Journal of Agriculture, Food, Environment and Animal Sciences
Tarım, Gıda, Çevre ve Hayvancılık Bilimleri Dergisi
http://www.jafeas.com, ISSN: 2757-5659

J. Agric. Food, Environ. Anim. Sci.
4(1): 62-77, 2023

Comparative Nutritional Evaluation of Eggs From Some Poultry Species in Nigeria

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Research Article

Article History:
Received: 05 November 2022
Accepted:27 March 2023
Published online: 01 June 2023

Keywords:
Local chicken
Duck
Quail
Cholesterol
Eggs

ABSTRACT

Nutritional assessment of eggs from some poultry species reared in south East, Nigeria was carried out to have a basic knowledge of the nutrient content of these poultry eggs with regards to their daily consumption. 6 quail eggs, 6 exotic layer egg, 6 duck egg and 6 local chicken eggs were randomly selected and purchased from reliable sources in Nsukka within Enugu State Nigeria for weekly laboratory analysis for 8 weeks. Raw and boiled egg samples of these poultry species were assayed for proximate compositions and cholesterol and energy content of the eggs were also determined. Significant differences ($P<0.05$) among treatments were recorded for both raw and boiled egg samples. Results obtained showed that quail eggs had the least cholesterol value both in the raw and boiled form. Crude protein was observed to be very high in the local chicken both for raw and boiled egg samples. There was no crude fiber in all the analyzed egg samples for both raw and boiled samples. Egg sample from the Exotic layer recorded the lowest value of ash, while the highest value was observed in local chicken egg samples (both in the raw and boiled form). The raw egg sample from the quail had the highest value of nitrogen free extract (NFE), while the duck had the highest value in the boiled sample. Raw egg sample from local chicken had the highest energy value while boiled egg sample from duck had the highest value in the boiled form. Therefore, it could be concluded from the results obtained in this study that quail eggs are nutritionally better both in the raw or boiled forms for moderately high protein and low cholesterol, especially for adults and people with coronary heart problems. But where quail eggs are not available, boiled duck eggs can be consumed as they are equally low in cholesterol. On the other hand, when energy and protein value is of keen interest, local chicken eggs or duck eggs should be consumed not more than once a day, especially for adults.

To Cite : Celestine E, Onochie OC, Kingsley O., 2023. Comparative Nutritional Evaluation of Eggs From Some Poultry Species In Nigeria. Journal of Agriculture, Food, Environment and Animal Sciences, 4(1): 62-77.

INTRODUCTION

Among several countries globally, poultry egg is a low-priced and a good balanced food source of great value nutrients (Xu et al. 2018). According to Food and Agricultural Organization Statistics (FAOSTAT, 2015) production of poultry egg

globally has amplified during the previous few years). In the year,2018, laying birds produced about 7,466,460 tons of eggs globally. However, poultry eggs have long been a crucial aspect of the human diet because of their excellent protein content, which also contributes to their high nutritional value. Eggs are a crucial source of vitamins, minerals, quality protein, phospholipids, vital fatty acids, lutein, and zeaxanthin. They also include a large number of antioxidants, choline, and other bioactive components, according to Zdrojewicz et al. (2016). The amount of nutrients present in eggs varies greatly between species (Feeney et al., 1980). These variations in egg nutritional content among different poultry species can be greater, smaller, or even completely absent in some species.

Eggs are a cheap and nutrient-dense food. Because eggs have a high biological value, when consumed, the body uses them totally. Egg bioactive components have anti-inflammatory, anti-cancer, anti-microbial, and anti-hypertensive properties (Andersen, 2015). However, studies have suggested that eating eggs helps protect against illnesses by raising levels of high-density lipoprotein and thus lowering inflammation (Balkan, 2013; Andersen, 2015). On the other hand, a large egg has between 182 and 230 mg of cholesterol. This has led to the perception that eggs may raise people's risk of cardiovascular disease and other illnesses. However, healthy people are encouraged to eat eggs unless they have a hypersensitivity to the nutritious components of eggs.

