



Variations in Micronutrients Content and Lipid Profile of Some Avian Eggs

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ABSTRACT

Ten eggs each from avian species: duck, local fowl, exotic fowl, pigeon and guinea fowl were analyzed for protein, phospholipids, cholesterol, vitamins and some mineral elements using standard methods. Total lipids were high in duck (2.9 ± 0.07 mg/g) and local fowl eggs (2.0 ± 0.04 mg/g) and low in others while cholesterol was only high in local fowl (3.40 ± 0.01 mg/g). Phospholipids in exotic and pigeon eggs yielded values of 8.4 ± 0.65 mg/g and 7.5 ± 0.55 mg/g, respectively. Whereas Fe and Ca content in guinea fowl were 5.04 ± 0.45 mg/g and 4.68 ± 0.006 mg/g, the vitamins, thiamine and riboflavin were almost twice these amounts. Mineral micronutrients were of significant amounts. The results of these analyses are discussed in line with the sources of essential nutrients obtained from avian species to ameliorate the acute shortage of animal protein and micronutrients in the diet of Nigerians.

Keywords: Avian; egg yolk; lipid; micronutrient;

1. INTRODUCTION

There is acute shortage of animal protein in the diet of most Nigerians. The demand is always greater than the supply. Eggs and products are specifically out of the reach in the diet of poor peasants. Consequently, FAO (1970) till date still call for increase in protein production of domestic stocks as well as the wild birds. The poor nutritional status of individuals in Nigeria has been attributed to low food production, purchasing power, socio-

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cultural factors and nutritional education (Akinwumi et al., 1979). The most commonly used bird eggs are those from the chicken (Brothwell et al., 1997). Duck and goose eggs, and smaller eggs such as quail eggs are occasionally used as a gourmet ingredient, as they are the largest bird eggs from ostriches. Gull eggs are considered a delicacy in England Roux and Martin (2006), as well as in some Scandinavian countries particularly in Norway. In some African countries, guinea fowl eggs are commonly seen in market places, especially in the spring of each year (Stadelman, 1995) pheasant eggs and emu eggs are perfectly edible but less widely available Roux and Martin (2006), sometimes they are obtained from farmers, poulterers, or luxury grocery stores. Most wild bird eggs are protected by laws in many countries, which prohibit collecting or selling them or permit these only during specific periods of the year (Roux and Martin, 2006).

Eggs from any source are widely taken as supplement to predominant carbohydrates. They play important roles in nutrition of a large proportion of the populace, particularly passenger traveling in buses from one town to another in Nigeria.

The science of food nutrition, takes into account the study of nutrient that each organism obtains from the environment (McGraw, 1987; Patty and Anorld, 1979). Man needs for nutrition a highly complex mixture of chemical substance: amino acids carbohydrate, certain lipids, a great variety of minerals including several others which are required in minute amounts (trace elements) and vitamins. The whole egg has been used as a standard in nutrition.

Eggs are excellent sources for nutrition with all vitamins present except vitamin C (Eleanor, 1981). The lipid of egg yolk is composed of oleic, linoleic and arachidonic acids (Hodges, 1966; Hodges, 1974).

The whole egg is made of three distinct parts: egg shell and white; and contain 3.0, 17.5 and 11.0% protein, respectively. One egg white and yolk provides 15 and 60 Kcal of energy respectively and give 4 and 3mg of protein (Elinnor, 1981). An enzyme β - N - *acetylglucosaminase* has been reported to be present in the shell and membranous components in the egg. Small amounts of lysozyme activity were found in the shell membrane as well (Baker, 1968; Feeney et al., 1980). Egg yolk proteins have been found to compose of a number of complex types of macromolecules (glycoproteins) phosphoglyoproteins and lipoproteins. These have been purified by techniques of centrifugation, extraction, electrophoresis and chromatography, (Feeney et al., 1980). In this study, we have analyzed micronutrients and lipid profile of some avian eggs produced in Bida, Nigeria – with the significant aim of ascertaining these nutrients in various species of birds – a source of protein for peasant population.

2. MATERIALS AND METHODS

Ten (10) samples of eggs of different species of birds were randomly selected viz., Duck fowl, local fowl, Exotic fowl, Guinea fowl, and Pigeon from Bida Market – Nigeria.

