when consumed by man.

MATERIALS AND METHOD

Collection and treatment of samples

Freshly laid eggs of RE and QE (Plates I and II) used for this study were purchased from local poultry farmers in Zaria, Kaduna State, and were identified at the Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria. All the samples (n=48) were collected at the same time. There were eight experimental groups for each of the egg type. Each group of the RE

egg was put into a 500 cm^3 pyrex beaker containing 300 cm^3 water and heated on a thermostated hot plate till boiling at 100°C for varying time of 0, 10, 15, 25, 30, 60, 90 or 120 minutes in triplicate.

Each group of the QE eggs (n = 48) was heated in water at 63°C (the optimum boiling temperature recommended for quail egg) on a thermostated hot plate at 0, 2, 5, 10, 15, 30, 60 or 90 min. After the boiling, each group was allowed to cool in water at room temperature. Then each of the forty eight whole egg samples was cracked, the shell removed and the egg transferred into separate well-labeled crucibles and mixed thoroughly. The mixture from each group of egg was gradually dried in an oven at 60 °C. After drying, the samples were crushed into powder for analyses of the ash content, crude protein, lipid and carbohydrate contents.

The experiment was carried out at the Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria.

Plate Ia: Rhode Island Red

Plate Ib: Rhode Island Red eggs

Plate II: Japanese quail (*Coturnix japonica)* bird and egg

Determination of moisture contents

The moisture content of each whole egg sample was determined according to AOAC procedure [19]. This was done by washing a crucible and drying it to a constant weight in an oven at 100 °C. This was later removed, cooled in a dessicator and then weighed again. The initial weight was labeled (W_1). About 2 g of the properly mixed egg sample in each of the experimental groups were placed in each weighed crucible, and reweighed. The weight in each case was represented as (W_2). The crucible containing the sample in each case was kept in an oven at 100 ºC for 45 - 60 min, until when dried and then weighed. It was kept back in the oven and reweighed after about 2 h to ensure a constant weight (W_3). Then the moisture content was calculated as follows:

$$\%\,Moisture = \frac{(W_2 - W_1)}{(W_3 - W_1)}\ X\ 100$$

Determination of Lipid Content [19]

Lipid content of each whole egg sample was determined according to the procedure of AOAC [19]**.** Round bottomed flasks were washed and few anti-bump granules added to prevent bumping, then 300 cm^3 petroleum ether (40 – 60°C boiling point) was poured into the flask. This was fitted to soxhlet extraction units. The extraction units and extraction thimbles were weighed. Then 2.0 g of dried egg sample was placed in it and taken as (W_1). The thimble was fixed into the soxhlet extraction unit and the cold water circulation system was put on. The heating mantle was switched on and solvent fixing refluxing was adjusted at a steady rate. Extraction was carried out for 8 h. The thimble was removed and dried to constant weight in an oven at 70 ºC and then labeled (W_2). The percentage by weight of lipid was calculated as

$$Lipid\ (W/W) = \frac{Weight\ of\ lipid\ extracted}{Weight\ of\ dried\ sample}\ X\ 100$$

Determination of Nitrogen and Crude Protein according to AOAC [19]

a. Digestion: This involved oxidation of the matter with sulphuric acid reduction of nitrogen to ammonium sulphate.

$$H_2SO_4 + 2NH_3 \rightarrow (NH_3)_2SO_4$$

$$C + O_2 \rightarrow CO_2$$

Distillation: This involved liberation of the ammonia by sodium hydroxide. The ammonia was trapped in an (excess) boric acid and titrated with hydrochloric acid (HCl)

$$(NH_3)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O + 2NH_3$$

$$NH_3 + H_2O \rightarrow NH_4OH$$

$$H_3BO_3 + 3NH_4OH \rightarrow (NH_4)_3BO_3 + H_2O$$

Titration: The back titration method was employed i.e the ammonia reacts with the boric acid in the receiving flask and the amount of excess acid determined by titration with HCl.

$$(NH_4)_3BO_3 + 3HCl \rightarrow NH_4Cl + H_3BO_3$$

The percentage total nitrogen was calculated and crude protein was estimated by multiplying the percentage nitrogen with the standard conversion factor of 6.25.

