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Research Article
Analysis of Proximate, Mineral and Toxicant Compositions of Eggs of Quail and Chicken Given Aflatoxin Contaminated Feed

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Abstract

Background and Objectives: Eggs are consumed globally and constitute an important part of man's diet. High nutrient content, low caloric value and easy digestion make them valuable in many therapeutic diets. This study was designed to analyze the proximate, mineral and toxicant compositions of eggs of quail and chicken given aflatoxin contaminated feeds. **Materials and Methods:** Sixteen mature birds were randomly divided into 4 groups (1-4) of 4 birds each. Group 1 consisted of 2 broilers and 2 layers given uncontaminated feed. Group 2 consisted of 2 male and 2 female quails given uncontaminated feed. Group 3 consisted of 2 broilers and 2 layers given aflatoxin contaminated feed. Group 4 consisted of 2 male and 2 female quails given aflatoxin contaminated feed. Birds were fed for 12 weeks and 30 eggs from each group were weighed and analyzed. **Results:** It was observed that tannin, hydrogen cyanide, oxalate, phytate, fat and cholesterol levels were higher in chicken egg; while in quail egg iron, sodium, phosphorus, zinc and protein levels were higher. Eggs of quail given aflatoxin contaminated feed recorded elevated fat and cholesterol levels. Aflatoxin also reduced egg weight significantly ($p<0.05$). **Conclusion:** Findings of this study suggest that quail eggs are more nutritious than chicken eggs and aflatoxin is capable of reducing the quality of both egg types. Therefore, birds should be given aflatoxin-free feed.

Key words: Chicken eggs, quail eggs, aflatoxin, minerals composition, toxicants analysis

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Nutrition plays a vital role in the growth and development of the body. Studies on nutritional composition have shown that eating balanced diet can improve human health. The United States Department of Agriculture, Food and Nutrition Service encourage eating a variety of foods with the right balance of calories, protein, fats, carbohydrates, minerals and vitamins by both children and adults[1]. Eggs are among the few foods that are consumed throughout the world and they constitute an important part of the food industry. They are highly versatile containing many essential nutrients and these make them an important part of human diet[2]. Their high nutrient content, low caloric value and easy digestion make them valuable in many therapeutic diets for adults[3,4]. Egg consumption is a popular choice for food nutrients, examples of which are eggs of chicken, duck, pigeon, quail, guinea fowl and caviar but by a wide margin the egg most often consumed is the chicken egg[5].

Chicken eggs on one hand are highly nutritious and form an integral part of a wide variety of recipes. They are a rich source of protein, minerals and vitamins. They are also cheap, readily available and relatively easy to prepare. Apart from the nutritional benefits, chicken eggs find application in vaccine production and cultural activities. Quail eggs on the other hand, are packed with vitamins and minerals and their nutritional value is 3-4 times greater than chicken eggs regardless of size[6]. Regular consumption of quail eggs help fight against diseases such as stomach ulcer, anaemia, tuberculosis, asthma and diabetes[7,8]. They can also help prevent and remove kidney stone, liver stone and gallbladder stone. The nutritional value of quail eggs is much higher than those offered by other egg-types because they are rich sources of anti-oxidants, minerals and vitamins[6].

Japanese quail egg ranges from 9-12 g with an average weight of 10 g which is one-fifth of the size of chicken egg[9]. Quail egg hatches within 16-18 days, while chicken egg hatches at the end of 21 days of incubation. Quail eggs are characterized by a variety of shell colour patterns, ranging from dark brown to blue white or speckled white. Chicken eggs are mostly dark and light brown in colour. Nazligul *et al*.[10] and Yilmaz *et al*.[11] reported that these species of birds differ in their egg-laying age. Quails start laying eggs at 6-8 weeks of age, while layer-type chickens begin at 20-24 weeks of age. Quails lay eggs at least twice a day, while layer-type chickens lay at most twice a day[12]. Several factors including diet can influence the quality and quantity of eggs produced by both chicken and quail.

Fungi are ubiquitous plant pathogens which are major agents of food and feedstuffs contamination. The infection of plants by fungi not only results in poor crop quality and yield but also contaminates grains with poisonous fungal secondary metabolites called mycotoxins. The ingestion of mycotoxins contaminated grains by both animals and humans has enormous public health impact[13]. Example of these mycotoxins is aflatoxin, which is produced mainly by *Aspergillus flavus*, *Aspergillus nomius* and *Aspergillus parasiticus*. Aflatoxins have the ability to bioconcentrate, bioaccumulate and remain stable in biotic and abiotic environments. They also influence metabolism in poultry by suppressing enzymes responsible for the digestion of starch, proteins, lipids and nucleic acids, thereby reducing blood protein, total cholesterol and urea and could lead to liver damage[14]. Aflatoxins can affect egg quality and may also lead to death of birds. In view of this backdrop, this study was designed to investigate the nutritional composition of quail and chicken eggs, as well as analyze the effects of aflatoxin contaminated feeds on the quality of both egg-types.

