International Journal of Research in Agricultural Sciences
Volume 6, Issue 5, ISSN (Online): 2348 – 3997

Comparative Evaluation on Preference and Composition of Different Avian Egg Types

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Date of publication (dd/mm/yyyy): 30/09/2019

Abstract **– Eggs from seven different Avian/poultry species (Guinea fowl, Quail, local fowl, Exotic fowl (ISA-Brown), Turkey, Duck and Pigeon) were examined to determine the proximate, mineral, lipid and fatty acid composition and sensory properties. A total number of two hundred and ten (210) eggs, 30 eggs for each of the poultry type were bought from local market and Teaching and Research farm Ladoke Akintola University of Technology, Ogbomoso, Oyo state, Nigeria. The results revealed that turkey eggs have the highest (P<0.05) value for crude protein (12.80%), margaric acid (0.14), steric acid (0.15), arachidonic (0.16), linoleic (0.15), linolenic (0.09). Exotic fowl eggs were highest (P<0.05) in potassium and sodium with 268.24 and 286.54 mg/L respectively. Quail eggs had the lowest (P<0.05) total cholesterol (106.85), low (22.01) and very low density lipoprotein (44.21). The sensory panelist rated (P<0.05) exotic and turkey eggs best for shell colour, exotic eggs for ease of pealing, exotic and Duck eggs for yolk colour as no (P>0.05) differences were observed with their perception on albumen colour. The panelist however preferred (P<0.05) eggs from quail and exotic hens most for taste, texture and overall acceptability. In conclusion, eggs from other lesser known poultry types compare favourably well in terms of both consumer preference and chemical composition with exotic eggs, hence, providing alternatives and option for better human nutrients.**

Keywords **– Consumer Preference, Proximate, Lipid Profile, Fatty Acid Profile, Avian/Poultry Eggs.**

I. INTRODUCTION

Poultry production remains one of the potential avenues to achieve sustainable and rapid production of high quality protein to meet the increasing demand for animal protein (1, 2). Over the past four decades, global egg production has grown 203.2%, due to a rapidly increasing demand for proteins in the developing world (3). Food and Agriculture Organization (4) estimated poultry population in Nigeria to be about 33 million. With the ever growing population and improvement in the living standard of Nigerians, the demand for egg and other poultry products will continue to grow. As this increase continues, the quality of food stuff produced by poultry and other agricultural animals becomes increasingly important with growing consumer awareness for healthy aspect of food which includes not only pathogens or trace of contaminations but also the compositions and nutritional values of the products (5).

Also, poultry eggs are considered as one of the most preferred poultry products because they are principal food for human consumption practically for the children and elderly, it is delicious, easy to digest, and contains most of the nutrients needed by human based on recommended daily allowance. It is found on breakfast and dinner tables and is used for enrichment of other human foods (6, 7). High nutritive value, better digestibility, low cost and ready availability are some of the reasons for its preference and as such the common and most favoured dietary source of protein for low income households, who often times are unable to afford more expensive protein sources (8).

The avian egg is an important source of nutrients, containing all of the proteins, lipids, vitamins, minerals, and growth factors required by the developing embryo, as well as a number of defense factors to protect against bacterial and viral infection (9).

Moreover, eggs contain substances with biological functions and activities, i.e. immune proteins, enzymes, etc. (9, 10), characterized by anti-adhesive and antioxidant properties, antimicrobial activities, immunomodula--tory, anticancer, and antihypertensive activities, protease inhibitors, nutrient bioavailability, and functional lipids, highlighting the importance of egg and egg components in human health and in disease prevention and treatment (11).

The most commonly used avian eggs are those from the exotic chickens and the demand is often greater than supplies but in real sense there are other poultry birds that produce eggs for human consumption, among these birds are domestic chicken (*Gallus domesticus*), Guinea fowl (*Numida melleagris*), Quail (*Coturnix coturnix japonica*), Duck (*Anas platyhyncha*), Pigeon (*Columbia livia*), Turkey (*Melleagris gallopavo*). Although chicken eggs are currently most commonly eaten by humans, the eggs from other birds are also used for daily consumption. For example Japanese quail eggs are gaining popularity in Europe and America, ostrich eggs in South Africa (12) and duck eggs in Southeast Asian countries. Recently there is growing interest in alternative bird species including guinea fowl, ostrich, emu, pheasant and Japanese quail since these birds provide valuable eggs and meat which are called niche products (13, 14).