The whole-egg was weighed using electronic balance (Metledo) and recorded. Each sample of egg was broken up with the aid of a sterilized stainless steel knife and the contents poured into a clean conical flask and the weight recorded by differential.

The egg white was separated from the yolk using micropipettes. The egg-white and yolk were placed in separate sample bottles and stored in the deep freezer for analysis within one week.

Total protein was determined by the method described by AOAC, (1990). The nitrogen value was converted to protein by multiplying a factor of 6.25. Total phospholipids/phosphorous was by ammonium molybdate reaction while lipid was determined by sulphosphovanillin reaction method. Cholesterol and thiamine was determined by Liebman-Bachan Method. While Riboflavin was determined by fluorimetric method. Calcium (Ca) and iron (Fe) was by Atomic Absorption Spectrophotometer.

2.1 Determination of Total Phospholipid/Phosphorous Concentration Using Ammonium Molybdate Reaction

2.1.1 Procedure

A portion of sample 0.2 ml (well mixed Egg) and 2.8ml of distilled water was transferred to sample test tube and 3ml distilled water to control test tube and 3ml of 0.6M trichloroacetic acid was added to each test tube and the content were mixed with shaking.

The sample solution was centrifuged for 15 minutes at 3000rpm. The supernatant liquid was decanted and the test tubes placed upside down on a piece of filter paper to let the residual liquid flow out. Then 1ml of concentrated perchloric acid (with special sampling pipettes) was poured into the test tubes and glass bead were placed in each and mixed. The test tubes were placed in the sand bath of 130°C for 30 minutes to hydrolyze the content till the solution was decolorized i.e cleared solution.

It was allowed to cool down in the air to room temperature and the 3ml distilled water, 1ml of ammonium molybdate reagent and 1ml freshly prepared reducing agent were added. The contents were mixed thoroughly and it was allowed to stand for 10 minutes at room temperature.

Measurement of the absorbance for sample solution against control solution on spectrophotometer at 560nm with 0.5cm thick cells was done on each sample.

2.1.2 Calculation

The total phospholipid concentration mg/g in egg was calculated by the formula.

$$X = M \times 25$$

Where: M is the mass of inorganic phosphate in the sample solution as determined by analytical curve in mg. 25 is the scaling factor (lipid phosphorus accounts for 4% of relative molecular mass of phospholipids).

2.2 Determination of Total Lipid Concentration in Egg Sample by Reaction with Sulphophovanillin

2.2.1 Procedure

0.1ml of sample was transferred into a dried test tube plus 2.9ml of concentrated tetra sulphate vi acid (with special sampling pipettes for strong acid).

A Portion (0.2ml) of distilled water plus 5.8ml of concentrated tetraoxosulphate (vi) acid was put in another test tube (control) and the contents were mixed thoroughly with glass rod. The test tubes were then placed in a boiling water bath for 10 minutes.

The test tubes were then cooled promptly under a stream of running tap water. A portion (3ml and 6ml) phosphovanillin reagent was poured into two cleaned test tubes respectively. To the former test tube, 0.2ml volume of the solution from the cooled sample test tube was added and to the latter 0.4ml volume of the solution from the cooled test tube was added. The content was mixed thoroughly with glass rod and the test tube was placed in dark for about 45 minutes at room temperature to allow for colour development.

The measurement of the absorbance for samples solution against control solution on a spectrophotometer at 560m (green light filter) with 0.5cm thick cells was taken.

2.2.2 Calculation

The total lipid concentration in sample mg/g yolk was calculated from its formula.

$$X = \frac{M \ 100 \times 3}{0.2 \times 1000}$$

Where:

M is the mass of total lipids in the sample as estimated by analytical curve in mg. 3 is the total volume of initial mixture (0.1ml of sample + 2.9ml of concentrated H₂SO₄ in ml. 0.2 is the mixture portion sampled for carrying out color reaction in ml.

2.3 Determination of Cholesterol in Egg

2.3.1 Procedure

A portion (200µl) of sample was measured into 15ml glass stopped centrifuge tube and 2.0ml alcoholic potassium hydroxide was added and mixed, then incubated at 37^o C for 25 minutes.

The tubes were then cooled to room temperature and 5ml ether plus 2ml of distilled water was added and mixed thoroughly and centrifuge at low speed to break the emulsion. 4ml aliquots of petroleum ether layer were transferred to dried clean test tube and the solvent was vapourised at 60^oC.