However, there is no detailed nutritional guide and valuable information on nutrient intake pertaining to egg consumption in Nigeria. This poses a problem as indigenes consume egg without knowing its implications on their health at the long run. Therefore, this present study was designed to investigate the knowledge of the nutrient content of eggs from various species of birds reared in South East Nigeria to provide dietary guidance and thus reducing the fear in people about the nutritional

status of eggs from some poultry species most especially now that people are conscious of cholesterol intake and its health implication.

MATERIALS AND METHODS

Location and duration of the study

The study was conducted at the Department of Animal Science Biochemistry/Nutrition Laboratory, University of Nigeria, Nsukka. The experiment lasted for a period of 4 weeks.

Experimental egg samples

Six local hen eggs, six duck eggs, six exotic chicken eggs and 6 quail eggs were purchased from reputable poultry breeders from Ibeagwa Nsukka, Enugu Nigeria for weekly laboratory analysis.

Data collection

Sample egg collection and diet

Five fresh eggs were bought from reputable poultry/keepers in Nsukka, Enugu State, Nigeria for this study. The live eggs were collected from quail, exotic layer hen, duck and local hens. The local hens and ducks whose eggs were used in this study were kept locally without given them an experimental diet. It was only the exotic layer hens and quails whose eggs were used in this study that were given formulated diets that are shown in Table 1 below.

Table 1. Experimental % compositions of diet for exotic hens and quails-%

Ingredients	Quantity
Maize	42.00
Wheat offal	18.00
Palm kernel cake	13.00
Soybean meal	16.00
Oyster shell	7.00
Bone meal	2.00
Lysine	0.25
Methionine	0.25
Salt	0.25
Vitamin premix	0.25
Total	100
Calculated compositions	
Crude protein (%)	16.50
Energy(Kcal/kgME)	2750

Preparation of eggs for boiling

The eggs were gutted, given identification and boiled by putting them in clean water that was boiling at 100 degrees. The boiling water was adequate to cover the entire sample of eggs in the stainless cooking pot. The eggs were allowed to boil for ten minutes after which they were rapidly removed from the pot and permitted to cool in water at room temperature. The Eggs were boiled differently and their shells were removed after cooling. Then, the eggs were situated in a dirty free, well labelled beaker and parafilm was used close them before exposing them to freeze-drying. The whole eggs after boiling were crushed and then freeze-dried again using freeze-drier. Furthermore, the freeze-dried samples were milled to yield fine powder, by use of lab miller (Breville kitchen Wizz BFP650). Milling took place under very reduced temperature. Immediately milling the eggs, fifty grams per sample were immediately taken to the lab for analysis.

Raw egg preparation

Each of the eggs was well cleaned, broken and the contents were emptied gently in clean, identified glass laboratory beakers. The contents of the raw egg samples were

immediately then standardized and frozen at −40°C and ready to be used for analysis.

Egg chemical/proximate compositions

Egg moisture, crude ash, crude fat, crude protein and fiber were determined using (AOAC, 2011).

Cholesterol determination

Egg cholesterol was determined 5mls of mixed egg sampled in bottles with anticoagulant, ethylene diamine tetra-acetic acid for lipid profile examination. At 1800r/m, the samples were centrifuged and analysed using Hitachi 902: Auto Analyzer for total egg cholesterol.

Egg energy determination

The frozen eggs, both the shells, were freeze-dried, weighed, milled, and analysed for gross energy using an adiabatic oxygen bomb calorimeter.

Statistical analysis

Data generated were subjected to the analysis of variance (ANOVA) using a statistical package (SPSS, 2003) Windows version 8.0. Mean differences were separated using Duncan's New Multiple Range Test (Duncan, 1955) as outlined by Obi (2002).