Since all species of birds have different genetic background, the nutritional composition, cholesterol content and sensory properties may vary significantly as a result of differences in breed, feed, feeding way and growing environment. The choice of consumers has sometimes been attributed to one being sweeter than other however; these assertions need to be correlated to the nutritional values of these preferred egg types. This present research work is aimed at evaluating the consumer preference and chemical composition of seven different poultry egg type in Ogbomoso metropolis.

II. Material and Methods

A. *Collection of Samples and Identification*

Guinea fowl, Quail, Turkey, Duck, Pigeon, Local fowl and Exotic chicken eggs were bought at Teaching and Research farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. All eggs (210 eggs) from different species were properly identified and well labeled.

B. *Chemical Analysis*

Twenty (20) eggs from each of the poultry type were carefully cracked and the contents emptied into a beaker. Egg samples were weighed using electronic balance and recorded. They were homogenized and kept in a dry, clean sample bottles and later used for the chemical analysis.

C. *Proximate Analysis*

Moisture, ash, crude protein and ether extract were determined by the method as described by AOAC (15). Moisture of egg is commonly determined by drying a sample at some elevated temperature approximate 105^0C and reporting the loss in weight in terms of moisture. Ash in the egg is readily determined by incineration from

dried sample at about 750°C for 8 hours by muffle furnace. Protein content in the egg was determined and demonstrated. The fat content was determined by Soxhlet method.

D. *Cholesterol Evaluation*

The cholesterol content of the eggs was determined using the method of Richmond (16) and Allain *et al.,*(17).

E. *Fatty Acid Determination*

Fatty acids of eggs were determined by A.O.A.C official method (15).

F. *Lipid Peroxidation Determination*

Malondialdehyde (MDA) method stated by Raharjo and Sofos (18) was used for assessing the extent of lipid peroxidation of egg samples.

G. *Mineral Determination*

The samples were burned in a muffle furnace at 550 °C for 6 hours, and the ashes were dissolved in concentrated hydrochloric acid (Merck). Sodium and potassium were determined by flame photometry (Micronal B260) and phosphorus by visible spectrophotometry (Femto 600s), via the ammonium phosphovanadomolybdate. The mineral analyses were performed according to AOAC official method (15). All reagents used in the analysis were of analytical grade.

H. *Sensory Evaluation*

A total of 70 eggs 10 for each of the strains were placed in boiled water 5 minutes and allowed to be cooled for 10 minutes in cold water. Ten trained panelists were used for this assessment they were served the whole egg and allowed to break it themselves to access the ease of breaking. The panelists were provided with cool water to rinse their mouth after every sample. A 9 points hedonic scale (9 = extremely like condition while the lowest score was 1 for the poorest condition) was used to judge for shell colour, ease of pealing, albumen colour, yolk colour, smell, taste, texture and overall acceptability.

I. *Statistical Analysis*

Data collected were subjected to Analysis of Variance using SAS (19). Means were separated by Duncan's range option of the same statistical softwares.

III. RESULTS

The proximate and cholesterol composition of six different poultry eggs is presented in Table 1. The result revealed that significant ($P<0.05$) differences exist for all the parameters except in ash content. Eggs from Turkey hens was highest ($P<0.05$) for CP closely followed by the Exotic hens. Quail and Duck eggs were statistically ($P>0.05$) similar while the lowest values was found in Guinea fowl eggs. Eggs from the local hen were lowest ($P<0.05$) in terms of the ether extract when egg from exotic and duck hens present the highest ($P<0.05$) values.

Table 1. Proximate and Cholesterol composition of six different poultry egg types.

Parameters	Guinea fowl	Quail	Local fowl	Exotic fowl	Turkey	Duck	Pigeon	SEM
Crude protein	9.85^{d}	10.43^{c}	9.21^{e}	11.35^{b}	12.80^{a}	10.63^{c}	10.67^{c}	1.24
Ether extract	9.56^{bc}	9.69^{b}	9.21^{c}	10.71^{a}	10.04^{b}	10.83^{a}	10.73^{a}	1.19
Ash content	0.80	0.87	0.90	0.92	0.91	0.97	0.90	0.43
Moisture content	73.90^{ab}	71.23^{b}	72.18^{b}	77.16^{a}	73.10^{ab}	68.26^{c}	68.20^{c}	4.21
Dry matter	26.10^{b}	28.77^{c}	27.82^{c}	22.84^{d}	26.90^{b}	31.74^{a}	31.20^{a}	2.86

^{a,b,c,d,e} Means along the same row with different superscripts differ significantly (P<0.05).