The tubes were placed in water both at 25^oC for 5 minutes. A portion (6ml) of Lieberman Burchard reagent was put into empty tube for blank. At 15 seconds interval Lieberman

Burchard reagent was added to sample and standard and mixed and returned to 25°C for 30 minutes.

The absorbance of the sample and the standard was read on Spectrophotometer (6405 UV/Visible spectrophotometer, Jenway) at 620nm at 15 minutes interval.

2.3.2 Calculation

$$\text{Mg cholesterol/100ml} = \frac{A_{un}}{A_{std}} \times C_{std}$$

Where: A_{un} is the absorbance of the unknown (sample)

A_{std} = the absorbance of the standard

C_{std} = concentration of the standard

2.4 Quantitative Determination of Thiamine and Riboflavin Using Fluorimetric Analysis

2.4.1 Procedure

A portion (5ml) of hydrochloric acid (0.1M) solution was added to about 5ml of sample (Egg) and the content were mixed thoroughly, 1ml of the sample was transferred to a cleaned test tube plus 4ml of distilled water. To the second test tube 5ml of thiamine solution was put (standard) and to the third test tube 5ml of 0.1M hydrochloric acid solution was transferred into it as control.

1.5ml of oxidizing mixture was poured into each test tube and the content was mixed with gentle shaking to homogeneity. 5ml of a butanol was added to the test tubes. Stopped and shaken vigorously for about 5 minutes. The phials (test tubes) were allowed to stand until their content separated into two layers. Then 0.5ml of 96% ethanol was added cautiously (to clarify the butanolic phase). The clarified butanolic layer were decant cautiously into a fluorimeter cell and successful measurement of the fluorescence intensity for the three (sample, standard and control) solution.

2.4.2 Calculation

Calculation is carried out from the formula.

$$X = \frac{(\text{sample} - E(\text{control})) \times 0.01 \times 5.5}{E(\text{std}) \times 5}$$

Where:

X is the amount of thiamine in the sample (mg). Sample is the fluorescence intensity (arbitrary units) measured for sample solution; E (control) is the fluorescence intensity arbitrary unit0 measured for control solution E (std) is the fluorescence intensity (arbitrary unit) measured for standard solution. 0.01 is the concentration of thiamine in standard solution (mg/ml). Polyvitamine dragee extract volume (ml); 5 is the extracted volume taken for analysis (ml); 5.5 is the solution volume clarifies by ethanol (ml).

2.5 Riboflavin Concentration Determination

2.5.1 Procedure

A portion (5ml) of 0.1M hydrochloric acid solution was added to the Egg sample and it was mixed thoroughly. Another portion (2ml) of sample was transferred into cleaned test tube plus 5ml of distilled water, to the second test tube. 1ml of standard riboflavin solution and 6ml water as standard and to the third test tube 7ml of distilled water as control. To each test tube, 10 drop of glacial acetic acid and 1.5ml 4% potassium permanganate solution (for oxidation of interfering fluorescence contaminants). The contents were shook up and 3% hydrogen peroxide was added drop wise (about 5 drops) stirred continuously with a glass rod till the solution became completely cleared. The solution were allowed to stand for about 5 minutes till no more gas micro bubbles are seen to evolved.

The solution was transferred to fluorimeter measuring cell and the fluorescence intensity for each was measured.

2.5.2 Calculation

Calculation was carried out by the equation:

$$X = \frac{(E \text{ sample} - E \text{ control}) \times 2 \times 0.005 \times 7}{E(\text{std}) \times 5}$$

Where: X is the amount of riboflavin in dragee (mg) E (sample is the fluorescence intensity (arbitrary units) measured for sample solution;

E (control) is the fluorescence intensity (arbitrary units) measured for control solution.

E (std) is the fluorescence intensity (arbitrary unit) measured for standard solution.

5ml is the polyvitamine dragee extract volume, (ml) is the polyvitamin extract volume taken for analysis (ml)

0.005 is the concentration of riboflavin in standard solution (mg/ml). 7 is the solution volume taken for fluorimetric intensity measurement in ml.

2.6 Statistical Analysis

Data collected were subjected to comparison based on the significance of the nutrient component. The differences were statistically significant at $p \leq 0.05$.

