A Comparative Study on the Total Cholesterol, Triacylglycerides and Lipid Concentrations of Quail and Chicken Eggs

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ABSTRACT

Introduction: Nowadays, people are increasingly becoming cautious about many foods especially lipid-containing foods because of the risk factors involved. These lipids are always implicated in coronary and other diseases of the heart. In this research work, spectrophotometric method was employed in the determination of the total cholesterol, triacylglycerol (TAG), high-density lipoprotein (HDL) and low-density lipoprotein (LDL) concentrations of the quail and chicken egg yolks.

Methods: A total of twenty eggs (10 quail and 10 chicken eggs) were used for this study. The eggs were stored in the refrigerator (4-7 ºC) throughout the period of the analysis. Analytical graded kits were used for the above-stated parameters in these eggs.

Results: The result of the experiment showed that the weights of the whole egg, egg yolk and egg shell in chicken egg were significantly (p < 0.05) higher compared to these traits in quail egg. The total cholesterol concentration, HDL and LDL of quail egg yolk were significantly (p < 0.05) higher compared to their concentrations in chicken. However, these parameters were found to be higher in chicken whole egg when compared with that of quail.

Conclusion: Lipids determination was conveniently performed spectrophotometrically. Moreso, the lipids concentrations in quail egg yolk were higher than those of chicken egg but with the whole egg, they were higher in chicken than in quail.

Keywords: Total cholesterol; lipids; triacylglycerol; quail and chicken eggs; coronary heart diseases.

INTRODUCTION

Of all the various kinds of foods, egg is special for its content of all essential food nutrients (Maryam & Judith, 2012). The most commonly used poultry eggs are those from chicken, duck, goose; smaller eggs such as those of quail are occasionally used as a gourmet ingredient (Adeyeye, 2012).

Eggs’ qualities such as egg weight, egg shape, shell thickness, shell weight, shell density, egg surface area and cleanliness are external characteristics that influence grading, price, consumer preference and hatchability (King’ori, 2012).

Significant amount of vitamins such as vitamins A, D, E, K and the B vitamins are found in an egg (Bradley & King, 2004). In addition to the vitamins and minerals, poultry egg contains the phytochemicals, lutein and zeaxanthin which are usually classified as carotenoids (Maryam & Judith, 2012). These compounds are believed to protect eye sight by acting as shields or filters helping to mop up dangerous free radicals and harmful UV-light which threaten retinal tissue. Lutein and zeaxanthin have been found to be in abundance in egg yolk (Chung, Rasmussen, & Johnson, 2004).

Essential polyunsaturated fatty acids, total cholesterol, low-density lipoproteins (LDLs) and high-density lipoproteins (HDLs) fractions have been found to be available in egg yolks. Most of these nutrients determined in quail egg yolks (Tanasorn, Tungjaroenchai & Siriwong, 2013) were significantly higher in contents than those of quail egg whites. The quail egg yolk plasma contains a large quantity of phosphatidylcholine as well as sphingomyelin,
and this led to the recommendation of the use of quail eggs in diets. These phospholipids contribute to the decrease of lymphatic absorption of cholesterol (Cioceanu et al., 2007) and some people who are allergic to chicken eggs have been found to be tolerant to quail eggs.

The most essential fatty acids observed in quail egg yolks are linoleic acid, docosahexaenoic acid and arachidonic acid (Tanasorn et al., 2013). Also known as polyunsaturated fatty acids, they help stimulate skin and hair growth, maintain bone health, regulate metabolism, and maintain the reproductive system (Watkins et al., 2011). In addition, quail eggs have very low levels of trans-fatty acids, a threat to human health because its consumption increases LDLs in the blood serum. Cholesterol and its esters are found in egg yolk, where they form emulsion of LDLs, very low density lipoproteins (VLDLs) and HDLs which accounts for 8 % of dehydrated yolk of chicken egg. Its content in eggs is influenced by genetic factors, diet composition, laying intensity, layer age and medical treatment (Vorlová et al., 2001).

Egg consumption is believed to raise the risk of cardiovascular disease by increasing blood serum cholesterol levels (Jung et al., 2011). Consumer awareness of the correlation between high blood serum cholesterol level and obesity or cardiovascular diseases has stimulated the demand for food products with very low or no cholesterol content. It has been observed that some folks take this quail egg raw on the assumption that it contains little or no cholesterol and LDLs.

The main aim of this project is to determine and quantify the total cholesterol content and lipid content of a quail egg and to compare them with those of chicken egg as this would help the public to make wise decision over their diet.

MATERIALS AND METHODS

Materials

A total of 10 Japanese quail eggs were obtained from a poultry farm in Nsukka, Enugu State, Nigeria and also 10 chicken eggs were obtained from the same location. Both egg species were identified by the Department of Biochemistry, University of Nigeria, Nsukka. The eggs were stored in the refrigerator (4-7 °C) throughout the period of the experiment.