The differences in protein may be as a result of diets variation or due to differences in climate conditions. The recommended daily allowance of protein for children, adults male, adults female, pregnant women and lactating mother are 28, 63, 50, 60, and 65 respectively (20). Although, the protein contents of the eggs samples are not up to the recommended daily allowance yet, egg serve as a good source of protein for human nutrition. The values of the ether extract were within the range reported by Isah *et al.* (21). The consumption of fat and oil is advised not to exceed the recommended daily allowance of not more than 30 calories to avoid obesity (21, 22). Samples with high ash contents are expected to have high concentration of various mineral elements which are expected to speed up metabolic process, improve growth and development.

Table 2 shows the mineral composition of egg types of poultry species. No significant differences (p>0.05) were in the calcium and phosphorous compositions of the eggs. However, the phosphorus level of local and guinea fowls were higher compared to other eggs. The Potassium (mg/L) and Sodium (mg/L) levels were highest (P<0.05) in exotic egg (268.24mg/L and 286.54mg/L respectively) while the lowest (P<0.05) values were found in guinea fowl and duck eggs respectively.

Table 2. Mineral Compositions of eggs from different avian species.

Parameters	Guinea Fowl	Quail	Local Fowl	Exotic Fowl	Turkey	Duck	Pigeon	SEM
Calcium (%)	0.04	0.02	0.04	0.02	0.04	0.034	0.04	0.13
Potassium (mg/L)	167.27^{c}	221.12^{b}	175.56^{c}	268.24^{a}	227.38^{b}	177.14^{c}	210.6^{b}	4.61
Sodium (mg/L)	128.28^{c}	222.34^{b}	155.26^{d}	286.54^{a}	205.01^{c}	122.57^{c}	272.6^{a}	3.21
Phosphorus (%)	0.40	0.22	0.42	0.28	0.32	0.34	0.3	0.19

^{a,b,c,d}Means along the same row with different superscripts differ significantly (P<0.05).

Minerals are essential for building structural units of every living thing. The Turkey and pigeon eggs were higher in calcium and phosphorus concentration when compared with exotic egg and other egg species in this study, however, exotic egg was significantly higher in potassium and sodium. The turkey and pigeon egg had the most efficient calcium to phosphorus ratio of greater than 1, the calcium and phosphorus are important in bone, teeth and muscle metabolism (23) while exotic egg still has the highest value for sodium and potassium among all the poultry species when analyzed, however, Research showed that reducing sodium lowers cardiovascular disease and death rates over the long term (24) i.e too much of sodium than potassium when consumed is not good for health, thus could contribute high blood pressure. Moreover, Cook *et al.,* (25) had earlier reported that the higher the ratio of potassium to sodium in a participant's diet, the lower the chances of

developing cardiovascular trouble. Generally, turkey, pigeon and exotic eggs contain high concentration of mineral elements which are expected to speed up metabolic process, formation of red blood cells, and conduction of nerve cells and generally improve cell growth and development in human.

Table 3 shows the fatty acid profile of different egg types of poultry species. Turkey and guinea fowl eggs revealed highest (P<0.05) values of fatty acids (%) in stearic acid (0.15), palmitic acid (0.16), arachidonic (0.16), margaric (0.14), Linoleic (0.15) and Linolenic (0.19). Exotic fowl eggs had the highest (P<0.05) values (0.40%) of Lauric acids when compared with other egg types.

Table 3. Fatty Acid Profile of Eggs from different Poultry species.

Parameters	Guinea fowl	Quail	Local fowl	Exotic fowl	Turkey	Duck	Pigeon	SEM
Saturated fatty acid								
Lauric (12:0)	0.10^{b}	0.02^{c}	0.04^{c}	0.40^{a}	0.10^{b}	0.07^{c}	0.06^{c}	0.03
Palmitic(16:0)	0.13	0.10	0.10	0.05	0.16	0.09	0.08	0.01
Margaric (17:0)	0.14^{a}	0.10^{a}	0.11^{a}	0.05^{b}	0.14^{a}	0.10^{a}	0.09^{a}	0.01
Stearic (18:0)	0.14^{a}	0.11^{a}	0.11^{a}	0.06^{b}	0.15^{a}	0.10^{a}	0.09^{a}	0.02
Unsaturated fatty acids								
Arachidonic (20:4) n-6	0.15^{a}	0.12^{b}	0.12^{b}	0.06^{c}	0.16^{a}	0.11^{b}	0.10^{b}	0.01
Oleic (18:1) n-9	0.14^{ab}	0.04^{c}	0.11^{b}	0.06^{c}	0.15^{ab}	0.20^{a}	0.09^{b}	0.05
Linoleic (18:3) n-6	0.14^{a}	0.10^{a}	0.11^{a}	0.06^{b}	0.15^{a}	0.10^{a}	0.06^{b}	0.05
Linolenic (18:2) n-3	0.18^{a}	0.04^{b}	0.15^{a}	0.02^{b}	0.19^{a}	0.13^{ab}	0.11^{ab}	0.01

^{a,b,c,d}Means along the same row with different superscripts differ significantly (P<0.05).