3. RESULTS AND DISCUSSION

Variations in the micronutrients of various species of avian origin are imperative and justifiable in an environment where the birds are reared in different localities. Inadequate nutrient in the diet of indigenes of Bida become vital for sourcing and development of food composition data. In fact Feeney et al. (1980), reported that the amount of nutrient varies greatly from one specie to the other, and that the variation can be larger, small or appear to be completely absent in some species.

The eight (g) of the various avian specie and the percentage variation in the egg-white, yolk and shell are shown in Table 1 and 2. The results showed that in the local fowl and pigeon, the percentage in weight of yolk is higher than the egg white. This is in accordance with the

report of (Roux and Martin, 2006), the yolk makes up about 33% of the liquid weight of the egg. However, the exotic fowl has higher weight of the egg white.

Table 1. Weight of the whole egg

Sample	Weight in g
Duck	74.74 ± 0.74 ^{ab}
Local fowl	31.25 ± 2.46 ^b
Exotic fowl	66.65 ± 1.25 ^a
Pigeon	10.83 ± 1.19 ^b
Guinea fowl	31.00 ± 3.61 ^b

Values are expressed as mean±SD, n = 10. The mean values with the same superscript are not significantly different at p ≥ 0.05

Table 2. Variation in Percentage Weight (g) of egg white and yolk of each species of avian egg

Egg sample	% Egg white	% Egg yolk	% Shell
Duck	43.35 ± 3.47	44.15 ± 2.14	10.56 ± 1.64 ^b
Local fowl	40.16 ± 2.36	43.04 ± 3.20	16.80 ± 1.65 ^b
Exotic fowl	52.96 ± 4.90	32.86 ± 1.25	14.18 ± 1.55 ^b
Pigeon	36.93 ± 2.74	41.27 ± 2.0	21.80 ± 1.38 ^b
Guinea fowl	22.59 ± 1.10 ^a	45.80 ± 1.51	31.61 ± 1.65 ^a

Values are expressed as mean SD, n = 10 .The mean values with the same superscript in the same column and row are not significantly different at p ≥ 0.05

On the nutrient composition of eggs from different species (Table 3), guinea fowl egg has the least content in egg protein of 0.8mg/g while pigeon has the highest (4.5mg/g)-although smaller in size the cholesterol content of local fowl was the highest in this group of birds, while pigeon and duck fowl were the least (3.4mg/g) and (0.15mg/g) respectively. This agreed with the earlier report of Roux and Martin (2006).

From the result, most of the eggs have high protein value compared to other nutrient, the pigeon fowl egg which are less recognized has the highest nutrient contents especially protein and calcium. Thus the egg may supply all essential amino acids for human (FAO,2010) and provide several vitamins and minerals, including retinol, Vitamin A, riboflavin (Vitamin B2) Folic acid (Vitamin B9), Vitamin B6, Chorine, Iron, Calcium, Phosphorus and Potassium (USDA 2005). Focusing on the protein and crude fat content of Exotic fowl, local fowl and pigeon fowl the result show that there were no significant differences (P > 0.05) macronutrients, this is in consonance with the report of USDA (2010).

Cholesterol was seen to high in local fowl while Duck eggs had the highest fat. According to USDA (2007) more than half the calories found in eggs come from the fat in the yolk, 100g chicken egg contains approximately 10g of fat, people on a low cholesterol diet may need to reduce egg consumption especially local fowl egg as it revealed in the result, however, only 27% of the fat in egg is saturated fat (Palmitic, Stearic and Myristic acid that contains LDL cholesterol (USDA, 2007).