Instrument/Equipments

The instruments used for this work include; Beakers (Pyrex, England), Bench centrifuge (Vickas Ltd., England), colorimeter (EI Scientific Co. India), measuring cylinder (Pyrex, England), micro-pipette (Perfect, USA), refrigerator (LG, China), test tubes (Pyrex, England) and weighing balance (Vickas Ltd., England).

Chemicals/reagents:

The commercial kits used for this study were products of Randox, QCA, USA.

Methods

Total Cholesterol Determination

Preparation of Cholesterol Standard Solution

Six test tubes labelled S1, S2, S3, S4, S5 and S6 were used for the total cholesterol determination. Different volumes (0.02 ml, 0.04 ml, 0.06 ml, 0.08 ml, 0.1 ml) of cholesterol standard stock (192.23 mg/dl) were put into five test tubes respectively while the sixth test tube was left empty, serving as the control (blank). A little quantity, 1ml of the diagnostic cholesterol reagent was added to all six test tubes and diluted to final volume of 5 ml, using distilled water.

The test tubes containing the various mixtures were incubated at 20-25 ºC for 10 min. The absorbance was measured at 500 nm against the blank. The concentration of cholesterol standard in the test tubes was calculated and then a graph of their absorbance was plotted against their various concentration values, obtaining a calibration curve.

Preparation of Sample Solutions

Firstly, 3 eggs, each from the quail and chicken species were weighed and then their shells broken to get their contents (albumen and yolk). The eggs shells were also weighed using a weighing balance. The eggs yolks were carefully separated from their albumens and each of the yolks from the eggs were put in six beakers and labelled, Q₁, Q₂, Q₃ (for quail egg) and C₁, C₂, C₃ (for chicken egg). The remaining eggs were weighed and were also broken to be able to weigh their shells and yolk. An aliquot, 1ml of the bio-diagnostic cholesterol reagent was put into six test tubes. Using a micropipette, 0.01ml of each of the yolk in the labelled test tubes (Q₁, Q₂, Q₃, C₁, C₂ and C₃) was collected...
and put into the six test tubes and the solutions were diluted to 5ml using distilled water.

The test tubes were incubated for 10 min at 25 °C and then the absorbance of the different solutions taken at 500 nm against the already prepared blank. Their concentrations were estimated from the calibration curve already obtained by dividing the absorbance value by the slope of the graph.

Triacylglyceride Determination

Preparation of Triacylglyceride Standard Solution

Different volumes of triacylglyceride standard stock solution (196 mg/dl) was put as 0.02 ml, 0.04 ml, 0.06 ml, 0.08 ml, 0.1 ml into five test tubes labelled T1, T2, T3, T4, T5 and T6 respectively while the sixth empty (blank) test tube served as the control. Also, 1ml of the diagnostic triacylglyceride reagent was added to all six test tubes and diluted to final volume of 6 ml with distilled water.

The test tubes containing the various mixtures were incubated at 20-25 °C for 10 min and their absorbance were measured at 500 nm against the blank. The concentrations of triacylglyceride standard solutions in the test tubes were calculated and then a graph of their absorbance was plotted against their various concentration values, obtaining a calibration curve.

Preparation of Sample solutions

From the already separated egg yolks, 0.02 ml from each of the test tube was taken into six test tubes containing 1 ml each of the standard solution and then diluted to 6 ml with distilled water.

The test tubes were incubated at 25 °C for 10 min and then the absorbance of the different solutions taken at 500 nm. Their concentrations were estimated from the calibration curve already obtained by dividing the absorbance value by the slope of the graph. The knowledge of the triacylglyceride content of the egg would help in the determination of the LDL content eggs. 

HDL-Cholesterol Determination

Preparation of HDL-Cholesterol Standard Solution

Firstly, 0.2 ml of cholesterol standard stock solution (192.23 mg/dl) was put into a test tube, and then 0.5 ml of precipitating reagent kit (solution of phosphotungstic acid and magnesium chloride) was added to it and left to stand for 10 min. Afterwards, the solution was centrifuged at the speed of 3000 rpm for 5 min. Furthermore, 0.02 ml, 0.04 ml, 0.06 ml, 0.08 ml and 0.1 ml of the supernatant was put into a different test tube and then 1 ml of cholesterol reagent was put into each of the different test tubes and the solutions were left to stand for 10 min. The absorbance of the resultant solutions were taken against the blank at 500 nm and a graph of the absorbance against the concentrations of the solutions was plotted to obtain a calibration curve.

LDL-Cholesterol Determination

The LDL fraction of the eggs was calculated using the formular below;

$$\text{LDL} = \frac{\text{Total Cholesterol} - \text{Triacylglyceride} - \text{HDL (mg/dl)}}{5}$$

The formular above used for LDL determination was applied as directed by RANDOX laboratories Ltd., Ardmore, Diamond Road, Crumlin, Co. Antrim, United Kingdom.