Exactly 2.0 g of each dried egg sample was weighed into 100 cm^3 Kjeldah flask, then a few anti-bump granules, one gramme of catalyst (K_2SO_4 and $CuSO_4$) was added to speed up the reaction in the flask at first, until ferritin subsided and then more rigorous with occasional rotation of the flask to ensure even digestion and avoidance of over-heating of the content.

After a clear solution was obtained in the flask, the sample was transferred to 100 cm^3 volumetric flask and diluted to mark with distilled water. After cooling, 10 cm^3 of the diluted sample or digest was pipetted into markham semi macro nitrogen still; then 10 cm^3 of 40% NaOH solution was added. This made the sample distilled to liberate NH_3 into the 100 cm^3 conical flask containing 10 cm^3 of 40% boric acid and 2 drops of methyl red indicator.

The distillation continued until the pink colour of the indicator turned greenish. The control was titrated with 4% boric acid with end point indicated by a change from greenish to pink colour.

Determination of Ash Content [19]

Ash content was determined by first cleaning a crucible and then getting it oven dried. It was then cooled in a desiccator and weighted (W_1). Then 2.0 g ground whole egg sample was placed in the crucible and weighed (W_2). After which, each sample was transferred into a furnace set to 55 °C, then the sample was incinerated in the furnace for 8 h, after this, the crucible containing

the ash was removed and cooled in the desiccators and weighed (W_3). The weight of the residue in the crucible corresponds to the ash content of each egg sample.

Determination of Carbohydrate [19]

The total protein, moisture content, ash content and lipid content subtracted from 100 gave the carbohydrate content and this is referred to as estimation by difference.

Statistical analysis

The nutritional contents in each of the egg samples as a function of heating time in water was compared using Students' t-test with significance taken at $P < 0.05$.

RESULTS AND DISCUSSION

From the study, the results of the effect of duration of boiling on the nutritional quality of the whole eggs indicated that the moisture contents of the Rhode island red eggs (RE) was 76.70±0.002% in the raw and then decreased to 74.71±0.003% at 90 min; while for quail egg (QE) moisture content was 71.88±0.002% in the raw and then decreased slightly to 70.62±0.001% at 10 min and 60.34±0.002% at 90 min of heating (Figure 1 and 2).

Furthermore, the ash content for the RE increased from 0.9±0.002% in the raw egg to 1.01±0.001% for the egg boiled for 10 minutes, and thereafter recorded a rapid increase in ash content to 1.30±0.001% at 15 min, 2.39±0.002% at 90 min and 2.30±0.003% at 120 min boiling time. On the other hand, QE had the ash content being 1.56±0.003% for the raw, 4.29±0.002% at 5 min boiling time, and then increased to 6.19±0.001% at 15 min; this then significantly decreased to 3.49±0.001% at 90 min boiling time ($P = 0.029$). This showed that quail egg had higher mineral contents than RE, with optimum level attained at 30 min boiling for RE and 10 min boiling for QE. However, the value reported for ash content of whole quail egg by Oluwafemi and Udeh [12] (0.86±0.24%) was less than what was obtained in this study.

As depicted in Figures 1 and 2, the mean fat content of raw whole RE egg was 9.1±0.007%. This increased steadily to 9.3±0.013% at the 10 min and 15 min boiling time, and was 9.6±0.003% at 30 min and 60 min of boiling. Then the fat content then decreased slightly at 90 min and then increased at 120 min (9.6±0.011%). However, for whole QE, the fat content in the raw was 11.03±0.005%, and then steadily decreased to 10.07±0.003% at 2 min and then to 9.54±0.002% at 5 min of boiling. The fat level then decreased drastically to 8.36±0.011% at 10 min, and to

7.91±0.003% at 15 min. Thereafter, the fat content decreased rapidly and was 4.71±0.003% at 90 min of boiling. The values in this study are lower than the fat content reported for fresh hybrid chicken by Bashir *et al.* [20] (27.65+0.70%).

This study showed that the cooking of RE at 100 ^{o}C beyond 15 min drastically reduced fat content, and cooking QE at 63°C beyond 15 min also led to sharp reduction in fat content.