The statistical model used was stated below:

$Xij = \mu + ti + \varepsilon ij$

Xij = individual observation

μ = population mean

ti = treatment effect

εij = experimental error

RESULTS

The result of the proximate compositions of raw egg samples from quail, exotic layer, duck and local chicken used in this study are presented in Table 2 and Figure 1. There were significant differences ($P<0.05$) among the treatments in all the parameters measured. Raw samples of eggs from quail and exotic layer had similar moisture values of (73.15% and 73.23% respectively) and they were significantly higher ($P<0.05$) than the moisture contents of raw egg samples from duck and local chicken. The raw egg sample from the duck had significantly higher ($P<0.05$) moisture content than the raw egg sample from the local chicken which had the least moisture content of (71.53%). Raw egg sample from the local chicken had the highest ash content (1.61%) followed by quail egg with the ash content (0.94%). The egg of the exotic layer had the least ash content (0.59%). Raw egg samples from the local chicken and the exotic layer had similar ether extract values of (11.55% and 11.49%) respectively and they were higher than the fat content of raw egg samples from the duck and the quail. Raw egg sample from the duck and quail also had similar values (10.64% and 10.34% respectively) and they had no significant difference between them. Raw egg sample from the local chicken had the highest crude protein (14.62%) which was significantly higher ($P<0.05$) than the crude protein values of raw egg samples from duck, exotic layer and quail. The raw egg sample from the duck had significantly higher ($P<0.05$) crude protein content (13.65%), than raw egg samples from quail and exotic layer. The crude protein content of raw egg samples from the exotic layer and the quail had a similar value of (11.75% and 11.16% respectively), hence had no significant difference. Nitrogen free extract composition of raw egg samples from quail, exotic layer, duck and local chicken showed that the raw egg sample from quail had the highest nitrogen free extract value of (4.41%) which was significantly higher ($P<0.05$) than the nitrogen free extract values of the raw egg samples from exotic layer, duck and local chicken. The raw egg samples from the

exotic layer and the duck had similar values of NFE (2.47% and 2.47%) and they were significantly (P<0.05) higher than the result from the raw egg sample of the local chicken which had the least value of (0.69%).

Table 2. Proximate composition of raw egg samples

Parameters	Quail	Exotic Layer	Duck	Local Chicken	SEM
Moisture (%)	73.15a	73.23a	72.54b	71.53c	0.257
Crude ash (%)	0.94b	0.59d	0.71c	1.61a	0.149
Crude fat (%)	10.34b	11.49a	10.64b	11.55a	0.199
Crude protein (%)	11.16d	12.21c	13.65b	14.62a	0.504
Crude fibre (%)	0.00	0.00	0.00	0.00	0.000
Nitrogen free extract (%)	4.42a	2.47b	2.47b	0.69c	0.502

(abcd) Means on the same row with different superscripts are significantly (P<0.05) different. SEM = Standard Error of Mean.

