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EFFECT OF OVEN DRYING ON THE NUTRITIONAL PROPERTIES AND SENSORY CHARACTERISTICS OF EGG POWDER FROM DIFFERENT POULTRY SPECIES

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Abstract

Nutritional content such as protein, carbohydrate and fat are some of the important properties of an egg which play important culinary roles for the maintenance of the human body system through a proper balanced diet. This study was aimed at determining the effects of oven drying on the nutritional properties and sensory characteristics of eggs obtained from layer chickens, quail and turkey birds. About 1000g of liquid egg for each of the three poultry species was dried at 60°C for the study. The necessary parameters such as moisture content, crude protein, ether extract, ash and the cholesterol level were all recorded using standard procedure. Data were analyzed using descriptive statistics and ANOVA at 0.05 Sensory characteristic for both the flavour and aroma showed no significant difference at (P<0.05) with values ranging from (2.50±0.27-3.50±0.34) for flavour and (2.30±0.37-3.30±0.26). The nutritional composition determined showed high values when compared to that of fresh eggs, this is an indication that the drying temperature of 60°C did not adversely affect the nutritional value of the oven dried egg components. This study will helps to provide information on the effect of oven drying egg on functional and nutritional ability.

Keywords:
Processing, Egg, Sensory properties, Temperature, Poultry

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Introduction

Eggs are an excellent source of high quality protein, vitamins and minerals. Human being require protein for building of their body structures because we depend upon animal protein that supply of amino acids which are essential for our body system (Weggemans *et al.,* 2001). Eggs also have vitamins, particularly vitamin E (tocopherols), vitamin A (retinol), vitamin B_{12} (cyanocobalamin), vitamin B_2 (riboflavin) and folic acid (Surai *et al*., 2001).

Dietary protein is utilized by the human body to maintain and build muscular organs and other body organs like nerves, blood and bones. Quality of protein is determined by how effectively the human body can utilize it for growth. It has been revealed that eggs contribute the highest food protein quality known after mother's milk. The FAO of the United Nations, rated the whole egg protein's biological value at (93.7) which is based on a 100-point scale, followed by biological value of cow's milk (84.5), biological value of fish (76), biological value of beef (74.3), biological value of soybeans (72.8), biological value of polished rice (64), biological value of whole wheat (64), corn (60) and biological value of dry beans (58).

Human body can synthesize some amino acids which are referred to as non-essential amino acids while other amino acids which human body cannot synthesize are called essential amino acids. Eggs have all nine amino acids which are essential to our body and so called essential amino acids (EAA) including histidine, leucine, lysine, isoleucine, threonine, tryptophan, methionine, phenylalanine, and valine. Because the essential amino acids in egg protein have the same pattern as the pattern of amino acids needed by the human body that's why egg is often utilized as a standard of comparison for determining the quality of protein with other foods (American Egg Board, 1999). In addition to this, eggs are very good sources of leucine. Leucine is an EAA that increases the energy using ability of muscles and helps muscle recovery after resistance and dynamic exercises; muscles utilize complementary effect between glucose and leucine so men and women doing resistance exercise can have advantage from leucine rich diet. Even more, leucine is an important element in regulation of muscles and synthesis of protein and may be the key amino acids optimizing the skeletal muscle mass by defining increased EAA need (Layman & Rodriguez, 2009).

Eggs contribute little to considerable quantity of all minerals and vitamins which are known to be needed by the human body, excluding vitamin C (AEB, 1999). Eggs are also an excellent source of choline, folate, and selenium, nutrients which are required for normal development of brain (Herron & Fernandez, 2004). An egg has two important parts: the egg white (albumen), and the egg yolk. Both the white and the yolk contribute essential nutrients to the human body.

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An average large egg contributes 6.25 g of high-quality protein based on 10-12.5% of the Daily Reference Value for protein, and 5 grams of mostly unsaturated fat. according to Weggemans *et al., (*2001)one large egg also contributes around 200 milligrams of cholesterol, which nearly meets the dietary cholesterol intake limit as established by the American Heart Association at ≤ 300 mg/d; and eggs are not a good source of fibre and carbohydrates (AEB, 1999). Cholesterol is a compound of sterol type that is present in most body tissues. It is an important constituent of cell membranes and precursor of other steroid compounds but high concentration of it in the body may predispose the body to atherosclerosis which is the deposition of cholesterol in the arterial vessels. The formula for cholesterol is $C_{27}H_{46}O$ with molar mass 386.65g/mol, melting point of 148°C and boiling point 360°C. The body needs some cholesterol to produce hormones, vitamin D and some components that participate in food digestion. It is of interest to note that the body is capable of producing the cholesterol that it needs, hence, the extra consumed from foods may predispose the body to some ill health states or conditions.