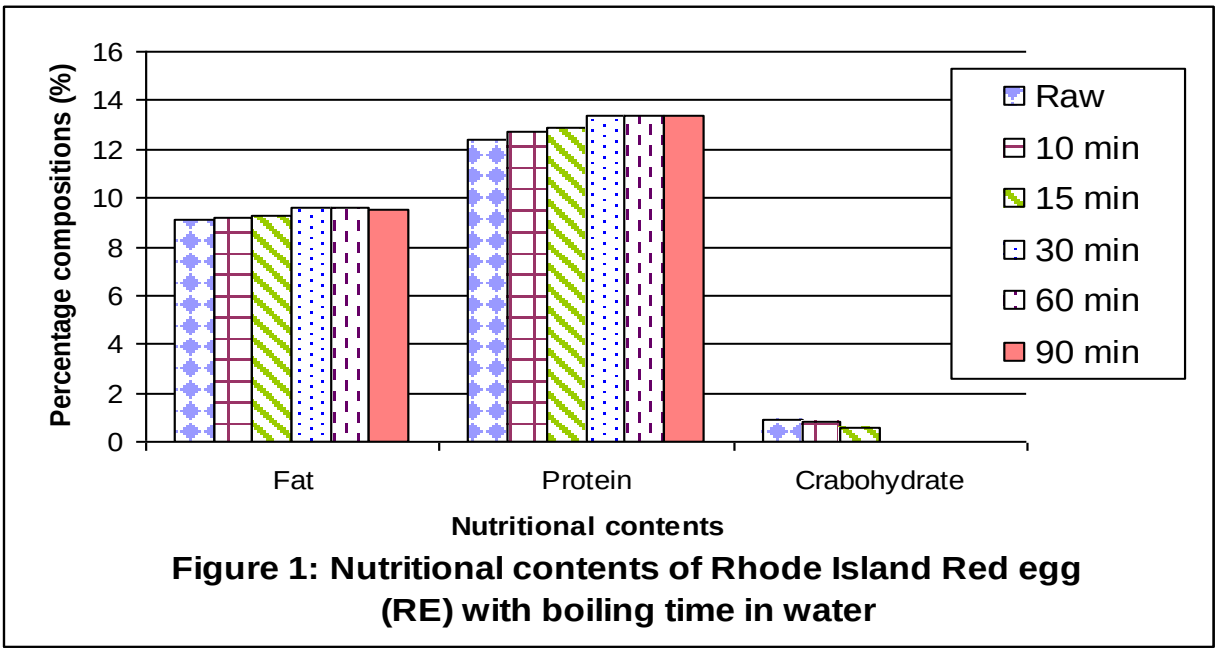

Figure 1: Nutritional contents of Rhode Island Red egg (RE) with boiling time in water

From the results, protein in the raw whole RE was 12.40±0.004% This continuously increased to 12.71±0.003% and 12.09±0.002% at the 10 and 15 min boiling respectively (Figures 1). Further heating resulted to a steady value at 25 min, and slight decline at 30 min (13.39±0.005%), protein content was then maintained as 13.40% up to the 120 min boiling time.

On the other hand, whole QE had the protein content in the raw as 15.65±0.004%. This is higher than in RE. Also, a rapid decrease in protein of QE to 12.33±0.004% at 2 min and then to 10.06±0.003% at 5 min of boiling was recorded. The protein then further decreased drastically to 8.90±0.004% at 10 min, and to 8.78±0.003% at 15 min. Thereafter, the protein content decreased rapidly and was 5.93±0.003% at 90 min of boiling. The values in this study in slightly lower than the protein content reported for fresh quail egg (12.40+0.23%) by Oluwafemi and Udeh [12]. The decrease in protein content is due to the fact that when egg white is subjected to heat, its

globular proteins are prone to changes in structure and conformation, depending on the extent of the temperature and duration of the treatment. These changes can range from denaturation at the gelation or coagulation [17, 21]. This study showed that optimum protein content of RE is at 15 min cooking, while it is at 5 min for QE.