Table 3. Proximate nutrient composition of eggs from different avian species

Units of Nutrients	Duck egg	Local fowl	Exotic fowl	Pigeon fowl	Guinea fowl
Total protein (x10 ⁻¹ g)	1.0 ± 0.03 ^{ab}	4.5 ± 0.06 ^b	3.5 ± 0.46 ^b	4.5 ± 0.58 ^b	0.80 ± 0.071 ^a
Total Lipid (mg)	2.9 ± 0.07 ^b	2.0 ± 0.04 ^b	1.15 ± 0.039 ^b	1.4 ± 0.045 ^b	0.9 ± 0.052 ^a
Phospholipid (mg)	3.4 ± 0.95 ^a	6.5 ± 0.08 ^b	8.4 ± 0.65 ^b	7.5 ± 0.55 ^b	6.5 ± 0.042 ^b
Cholesterol (mg)	1.15 ± 0.06 ^b	3.40 ± 0.01 ^b	0.40 ± 0.03 ^a	0.15 ± 0.02 ^a	1.60 ± 0.01 ^b
Thiamine (B1) (mg)	3.5 ± 0.009	4.0 ± 0.05	4.3 ± 0.007	4.8 ± 0.008	1.8 ± 0.009 ^a
Riboflavin (B2) (mg)	1.45 ± 0.008 ^b	1.45 ± 0.006 ^b	1.50 ± 0.004 ^b	1.60 ± 0.003 ^b	1.65 ± 0.002 ^b
Iron (mg)	2.88 ± 0.35	2.88 ± 0.42	3.30 ± 0.49	3.18 ± 0.60	5.04 ± 0.45 ^a
Calcium (mg)	2.80 ± 0.006	2.80 ± 0.004	1.12 ± 0.008	9.00 ± 0.005 ^a	4.68 ± 0.006 ^a
Phosphorous (mg)	1.35 ± 0.002 ^b	1.35 ± 0.003 ^b	3.35 ± 0.005 ^b	3.00 ± 0.004 ^b	2.60 ± 0.007 ^b

Values are expressed as mean SD, n= 10.

The mean values with the same superscript in same row are not significantly difference at $p \geq 0.05$

Unisci.com (2010) reported that a large yolk contains more than two-third of the recommended daily intake of 300mg of cholesterol, although the study indicates that the human body may not absorb much cholesterol from egg. Also other research supports the idea that a high egg intake increases cardiovascular risk in diabetic patients (Scharer and Schulthess, 2005). Thus, this study suggest (as revealed in the result) that a diabetic patients should eat less local fowl eggs or eat pigeon fowl egg if at all it needed to eat egg because of its low cholesterol level.

As for the minerals element content, while Fe was 5.04mg/g in guinea fowl followed by Ca in pigeon; phosphorous was low (1.35/g) in the duck fowl. The high content of iron, calcium and phosphorus of pigeon egg make it to be more preferable to patient deficient in mineral element. However in all the eggs the Ca/P ratio elicited between 0.5 to 1. Thus, in accordance with report of Niemans et al. (1992) that food is considered good if the Ca/P ratio is > 1 but poor if < 0.5.

Calcium and phosphorus are important in bone, teeth and muscle metabolism (Dosunmu, 1997), while Fe is an essential trace element for hemoglobin formation, normal functioning of central nervous system and energy metabolism (Ishida, 2000).

In term of vitamins, thiamine was found in an appreciable amount in the five species; higher than riboflavin in the same species. The results indicate that the selected avian species have considerable amounts of vitamins, mineral and proteins which are contributory to the nutrient need of the populace. In our study, local fowl egg appears to have the highest cholesterol value compared to others like the duck fowl. The avian egg has been an object of interest to study. The chicken egg, typical of birds generally contains about 12% by weight of protein (Gilbert, 1979 in protein deposition in animals)

The mechanisms for the accumulation of various components in the oocyte differ. Whereas the proteins of albumin of shell are synthesized in the oviduct (Gilbert, 1979) others have

been located in the liver (Tarlow et al., 1977). This therefore authenticates the variations in the protein content of these groups of birds. Others researchers have attributed the variations to genetic manipulations and maturation indices (Gilbert, 1979; Marza and Marza 1935). In this study, we have established the micronutrient composition of some avian species. Total lipids and cholesterol was high in local fowls while phospholipid varies in exotic fowl and pigeon. Essential minerals of calcium and iron as well as the vitamin riboflavin were also of significant amounts.

10. CONCLUSION

The composition of the avian egg protein and other micro constituent will continue to provide sources of nutrients for human. In fact, knowledge of the nutrient content from various species of birds will also serve as nutritional guide in food composition table as well as providing valuable information on nutrient intake.

The variation in the micronutrient content and lipid profile of some avian eggs produced in Bida, Nigeria have been documented as a guide of providing useful information on food composition and nutrient requirement, it is hoped that this approach in sourcing for various nutrients in species of avian origin will continue to form the basis of food composition data and nutrition for our populace in Nigeria.

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