Poultry eggs have been identified as a rich dietary source of cholesterol and many have been cautious in its inclusion in their diets. The clamour for low cholesterol diet has drawn the attention of many to the preference of quail eggs over chicken eggs owing to the claim that the former is lower in cholesterol but little attention has been paid to the effect of storage on the cholesterol content of these eggs. The conflicting nature of past scientific findings on the comparison of cholesterol content of both chicken and quail eggs demands the exploration of this concept. It was reported that the egg yolk of exotic chicken (ISA Brown) was 243.8mg/dl which was higher than that of Japanese quail that was observed to be 80.60mg/dl (Olugbemi *et al*., 2013). On the other hand, it was reported that there existed no significant difference in the cholesterol content of Brazilian chicken egg yolk and that of quail eggs (Bragagnolo *et al*., 2013). All yolks from the birds especially that of ostrich, were found to be excellent sources of lecithin (Sinanoglou *et al.,* 2011).

Justification of the Study

Eggs are used in the preparation of many food products. Egg glut is one of the major problems experienced by most farmers in Nigeria due to factors such as government policies, poor storage facilities, poor road network, etc, all these can be curtailed by value addition to egg. Evaluation of nutritional and sensory properties of oven dried eggs can help project areas that can be improved upon to curtail these seasonal losses for a better shelf-life.

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Objectives of the Study

The objectives of the study are to;

1. To evaluate the nutritional properties of oven dried eggs from different poultry species.
2. To evaluate the sensory characteristics of custard produced from the egg powder from different poultry species.

MATERIALS AND METHODS

Three treatments namely chicken, turkey and quail with three (3) replicate each, were used for the study. Freshly laid eggs were used for the research.

Powdered egg was produced by de-shelling a whole egg into a plastic bowl and homogenized. The samples were oven dried at 60°C for 27hrs and allowed to cool. The egg liquids were weighed before and after drying. The egg powders were packed into different air tight plastic films for further evaluation. Produced egg powders were used as a treatment in the production of three different egg custard which were compared with local custard.

The composition of the local custard was edible maize starch, milk powder, sugar, milk flavour and sunset yellow. The custards were also with the produced egg powder which was then compared with local custard. The produced egg custard comprised of corn flour(15g), vanilla extract(6g), produced powdered egg(8g), sugar(15g) and milk(20g) according to (Allrecipes.com 2016).These were all thoroughly mixed together with a blender before hot water was added for sensory evaluations while the determination of it nutritional composition was done for the powdered form.

VARIABLES RECORDED

Proximate Composition (Nutritional quality):

The proximate composition for both the egg powders produced and the three different custards was evaluated according to AOAC (2000) procedure.

Moisture Content

Moisture content determination was carried out using the air oven method. Crucibles were washed and dried in an oven. They were allowed to cool in the desiccator and the weight was noted. The samples were dried at temperature 60°C for 3 days. The dried samples were cooled in a desiccator and weighed. They were later returned to oven and the process continued until constant weights were obtained.

$$MC = \frac{\text{Weight of sample before drying (g)} - \text{Weight of sample after drying (g)}}{\text{Weight of sample before drying}} \times 100$$

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Crude Protein

The crude protein content was determined using micro Kjeldahl method as described (AOAC, 2000). 0.5g of sample was weighed into a long necked Kjeldahl flask. 1 tablet of Kjeldahl catalyst was added to the sample in the flask with 25cm^{3}of concentrated H_2SO_4. The flask was swirled, gently clamped in an inclined position and heated in a fume cupboard. The heating continued until a clear solution was obtained. The clear solution was cooled, then poured into a 100cm^3 volumetric flask and made up to mark with the distilled water. 10 ml of the resulting mixture was measured into the distillation set through the funnel. 5cm^3 of boric acid was pipetted into a 100cm^3 conical flask and placed at the receiving end of the distillatory.