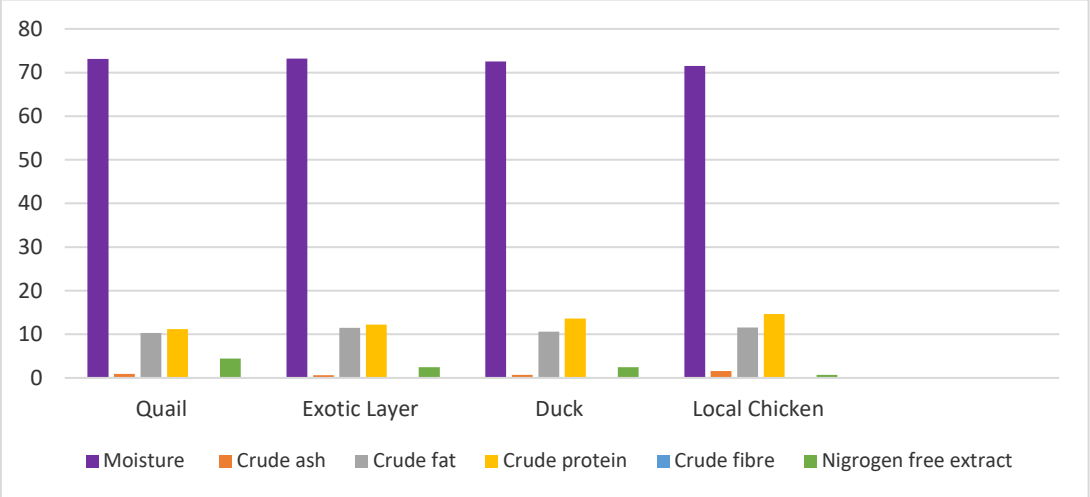

Figure 1. Proximate compositions of raw egg samples

Table 3 and Figure 2 show the cholesterol composition of raw egg samples from quail, exotic layer, duck and local chicken. Results obtained showed that there was a significant difference (P<0.05) among treatments in all the parameters measured. The raw egg sample from the exotic layer had the highest cholesterol value of (89.00 mg/dL) followed by the raw egg sample from the local chicken which had the cholesterol value (84.50 mg/dL). Raw egg sample from the quail had the least cholesterol value of (65.00 mg/dL). The raw egg sample from the local chicken had the highest energy value of (1481.00 kcal/kg) followed by the raw egg sample from

the exotic layer which had the energy value of (1455.40 kcal/kg), and this was significantly higher (P<0.05) than the energy value of raw egg sample from the duck with the value of (1435.60 kcal/kg). The raw egg sample from the quail had the least energy value of (1393.10 kcal/kg).

Table 3. Cholesterol and energy composition of raw egg samples

Parameters	Quail	Exotic Layer	Duck	Local Chicken	SEM
Cholesterol(mg/dl)	65.00d	89.00a	69.50c	84.50b	3.78908
Energy (kcal/kg)	1393.10d	1455.40b	1435.60c	1481.00a	12.1512

(abcd) Means on the same row with different superscripts are significantly (P<0.01) different. SEM = Standard Error of Mean.

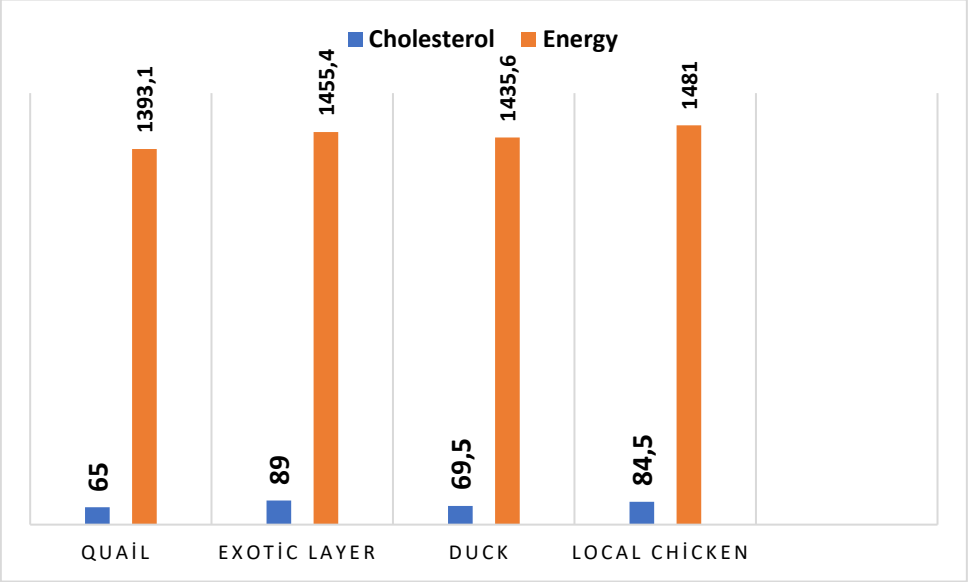

Figure 2. Cholesterol and energy compositions of raw egg sample

Table 4 and Figure 3 show the proximate composition of boiled egg samples of quail, exotic layer, duck and local chicken eggs used in the study. There were significant differences (P<0.05) among treatments in all the parameters measured. Moisture composition of boiled egg samples from exotic layer was the highest followed by quail, local chicken and duck. The boiled egg sample of the local hen had the highest ash content followed by quail, duck and exotic layer. Boiled egg samples from local chicken and duck had a similar fat content of 7.25% and 7.53% respectively and they