Statistical Analysis

Results obtained from the study were reported as, mean ± mean deviation

RESULTS

The result of the weight of the whole egg, yolk weight and shell weight of the quail and the chicken are presented in figure 2 below. The weights of the whole egg, egg yolk and egg shell (58.50 ± 4.5; 18.50 ± 1.30 and 5.9 ± 0.60) in chicken egg were significantly higher compared to these traits in quail egg (9.9 ± 3.3; 4.2 ± 0.4 and 1.10 ± 0.20) respectively.

In 1 g of the quail egg yolk (figure 3), the total cholesterol, HDL and LDL concentrations (6.79 ± 0.41; 3.95 ± 0.08; 1.80 ± 0.03 respectively)
were significantly higher compared to their concentrations (4.03 ± 0.63; 1.84 ± 0.15; 0.40 ± 0.04 respectively) in 1 g of chicken egg yolk. The concentration of the triacylglycerol (TAG) (1.60 ± 0.02) in 1 g of quail egg yolk was found to be non-significantly higher its concentration (1.53 ± 0.09) in the amount of chicken egg yolk.

The total cholesterol, high-density lipoprotein and low-density lipoprotein concentrations in whole egg (both of quail and chicken) were assayed and the result presented in figure 4. The concentrations of these parameter in chicken egg (239.30 ± 35.40; 107.63 ± 8.72; 23.39 ± 5.87 respectively) were found to be higher than their concentrations (66.97 ± 4.06; ± 38.95 ± 0.77; 17.74 ± 0.06 respectively). The disparities between the total cholesterol and high-density lipoprotein of chicken egg and quail egg are far greater than the disparity between their low-density lipoprotein content.
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![Graph: Comparison of Total Cholesterol, HDL, and LDL Contents of Quail and Chicken Whole Eggs]

**DISCUSSION**

Determination of cholesterol in eggs has been studied extensively. The common methods used include; extraction of total lipids, removal of solvents, hot saponification in alkaline medium, extraction of non-saponifiable material, repeated washes, concentration of extracts and derivation prior to analysis. These steps are time consuming and expensive (Madzlan, 2008), so the need to use a more convenient spectrophotometric method arises.

Result obtained during this study revealed that a chicken egg has higher total cholesterol content and HDL content than a quail egg (figure 4). Figure 3 shows that 1g of the quail egg yolk possesses higher total cholesterol content and HDL content than the chicken egg which is supported by report by Bragagnolo and Rodriguez-Amaya (2003). On the contrary, another report by, Kaźmierska et al. (2005) stated otherwise. Moreover, the total cholesterol content per gram of quail egg yolk of this work is lower than the value reported by USDA (2000) but higher than that reported by Bragagnolo and Rodriguez-Amaya (2003).

The disparity between the cholesterol content of the two species of eggs is possibly as a result of the difference between the weight of the yolk of the quail egg and that of the chicken egg as seen in figure 2. Interestingly, this study revealed that there was significant lower LDL content in a quail egg than in a chicken egg. Also noteworthy is that 1g of a quail egg contains higher LDL content than 1g of a chicken egg (figure 3).

Vorlová et al. (2001) conducted a study on a diet with two chicken eggs daily for 3 weeks and detected both an increase of plasma LDL cholesterol and a decrease of HDL cholesterol by 11%. Lalwani, (2011) noted that if kids eat at least 2 quail eggs daily, they grow better and are less likely to suffer from infectious diseases. This statement could have been made, possibly, because the kids still need cholesterol for proper cell development. He also reported that quail eggs do not have LDL (bad cholesterol) and are very rich in HDL (good cholesterol), so even adults can eat them without incurring much risk.

Taking into account the findings of this study and with respect to the correlation of egg consumption and coronary heart disease which is enhanced by non-physiological high level of LDL in the blood vessels at the heart, it could be said that quail egg yolk consumption could be disastrous to the health of an individual with tendency of cardiovascular diseases when the individual eats 2 quail eggs daily. For a normal individual, consumption of at least 2 quail eggs thrice in a week would support health. As for the other redemptive claims attributed to the quail egg, is not within the scope of this study.

**CONCLUSION**

The lipids levels in the egg yolk of quail are higher than those of the chicken egg yolk. However, in quail’s whole egg, the lower total cholesterol, LDL and HDL contents were found to be lower than the chicken whole egg. This could be attributable to partitioning of the lipids into other divisions of the egg such as albumin. Also, the chicken egg has better quality traits such weight of the shell than the quail egg and
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this can enhance the keeping quality of chicken egg. Spectrophotometry could be used as a method of lipid determination.

RECOMMENDATION

Egg diets are beneficial to health but should not be eaten in excess to avoid increases in the lipids levels in the blood serum, especially LDL and cholesterol, which could lead to coronary heart diseases such as atherosclerosis and related diseases. The cholesterol and other lipids profile of the albumen of the quail egg should be determined.

The authors hereby declare that there is no conflict of interest and that no part of whole of this work has been forwarded to any other journal house for any publication.

REFERENCES