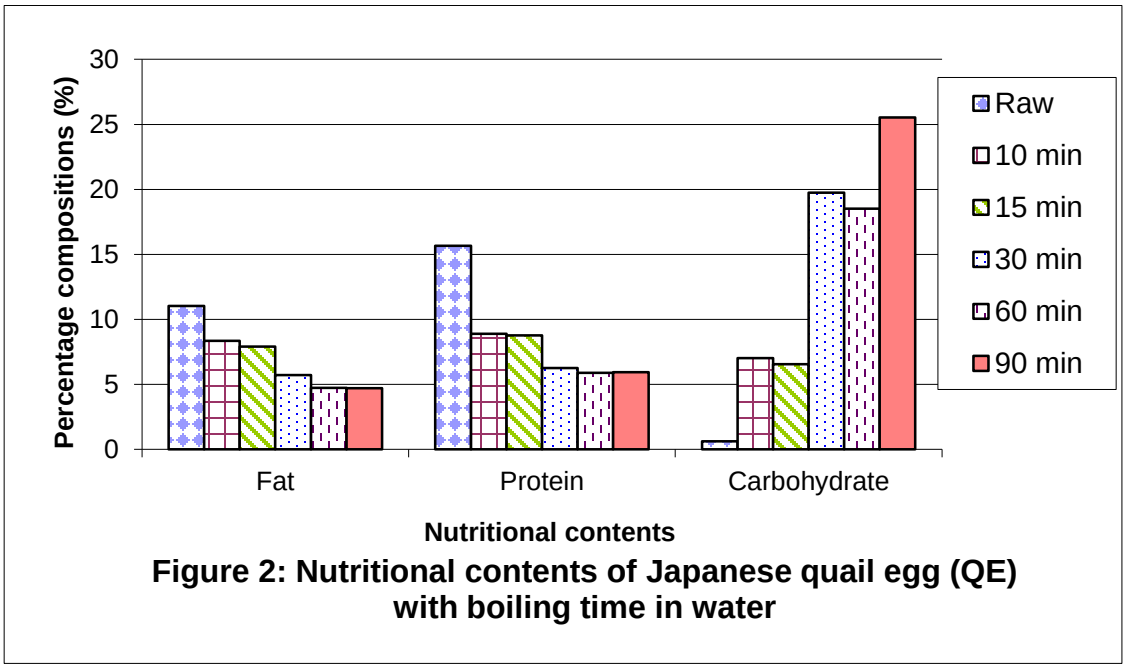

Figure 2: Nutritional contents of Japanese quail egg (QE) with boiling time in water

In addition, the work showed that whole RE egg contained 0.9% carbohydrate (raw sample). This decreased to 0.8±0.007% at 10 min boiling. A drastic decrease in carbohydrate content was recorded at 15 min (0.6±0.003%) after which it significantly decreased to 0.01±0.003% at 30 min ($P < 0.05$). Beyond this, the amount was 0.00% at 60 and 120 min boiling time (Figure 1).

As presented in Figure 2, the percentage carbohydrate in the fresh QE egg was 0.61 ± 0.01%. This increased from the 2 min heating period (2.34 ± 0.03%), and was two-fold and three-fold (7.01 ± 0.12%) in the 5 and 10 min heating periods respectively. After which the carbohydrate content decreased to 6.55 ± 0.19% % in 15 min and further to 19.75 ± 0.09%, 18.51 ± 0.12% and 25.52 ± 0.16% % in the 30, 60 and 90 min respectively.

Students' t-test (at $P < 0.05$) indicated a significant elevation of the carbohydrate content of QE egg by heating it in water (63^{o}C) beyond 5 min.

CONCLUSION

For quail egg, the fat and protein contents decreased, while the carbohydrate and ash contents increased with heating time at 63^{o}C. At 10 min of heating, the ash content was five-fold in the raw quail egg, fat content declined by 20% the raw quail egg, and protein content diminished by 40% compared to the fresh egg sample. Therefore, for quail egg the optimum levels of protein, fat and carbohydrate would be attained at 10 min heating time in 63^{o}C water. It is envisaged that this condition would also be suitable for maintaining the acclaimed medicinal efficacy of Japanese quail egg. Furthermore, for the chicken egg (RE), there was a gradual increase in the fat, protein and ash contents, but a decrease in moisture and carbohydrate contents with boiling time. The study infers that the optimum level of protein (12.09±0.002%), carbohydrate (0.6±0.003%) and fat (9.30±0.013%) was attained at 15 min of boiling time in water.

There is need to maximise the nutritional potentials of egg in human nutrition, especially in an era of economic recession, and food insecurity in developing economies.

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