were significantly higher (P<0.05) than the fat contents of boiled egg samples of quail and exotic layer respectively. The boiled egg sample from the local chicken had the highest crude protein value of (32.00) which was significantly higher (P<0.05) than the crude protein from the boiled egg samples from quail, exotic layer and duck. The boiled egg sample from the exotic layer had the highest NFE value and this was significantly higher (P<0.05) than that of boiled egg samples from the quail, duck and local chicken respectively. There was no significant difference between the boiled egg sample from the local chicken and the boiled egg sample from both the quail and duck. The boiled egg sample from the duck had the least NFE value of (5.75%).

Table 4. Proximate composition of boiled egg samples

Parameters	Quail	Exotic Layer	Duck	Local Chicken	SEM
Moisture (%)	55.01b	57.53a	52.93d	53.99c	0.65
Crude ash (%)	1.88b	1.51d	1.79c	2.41a	0.123
Crude fat (%)	6.77b	5.50c	7.53a	7.25a	0.301
Crude protein (%)	29.07c	26.21d	30.12b	32.00a	0.793
Crude fibre (%)	0.00	0.00	0.00	0.00	0.000
Nitrogen free extract (%)	7.28b	9.25a	5.75c	6.23bc	0.537

(abcd) Means on the same row with different superscripts are significantly (P<0.01) different, SEM = Standard Error of Mean.

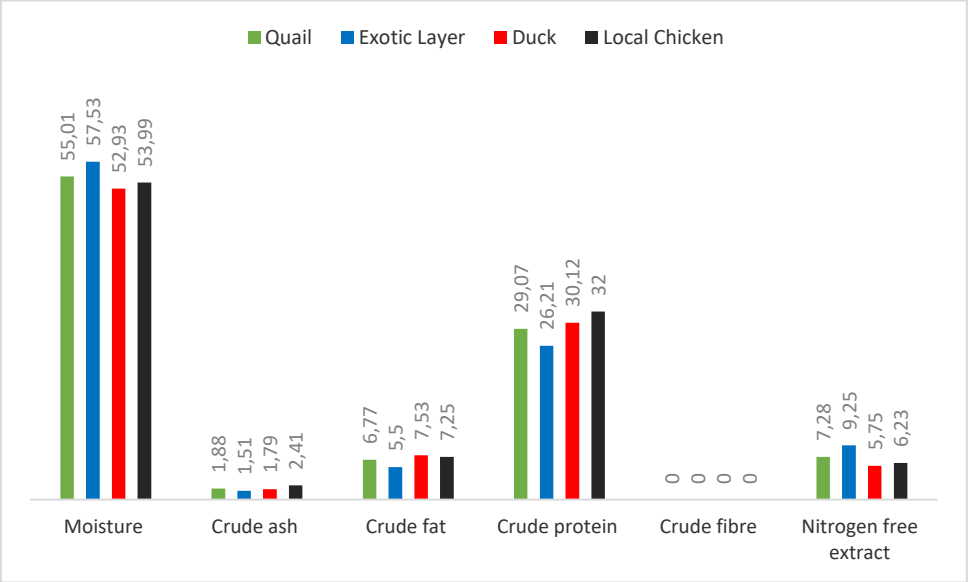

Figure 3. Proximate compositions of boiled egg samples

Table 5 and Figure 4 show the cholesterol composition of boiled egg samples from the quail, exotic layer, duck and local chicken. The result obtained showed that there were significant differences (P<0.05) in the cholesterol compositions of boiled egg samples from the quail, exotic layer, duck and the local chicken. Boiled egg samples from the exotic layer had the highest cholesterol value of (83.50mg/dL) and this was significantly different from boiled egg samples from the local chicken, quail and duck. The boiled egg sample from quail had the least cholesterol value of (63.00mg/dL). The boiled egg sample from the duck had the highest energy value of (1940.10kcal/kg) followed by the boiled egg sample from the local chicken which had the energy value of (1868.20 kcal/kg), significantly higher (P<0.05) than the energy value of boiled egg sample from the quail. The boiled egg sample from the exotic layer had the least energy value of (1695.80 kcal/kg).