MATERIALS AND METHODS

Experimental site: This study was carried out between June, 2017 and December, 2017 at the animal house of Genetics and Biotechnology Department, University of Calabar, Calabar, Nigeria.

Experimental animals/procedure: Sixteen sexually mature birds comprising of 4 broilers, 4 layers, 4 male quails and 4 female quails were purchased from University of Calabar Farm, Calabar, Nigeria. They were housed in cages and allowed unrestricted access to feed and water daily.

The birds were allowed to acclimatize for a week and then divided into 4 groups (1-4) of 4 birds each in a completely randomized design. Group 1 consisted of 2 broilers and 2 layers and received uncontaminated feed. Group 2 consisted of 2 male and 2 female quails and received uncontaminated feed. Group 3 consisted of 2 broilers and 2 layers and received aflatoxin contaminated feed. Group 4 consisted of 2 male and 2 female quails and received aflatoxin contaminated feed. Birds were fed throughout the experimental period of 12 weeks. Thirty eggs laid by birds in each group were collected, weighed and analyzed.

Toxicant analysis: Eggs collected from group 1 and 2 were used to determine hydrogen cyanide, oxalate, phytate and tannin contents using the method described by AOAC[15].

Mineral composition: Eggs collected from group 1 and 2 were boiled, sliced, oven dried and then pulverized. The egg samples were ashed in the furnace for 2 h. Atomic absorption spectrophotometer was used to determine the concentration of zinc, phosphorus, potassium, iron and sodium in the egg samples.

Proximate analysis: Eggs collected from the 4 group (1-4) were used to determine fat, protein and cholesterol compositions. The simple and sensitive colorimetric method described by AOAC[15] was used for this analysis.

Statistical analysis: Data collected for mineral and toxicant compositions were analyzed using the student's t-test. While data collected for proximate analysis were subjected to one-way analysis of variance (ANOVA) using predictive analysis software (PASW) version 18.0. Least Significant Difference (LSD) was used to separate means significant at $p<0.05$.

RESULTS

Toxicant composition of quail and chicken eggs: Results for toxicant composition revealed that there was no significant difference ($p>0.05$) in tannin, hydrogen cyanide and phytate levels between quail and chicken eggs (Table 1). However, hydrogen cyanide and phytate compositions were higher in chicken eggs (19.28 and 62.45 mg, respectively), whereas tannin was higher in quail eggs (66.50 mg). On the contrary, oxalate was significantly ($p<0.05$) higher in chicken eggs (35.22 mg) compared to quail eggs (22.00 mg).

Mineral composition of quail and chicken eggs: The result for mineral composition (Table 2) revealed that zinc, sodium, iron and phosphorus were significantly ($p<0.05$) higher in quail eggs than in chicken eggs. But, potassium was insignificantly ($p>0.05$) higher in chicken eggs (152.31 mg) than in quail eggs (133.56 mg).

Proximate composition of quail and chicken eggs: Result for proximate compositions of eggs of quail and chicken given contaminated and uncontaminated feed is presented in Table 3. The result revealed that there was no significant ($p>0.05$) difference in fat, total protein and cholesterol compositions of birds given contaminated and uncontaminated feed. The least mean value (25.00%) of fat was recorded in eggs of quail given uncontaminated feed, while the highest value (29.00%) was recorded in eggs of quail given contaminated feed. Total protein was least (44.41%) in eggs of chicken given contaminated feed and highest (48.06%) in eggs of quail given uncontaminated feed. Cholesterol composition was least (2.59%) in eggs of quail given uncontaminated feed and highest (6.59%) in eggs of quail given contaminated feed.

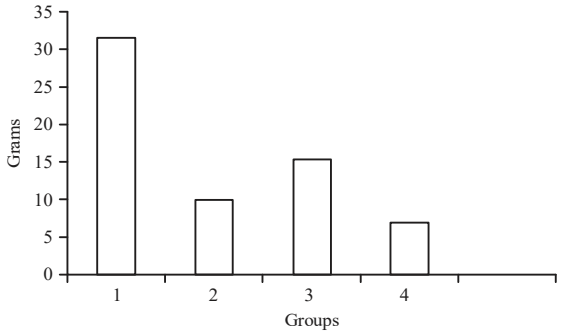

Fig. 1: Mean weight of quail and chicken eggs

Group 1: Eggs of chicken given uncontaminated feed, Group 2: Eggs of quail given uncontaminated feed, Group 3: Eggs of chicken given contaminated feed, Group 4: Eggs of quail given contaminated feed