The conical flask was placed such that the delivery tube dipped completely into the boric acid inside the flask. 40% NaOH was used to liberate ammonia out of the digest under alkaline condition. During the distillation, 2 drops of methyl orange were added to the round bottom flask containing the digested sample before 40% NaOH was added. As soon as the content became alkaline, the red colour changed to yellow showing NaOH to be in excess. Steam was then generated into the distillation set using a steam chest. The liberated ammonia was trapped in the boric acid solution and about 50cm^3 if the solution was collected into the conical flask. The solution in the flask was titrated against 0.1M HCL until the first permanent colour change was observed. A blank sample was used in the sample procedure and the titre value for the blank was used to correct the tire for the sample.

$$\%N = \frac{0.01 \times 0.014 \times t\ (250/\ 5 \times 100)}{\text{Weight of sample (g)}}$$

0.01 = molarity of HCL 0.014 = mole equivalent of nitrogen
t = titre value of HCL N = nitrogen sample

*****The determination of nitrogen allows the calculation of the protein content of the sample. The crude protein content was determined by multiplying percentage nitrogen by a constant factor of 6.25(since the average protein contains 16% nitrogen).

Ash Value

1g of dried samples was weighed into clean, dried preciously weighed crucibles. The samples were ignited over a low flame to char the organic matter using and electro thermal heat. The crucibles were then placed in muffle furnace at 600°C for hours until

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it ashed completely. The ashed samples were then transferred directly to desiccator, cooled and weighed immediately.

$$\% \text{ ash} = \frac{\text{Initial weight (g)} - \text{ash weight (g)}}{\text{Initial weight (g)}} 100$$

Ether Extract (crude fat)

The **s**oxhlets extraction method was used. 1g of sample was weighed into a weighed filter paper and folded neatly and then placed inside pre-weighed thimble. The thimble was inserted into the Soxhlets apparatus and extraction under efflux was carried out with petroleum ether (40°C-60°C) boiling range for 7 hours. At the end of extraction, the thimble was dried in the oven for about 30minutes at 100°C to evaporate off the solvent and thimble was cooled in a desiccator and later weighed.

The fat extracted from a given quantity of sample was then calculated:

$$\% \text{ Fat} = \frac{\text{Initial weight of sample (g)} - \text{final weight of sample (g)}}{\text{Original weight of sample (g)}} \times 100$$

Nitrogen Free Extract

The percentage Nitrogen Free Extract was calculated from subtracting the obtained percentage crude protein, ash, moisture and ether extract from 100

%NFE = 100 – (% crude protein + %ash + % moisture + ether extract)

RESULTS AND DISCUSSION

Nutritional composition

The nutritional composition determined are showed in Table 1 below, the table details the results with high values when compared to that of fresh eggs (Mark, *et al*. 2013). This is an indication that the drying temperature of 60°C did not adversely affect the nutritional value of the oven dried egg components. The crude protein and ether extract value recorded were all lower than that recorded by (Joel *et al.,* 2010 and Kenawi *et al.,* 2015). The result obtained for the moisture content of (8.63, 8.80 and 8.90%) for chicken, quail and turkey egg powder was higher than (2.74%) recorded by (Kenawi *et al*., 2015). The difference might be due to different temperature (44°C) used in the oven drying process.

Crude protein was highest for product from turkey (22.2±0.1%) followed by chicken (22.2±0.1%) and least in quail (21.8±0.1%), this might be due to the low moisture and ether extract recorded for CE The statistical analyses showed that these differences were significant at ($P<0.05$), it was the opposite for the ether extract which showed

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no significant difference at (P<0.05) with values of (25.2±0.1%, 25.3±0.1% and 25.20±0.06%) for chicken, quail and turkey egg powder respectively.