Table 5. Cholesterol and energy composition of boiled egg samples

Parameters	Quail	Exotic Layer	Duck	Local Chicken	SEM
Cholesterol(mg/dl)	63.00d	83.50a	68.00c	80.50b	3.222
Energy (kcal/kg)	1829.20c	1695.80d	1940.10a	1868.20b	33.663

abcd: Means on the same row with different superscripts are significantly (P<0.01) different. SEM = Standard Error of Mean.

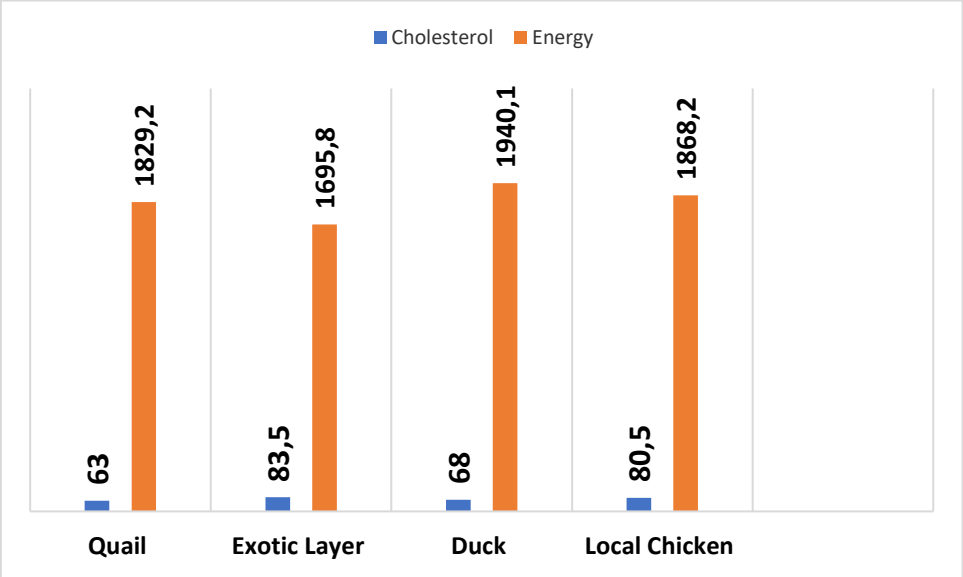

Figure 4. Cholesterol and energy compositions of boiled egg samples

DISCUSSION

The boiled sample from the exotic layer recorded the highest moisture value while the local chicken had the least value. This agrees with the findings of Babangida et al. (2006). The moisture contents of egg samples from exotic layer were higher than those of samples of duck whole eggs and this finding is consistent with the result reported by Mine (2007). In the ash content of boiled egg samples, the exotic layer egg samples recorded the least value while the highest value was recorded in the local chicken egg sample (both raw and boiled). This agrees with the report of Isidahomen et al. (2013) who reported that the exotic chicken eggs had a low ash value and that high ash value was recorded in the local chicken eggs. This could be attributed to environmental factors and the type of feed they feed on. Data obtained from this study revealed that the boiled egg samples from duck and exotic layer had the highest and lowest values of fat content respectively. This is in contrast with the report of Babangida et al. (2006) but agrees with that of Mine (2007). Crude protein was observed to be highest in the local chicken both for raw and boiled egg samples. This is in agreement with the finding of Fraga et al. (1989). The crude protein content was lowest in the raw egg sample of the quail and boiled egg sample of the exotic

layer. From this study, the consumption of local chicken whether it's in the raw or boiled form serves the most beneficial purpose in terms of crude protein content. Furthermore, quail eggs in comparison to exotic layer and duck eggs, have more quality irrespective of their numerical value. This is because, even though they are small and about five to six times the size of the chicken eggs, they have high crude protein content of (11.16) in the raw form and (29.07) in the boiled form when compared to the values of (14.62) in the raw form and (32.00) in the boiled form of the local chicken eggs. No crude fiber content was found in all egg samples from the poultry species evaluated. Besides animal-based products such eggs do not contain fibre.