Fatty acids are products from fats and oils. And fat and oil is essential as alternative source of energy, improve immune system, enhances healthy skin, as lubricants in the body, lowering cholesterol and reduces the risk of heart attack, acts as insulator against cold or foreign substances etc.

All the egg species examined (Turkey, guinea fowl, Local fowl, duck, quail and pigeon) had higher values of fatty acids (FA) when compared with exotic egg including the essential FA (Linolenic and linoleic). Turkey egg had the highest fatty acids (mono- and polyunsaturated, poly-saturated FA) values which are closely followed by guinea fowl and Local fowl egg had the third higher value while the exotic was found at the lowest. This implies that turkey, guinea fowl, Local fowl and duck can performed the above stated functions of Fat and oils better than the exotic egg. Exotic egg is high in lauric acid (saturated fatty acids - SFA), invitro and animal studies have demonstrated that SFAs can induce cellular inflammation and accelerate atherosclerosis through toll-like receptor activation (26). The lower value of linolenic acids in exotic egg may be as result of their intensive rearing of the exotic birds and their restriction from animal source feed ingredients (omega 3) FA because omega 3 FA in obtained from feed from animal source (Fish, worm, insects etc., 27) while extensive rearing of other birds and scavenging on living matters such insects, worm etc of other poultry bird species under study may constitute their higher values of linolenic present in their eggs when analyzed.

Table 4 shows the lipid composition of eggs from different poultry species. The total cholesterol of eggs from exotics layer birds was found highest (P<0.05) (390.00 mg/100g). However, turkey eggs had the highest

(P<0.05) HDL value (43.40mg/100g). The low density lipoprotein (LDL) was lowest (P<0.05) in quail eggs (22.01mg/100mg) but highest (P<0.05) in Local fowl and exotic egg (52.60 and 51.17mg/100mg respectively). Local fowl eggs had the highest level Very Low Density Lipoprotein (VLDL) (96.82mg/100mg), no significant difference (P>0.05) was found between Pigeon and Exotic eggs when compared with other eggs of poultry species. Triglyceride was highest (P<0.05) in Local fowl eggs (484.00mg/100mg) and closely followed by eggs from exotic birds (463.00mg/100mg) with the least (P<0.05) in guinea fowl eggs with 313.00mg/100mg.

Table 4. Lipid Composition of Different Egg types of Poultry species.

Parameters	Guinea fowl	Quail	Local fowl	Exotic fowl	Turkey	Duck	Pigeon	SEM
Triglycerides	313.00^{c}	215.00^{d}	484.00^{a}	463.31^{ab}	390.91^{b}	425.11^{b}	413.12^{b}	4.27
Total Cholesterol.	200.00^{d}	106.85^{f}	154.12^{e}	390.00^{a}	324.30^{b}	253.93^{c}	245.35^{c}	5.55
High Density Lipoprotein (HDL)	10.85^{d}	32.02^{b}	10.00^{d}	17.87^{c}	43.4^{a}	16.57^{c}	12.77^{cd}	2.12
Very Low Density Lipoprotein (VLDL)	82.73^{a}	44.21^{b}	96.82^{a}	92.60^{a}	58.18^{b}	85.00^{a}	92.73^{a}	2.34
Low Density Lipoprotein (LDL)	40.55^{b}	22.01^{c}	52.6^{a}	51.17^{a}	44.34^{ab}	29.01^{b}	42.53^{b}	2.44

^{a,b,c,d,e,f} Means along the same row with different superscripts differ significantly (P<0.05).

Jalaludeen *et al.,* (28) had earlier reported higher value of cholesterol for duck egg (884mg/100mg) and Isah *et al.,* (21) reported higher values for shika brown (exotic), guinea fowl and pigeon eggs. These were in contrast to the current findings which turned out to have lowest value of cholesterol in quail eggs. Studies had found that individuals vary widely in their responses to dietary cholesterol based on monitoring their plasma levels (29). Recent studies indicated that egg consumption is dangerous for people with diabetes possibly because of their altered ability to metabolize cholesterol (30, 31, 32). And moderate egg consumption led to 40-50% increased risk of heart disease for diabetics (33). Quail, guinea fowl and local eggs are good options for these categories of people.