Table 1: Proximate Composition of Egg Powder

Parameters %	Chicken	Quail	Turkey
Moisture Content	8.63±0.09^{b}	8.80±0.00^{ab}	8.90±0.00^{a}
Crude Protein	22.20±0.06^{a}	21.77±0.09^{b}	22.23±0.09^{a}
Ether Extract	25.17±0.09	25.30±0.06	25.20±0.06
Ash Content	9.30±0.06^{b}	9.53±0.03^{a}	9.13±0.09^{b}
Nitrogen free extracts	35.57±0.07	35.60±0.12	35.53±0.03
Cholesterol (mg/100g)	35.33±0.12^{a}	34.83±0.35^{a}	32.10±0.00^{b}

^{a,b,ab} Means with different superscripts in the same row differ significantly (p < 0.05) .

CE= Chicken egg powder

QE=Quail egg powder

TE= Turkey egg powder

The variation observed may be due to basal diet, strain of birds, feed intake level and age. The moisture contents (MC) which refers to the water content of the sample are low enough to extend the shelf life of the egg powders in an environment of low humidity (Jay, 2000). Moisture result obtained rage from (8.6±0.1-8.9±0.0%) with the lowest value recorded for chicken egg powder predicting a longer shelf-life than the other product. The statistical analysis showed that these differences were significant at (P<0.05). McLean *et al* (2002) stated that moisture content of foods above 15% will favour microbial activities which will result to food spoilage.

The high Nitrogen free extract (NFE) recorded particularly in quail egg powder (35.60±0.12%) makes it particularly attractive for infant food formulae (Krause and Maham, 1984; Vaclavik and Christain, 2008). The oven dying temperature of 60°C did play a role in the difference of the nutritional composition across the three species. Ash content which is a good indicator of the physiochemical properties of processed food was determined and showed a significant difference at (P<0.05) with the highest recorded for quail (9.5±0.0%), (9.3±0.1%) chicken and the lowest for turkey (9.1±0.1%) these results were higher than those recorded by (Joel Ndife *et al.,* 2010; Kenawi *et al.,* 2015). The ash concentration and type of minerals they contain determines food quality including their taste, appearance, texture and stability. The difference might be as a result of the feed and also the variation in specie.

Table 2: Proximate Composition of Egg Powder Custard

Parameters (%)	LC	CE	QE	TE
Moisture Content	8.43±0.09	8.63±0.03	8.63±0.09	5.87±2.94
Crude Protein	2.13±0.09^{c}	11.13±0.09^{a}	10.63±0.09^{b}	10.80±0.06^{b}

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Ether Extract	0.53±0.09^{b}	8.60±0.06^{a}	8.77±0.09^{a}	8.67±0.09^{a}
Ash Content	1.77±0.09^{c}	2.13±0.03^{b}	3.27±0.09^{a}	3.20±0.06^{a}
NFE	87.13±0.09^{a}	66.70±0.10^{b}	66.70±0.15^{b}	66.47±0.09^{b}
Cholesterol(mg/100g)	0.00±0.00^{d}	0.12±0.00^{b}	0.15±0.00^{a}	0.10±0.00^{c}

a,b, Means with different superscripts in the same row differ significantly ($p < 0.05$).

LC= Local custard

CE= Chicken egg powder

QE=Quail egg powder

TE= Turkey egg powder

Table 2 above shows the analysis of variance for the nutritional components of the local custard and that produce with the oven dried egg. There was a significant difference between the treatment and the control and this result may be due to low presence of egg ingredient in the control. Although the moisture content for both the treatments and control showed no significant difference. The protein value of 11.13% was recorded for chicken which was higher than that of quail and turkey of 10.63 and 10.80% respectively while it was the opposite for the ash value which was high for both the quail (3.27%) and turkey (3.20%) than that of the chicken egg powder (2.13%).

Cholesterol

The cholesterol content of an egg is one of its most important nutritional components because of its potential to be used in infant formula, health foods and nutritional supplements. It is an important constituent of cell membranes and precursor of other steroid compounds.

The result obtained for cholesterol levels for the oven dried eggs and their respective products were analyzed and presented in table 1. A value of 32.10(mg/100g) was recorded for turkey egg powder which was lower and statistically different at ($P<0.05$) from that of chicken 35.33(mg/100g) and quail 34.83(mg/100g). The cholesterol content in egg of chicken and quail as reported by (Aziz *et al*, 2012 and Sujatha *et al*., 2014) was higher than that observed in this study. The variation in cholesterol contents of the egg species can result from difference in the species, diet, genetics, drying conditions, liquid state etc. The ratio of water to proteins and lipids (Lecithin) found mostly in the yolk must have also contributed to the difference in cholesterol level (Okezie and Bello, 1988 and Bueschelberger, 2004).