Generally, looking at the nutrient contents in raw and boiled eggs from the entire poultry species eggs investigated, the moisture content in raw eggs was significantly higher when compared to boiled eggs. This may be linked to the effect of heat on boiled eggs. During boiling, more water must have been evaporated. Boiled eggs contained significantly less crude fat than the raw eggs. This may be due to lipid oxidation as a result of heat generated during boiling. Research states that oxidation of lipid requires a increased activation energy that can be made available by heat exposure and regularly happens at temperatures above 66ºC (World's Healthiest Foods. Web. 01 Jan. 2014). Protein was higher in boiled egg compared to raw eggs.

Cholesterol composition analysis showed that the highest value was obtained from the egg samples of the exotic layer (both raw and boiled samples), while the lowest value recorded was from raw and boiled egg samples from quail. This is in contrast with the report of Jalaludeen et al. (2004) who observed higher value of cholesterol in quail eggs compared to other species of poultry. The present finding is consistent with the work of Aziz et al. (2012) who reported that cholesterol value was significantly higher in both raw and boiled egg samples of the exotic layers when compared to other species. Scharer et al. (2005) support the idea that diabetic patients

should eat less exotic and local chicken eggs, but eat quail eggs if there is need to eat egg because of its low cholesterol level. This could be as a result of their small sizes, as one chicken egg is equivalent to about five to six quail eggs. Thus, this study suggests (as revealed in the result) that exotic and local chicken eggs have high levels of cholesterol. This could be as a result of the layer's genetic make-up or their period of lay. According to Kovacs et al., (1998), the cholesterol content of exotic layer eggs increases until the 45th week of age and after a sluggish period, the cholesterol content decreases towards the end of the production period. The cholesterol content was seen to be moderately low for raw and boiled egg samples of the duck as well. This tend to suggest that people should consume less eggs from exotic layer and local chicken (whether in the raw and boiled forms). But should eat quail or duck eggs instead because of their low cholesterol content especially now people are conscious of cholesterol consumption because of its negative effect on health. It is therefore advisable that people on low cholesterol diets or diabetic patients should reduce the intake of high cholesterol eggs (exotic layer and local chicken eggs) in order to avoid cardiovascular risks. Although adults consume eggs at regular intervals, egg yolk of any variety cannot be recommended to adults with coronary heart disease as the yolk contains a huge amount of cholesterol (Tarun and Chew, 1999). It is also imperative to note that although quail eggs are low in cholesterol, it has high content of high-density lipoproteins (HDL) cholesterol content, which helps to balance the low-density lipoprotein in blood levels. The energy content of the analysed eggs showed that the raw egg sample of local chicken had the highest value while the raw egg sample of quail had the lowest value. The boiled egg sample of duck had the highest value while the boiled egg sample of the exotic layer had the lowest value of energy content. From this finding, it can be asserted that the consumption of boiled duck egg or raw local chicken supplies more energy for body metabolism than the consumption of raw quail egg or boiled exotic layer egg.

CONCLUSION

It could be concluded from the results obtained in this study that quail eggs are nutritionally better whether in raw or boiled forms for moderately high protein, low cholesterol and low-fat content, especially for people of low cholesterol diets and coronary heart disease patients. But where quail eggs are not available, boiled duck eggs can be consumed. On the other hand, when energy and protein content is of keen interest, local chicken eggs or duck eggs should be consumed not more than once a day though, especially for adults. Exotic layer eggs should be consumed when necessary, at least once a day.

ACKNOWLEDGEMENT

The authors desire to acknowledge the Department of Animal Science, University of Nigeria Nsukka for providing the amenities for the successful analysis of the egg samples.

Ethical statement

No ethical approval is required, because no significant impairment to the well-being or general condition of the animals has been made.

Conflict of Interest

The authors declare no competing interest.

Authors Contribution

The authors contributed equally to the article.

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