From this current study, Quail and turkey eggs had the highest HDL, indicating an abundant high density lipoprotein which is able to transport other protein to/ across the cells for efficient functioning and build up. Quail, local and duck eggs had very low values of LDL which is an indication that they are safe for consumption when compared to the exotic eggs that had the highest value of LDL (bad lipoprotein). Exotic egg had the highest level VLDL and LDL where VLDL serves as a precursor of LDL; the bad type of cholesterol. Lipoprotein is a type of cellular protein known to be a carrier for the transport of other protein. High density lipoprotein (HDL) is regarded as a “good lipoprotein” that is beneficial and cause no adverse cardiovascular health issues while LDL is regarded as “Bad lipoprotein” which when in high level, it is associated with increased risk of health and cardiovascular related issues such as narrowing or blocked Blood vessel (peripheral artery disease), heart attack, hypertension, myocardial infarction, chest pain (Angina), coronary heart disease and stroke (34). In controlled metabolic studies conducted in humans, the dietary cholesterol raises the total LDL cholesterol levels in blood (35), the effects are relatively small if compared with saturated trans fatty acid (36).

The panelist rated (P<0.05) eggs from exotic and turkey hens far better than other in terms of shell colour (T-

-able 5). The ease of pealing strongly favoured ($P<0.05$) the exotic eggs. No differences ($P>0.05$) were observed with their perception on albumen colour they however rated eggs from exotic and Duck hens highest ($P<0.05$) than others in terms of yolk colour.

Table 5. Sensory evaluation of six different poultry egg types.

Parameters	Guinea fowl	Quail	Local fowl	Exotic Fowl	Turkey	Duck	Pigeon	SEM
Shell colour	5.70^{b}	4.50^{c}	4.50^{c}	8.40^{a}	7.90^{a}	5.30^{b}	5.40^{b}	0.45
Ease of pealing	5.50^{bc}	6.70^{b}	6.30^{b}	8.00^{a}	4.00^{c}	4.30^{c}	4.20^{c}	0.52
Albumen colour	6.90	7.01	6.90	7.50	7.10	6.90	7.00	1.01
Yolk colour	6.40^{c}	6.40^{c}	7.00^{b}	8.00^{a}	6.30^{c}	8.00^{a}	8.00^{a}	1.04
Smell	6.20^{ab}	6.10^{ab}	5.00^{b}	7.00^{a}	6.40^{a}	6.00^{ab}	6.00^{ab}	0.04
Taste	6.00^{b}	8.00^{a}	4.20^{d}	7.80^{a}	5.00^{c}	5.00^{c}	5.10^{c}	0.24
Texture	6.70^{b}	7.00^{a}	6.40^{b}	7.30^{a}	5.00^{c}	6.00^{c}	6.00^{c}	0.26
Overall Acceptability	7.30^{b}	8.10^{a}	7.00^{b}	8.40^{a}	7.00^{b}	6.80^{b}	6.80^{b}	0.40

IV. Discussion

This result confirmed the report of Olugbemi *et al.* (37) which also stated that yellow yolk colour is an important factor for consumer satisfaction. They further rated the smell of egg the same way except for local and exotic eggs that were rated lowest and highest respectively. The panelist however preferred eggs from quail and exotic hens most for taste, texture and overall acceptability. These results contradicted the report of Olugbemi *et al.* (37) who revealed that consumers could not detect the difference in smell and texture of hard boiled eggs. The variation might be as results of the different diets fed to the birds as feed composition affect the taste and overall acceptability of eggs by the consumers (38).

V. Conclusion

Exotic eggs were better in terms of mineral compositions, ease of pealing, shell and york colour. Turkey eggs were good choice for crude protein with highest values for fatty acid profile. Quail eggs were also favoured comparatively for lipid profile especially in total cholesterol and very low density lipoprotein. Egg played a vital role in human nutrition and the knowledge of the nutrient composition from various species will serve as nutritional guide in food composition table as well as valuable information on it nutrient intake. This study has revealed that lesser known poultry specie eggs (Guinea fowl, quail, local fowl) offer consumers good alternatives (nutritionally, culinary and sensorial) to the most common exotic poultry egg with limited risk to human health.

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