Table 1: Toxicant composition of quail and chicken eggs

Toxicant (mg)	Quail eggs	Chicken eggs	Significant difference
Tannin	66.50±7.50	60.75±7.90	p>0.05
Hydrogen cyanide	16.07±3.57	19.28±3.57	p>0.05
Phytate	56.34±17.33	62.45±20.02	p>0.05
Oxalate	22.00±4.39	35.22±3.12	p<0.05

Values are presented as Mean±SEM

Table 2: Mineral composition of quail and chicken eggs

Minerals (mg)	Quail eggs	Chicken eggs	Significant difference
Zinc	1.34±0.37	1.04±0.06	p<0.05
Sodium	166.02±0.31	140.07±0.04	p<0.05
Iron	0.07±0.03	0.03±0.02	p<0.05
Phosphorus	1.89±0.07	1.69±0.07	p<0.05
Potassium	133.56±0.14	152.31±0.14	p>0.05

Values are presented as Mean±SEM

Table 3: Proximate composition of quail and chicken eggs

Nutrients (%)	1	2	3	4
Crude fat	6.00±0.01[a]	25.00±0.01[a]	27.00±0.01[a]	29.00±0.02[a]
Total protein	46.09±0.08[a]	48.06±0.03[a]	44.41±0.01[a]	47.55±0.02[a]
Cholesterol	4.13±0.01[a]	2.59±0.01[a]	4.75±0.01[a]	6.59±0.01[a]

Values are presented as Mean±SEM, Means followed by the same case letter along the horizontal array indicate no significant difference ($p>0.05$), Group 1: Eggs of chicken given uncontaminated feed, Group 2: Eggs of quail given uncontaminated feed, Group 3: Eggs of chicken given contaminated feed, Group 4: Eggs of quail given contaminated feed

Weight of quail and chicken eggs: Figure 1 shows the mean weight of eggs of quail and chicken given contaminated and uncontaminated feed. The least mean weight (7.0 g) was recorded by eggs of quail given contaminated feed, while the highest value (31.7 g) was recorded by eggs of chicken given

uncontaminated feed. The result shows a significant decrease in egg weight of birds given contaminated feed compared to those given uncontaminated feed.

DISCUSSION

Result for toxicant composition revealed that hydrogen cyanide, phytate, oxalate were higher in chicken eggs than in quail eggs; whereas, tannin was significantly higher in quail eggs. According to the USDA National Nutrition Database, when the concentration of tannin, oxalate or phytate is more than 500 mg/100 g, it is said to be highly toxic and deleterious to health. Since tannin, oxalate and phytate levels were lower than the standard value, it thus suggested that both egg-types are safe for consumption[1].

Mineral composition analysis indicated that zinc, sodium, iron and phosphorus were significantly ($p<0.05$) higher in quail eggs than in chicken eggs, while potassium was insignificantly ($p>0.05$) higher; this suggested that quail eggs are richer in minerals than chicken eggs which is in tandem with Tunsaringkarn *et al.*[6], Szablewski *et al.*[16] and Tolik *et al.*[17]. High zinc content in quail eggs could be responsible for strengthening of the immune system, increase brain activity and stabilization of the nervous system[5]. 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.

Proximate analysis revealed that fat and cholesterol were higher in chicken eggs whereas protein was higher in quail eggs; this is in agreement with Tunsaringkarn *et al.*[6], Tolik *et al.*[17], Genchev[18], Polat[19], Ogunwole[20], Thomas[21] and Jeke[22]. This study also showed that aflatoxin contaminated feed increased fat and cholesterol contents and reduced total protein in eggs of quail[23,24]. Eating protein rich food can help replace worn out tissues, increase muscular mass and lower blood pressure. Fat and cholesterol are major constituents of egg which are needed in moderate quantity as too much of these could be harmful to health[21]. Hence, consumption of food containing huge amount of fat and cholesterol should be discouraged. This study also revealed a significant ($p<0.05$) reduction in mean weight of eggs laid by chicken and quail given aflatoxin contaminated feed corroborates the study by Dudusola[25]. It therefore implies that aflatoxin could be responsible for the reduction in weight of both egg types.

CONCLUSION

This study suggests that quail eggs are more nutritious than chicken eggs and as such should be given preference and wider acceptability. In addition, bird-feeds should be free of contaminants such as aflatoxin in order to produce eggs with desirable quality.

SIGNIFICANCE STATEMENT

This study discovered a significant reduction in egg weight of chicken and quail given aflatoxin contaminated feed. Therefore, this finding will help researchers to uncover the critical areas of aflatoxin feed contamination and the resultant effects on egg quality that many researchers were not able to explore.

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