Sensory Evaluation

Table 3 below shows the statistically analyzed result for the sensory assessment consisting of 10 individuals and post graduate students evaluate the sensory characteristics of egg custard for their appearance and colour, flavour, consistency,

aroma, and overall acceptability using 5-Point objective Scale (Bille *et al*., 2002), where 5 denoted extremely desirable and 1 denoted extremely poor.

The point scale used were flavour (1-2,perceptible; 3, intermediate; 4-5 intense), consistency (1-2, watery; 3,intermediate; 4-5, thick), aroma (1-2,perceptible; 3,intermediate; 4-5 intense) colour (1-2, dark; 3, intermediate, 4-5, light), sweetness (1-2, plain; 3, intermediate; 4-5, sweet) and overall acceptability (1-2, dislike; 3, intermediate; 4-5, like).

Table 3: Sensory Analysis of Egg Powder Custard

Parameters	LC	CE	QE	TE
Flavour	2.50±0.27	3.00±0.39	3.50±0.34	3.20±0.33
Consistency	4.20±0.29^{a}	2.60±0.31^{b}	3.70±0.21^{a}	1.60±0.16^{c}
Aroma	2.30±0.37	2.80±0.49	3.30±0.26	2.70±0.34
Colour	2.90±0.32^{b}	3.90±0.23^{a}	3.80±0.20^{a}	4.20±0.20^{a}
Sweetness	2.70±0.30^{c}	4.60±0.16^{a}	4.60±0.16^{a}	3.90±0.23^{b}
Acceptability	3.80±0.13	3.60±0.40	4.20±0.29	3.40±0.34

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

LC= Local custard

CE= Chicken egg powder

QE=Quail egg powder

TE= Turkey egg powder

Sensory characteristic for both the flavour and aroma showed no significant difference at (P<0.05) with values ranging from (2.50±0.27-3.50±0.34) for flavour and (2.30±0.37-3.30±0.26). The two highest values were recorded for quail egg custard. Characteristics such as consistency, colour and sweetness showed significant difference among each other. The consistency which is an indication of the custard thickness was significantly different among the product, the local custard was the highest recorded (4.20±0.29) followed by (3.70±0.21, 2.60±0.31 and 1.60±0.16) for quail, chicken and turkey egg custard respectively at (P<0.05). Obtained result also varied across the product with chicken and quail custard recording the same value of (4.60±0.16) which was the highest followed by turkey (3.90±0.23) and the lowest for the local custard (2.70±0.30).

The major difference was between the controlled treatment local custard (LC) and the three main treatment namely (chicken, quail, and turkey egg), the variation in result might be due to the use of high percent of corn flour in LC instead of a the required egg level. This fact can influence the panellists' responses about these sensory factors, as observed. Although, the overall acceptability showed no

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significant difference across the product at (P<0.05), but there was some numerical difference, with values ranging from (3.40±0.34-4.20±0.29) with the highest result obtained for the quail egg custard.

The data presented in Table 3, after analysis of variance at (P<0.05), showed that the custard prepared with an oven dried egg products had good acceptance by panellists in comparison with the locally made one.

CONCLUSION

This study showed that the whole egg powder, can be produced using the oven drying method, at controlled temperature of 60°C without adversely affecting it nutritional and sensory properties. Hence they could be incorporated as nutritive ingredients in the production of healthy food products. Turkey egg powder had the highest value for the crude protein while the highest value of (25.30) for ether extract was recorded for quail egg powder. The lowest moisture content was recorded for chicken egg powder with quail egg having the highest nitrogen free extract when compared to the other egg powders. The highest cholesterol content of (35.33mg/100g) was recorded chicken egg powder. The quail egg can be concluded to be the preferred choice with a slight advantage over chicken and turkey egg powder in terms of the nutritional ability.

Recommendation

- It is also recommended that storage days should studied to indicate the shelf life of the product
- Varying level of egg powder should be incorporated into the custard product for further evaluation of nutritional composition
- Further, studies should be undertaken to assess the effects of different oven temperature and evaluation of other bird species and could help establish a better functional properties.

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