

NUTRITIONAL COMPOSITION OF OVEN DRIED EGGS PRODUCED FROM ISA-BROWN HENS FED COMPOSITE LEAF MEAL-BASED DIETS

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ABSTRACT

The study investigated effects of diet compositions on nutrient composition of oven dried eggs. Eggs were obtained from birds fed composite leaf meal (CLM) and separated as egg white, egg yolk and whole egg. The separated portions and whole egg were homogenized separately. The samples were oven-dried at 40°C and allowed to cool. The different portions of the egg flakes were milled, sieved and proximate analysis was done. For the egg white, highest crude protein (71.83%) was recorded in egg from birds fed 5% CLM and lowest (62.88%) in egg from birds fed 0% CLM. For egg yolk, highest carbohydrate 38.66% was observed in egg from bird fed 0% CLM and lowest 25.50% in egg from bird fed 5% CLM. Food energy varied; 528.02g/cal to 544.56g/cal in egg obtained from bird fed 2% and 1% CLM, respectively. The crude protein of the whole egg varied; 48.40% (0%) - 56.15% (5% CLM). From the results, it could be concluded that the nutrient composition of the egg white, egg yolk and whole egg were affected by the levels of CLM in the diet.

Keywords: nutrient composition; bird; composite leaf meal; egg; egg powder.

INTRODUCTION

The egg is formed in the mature hen by a reproductive system composed of an ovary and oviduct. The egg is one of the most complete and versatile foods available. It consists of approximately 10.5% shell, 58.5% white and 31% yolk Jones *et al.* (2015). Neither the colour of the shell nor that of the yolk affects the egg's nutritive value. The average egg provides approximately 162 energy (kcal) Jones *et al.* (2015). Eggs are a good source of high-quality protein, they provide important sources of iron, vitamins and phosphorus Pandey (2015). As a nutritional value as a major supplementary source of iron for infants. Low caloric value, ease of digestibility and high nutrient content make eggs valuable in many therapeutic diets for adults Pandey (2015). Egg

quality is a general term which refers to several standards which define both internal and external quality. Interior egg quality is based on air cell size, albumen quality, yolk quality, and the presence of blood or meat. Maintenance of egg quality is a major problem for those involved in egg marketing. Eggs soiled by droppings or the contents of leaking or broken eggs spoil faster than clean eggs and therefore there is a need to turn such eggs into powder to preserve its shelf life. Processing protects the egg against spoilage during storage. The egg is bulky, as it is about 74% water. Drying form of processing removes water and allows for more egg solids to be stored or transported. Storage space is saved through drying. We may also process into egg powder during the period of peak production, eggs are processed and stored and these are released to the market when production falls or during scarcity. Quality determines the acceptability of a product to potential consumers. The quality of eggs and their stability during storage are largely determined by their physical structure and chemical composition Pandey (2015). This study is therefore aimed at determining the effects of oven drying on the nutritional properties of whole egg, egg yolk and egg albumen.

MATERIALS AND METHODS

Experimental sites

The fieldwork of this study was carried out at the Poultry Unit of the Teaching and Research Farm, of The Federal University of Technology, Akure, Nigeria, while the Laboratory assessment (Egg analysis) off eggs collected from the fieldwork was done at the Nutrition Laboratory of the Department of Animal Production and Health, Federal University of Technology, Akure, Nigeria. The towns are located within Latitude 7°20" N and Longitude 5° 12" E, the rainfall of the humid tropics which is characterized by the hot and humid climate. The mean annual rainfall is 1800mm and the rain period is bimodal with a short break in August. The altitude is about 323.03m above the sea level, the mean annual humidity is less than 70% and the mean annual temperature ranges between 22 - 30°C (Ashaolu and Adebayo, 2014).

Composite leaf meal production

Leaves from five (5) selected plants (Cassava, Moringa, Fluted pumpkin, African basil, and Bitter leaves) were "harvest" and air-dried. The air-dried leaves were milled using hammer mill and stored in plastic container prior to use. Thereafter, the leaves were mixed together in the same ratio (1:1:1:1:1) to produce the composite leaf meal.

Experimental diets

The commercial premix in the basal diet was reduced by 0, 20, 40, 60, 80 and 100% and replaced with 0, 10, 20, 30, 40 and 50gkg⁻¹ composite leaf meal designated as diets I, II, III, IV, V and VI, respectively. The gross composition of the experimental diet is shown in Table 1.

Table 1: Gross composition (g/kg) of the experimental diets

Ingredients	Diet I	Diet II	Diet III	Diet IV	Diet V	Diet VI
Maize	542.50	528.00	513.50	499.00	484.50	470.00
Soybean meal	120.00	120.00	120.00	120.00	120.00	120.00
Groundnut cake	90.00	90.00	90.00	90.00	90.00	90.00
Brewer's dried grain	40.00	40.00	40.00	40.00	40.00	40.00
Wheat offal	110.00	110.00	110.00	110.00	110.00	110.00
Bone meal	30.00	30.00	30.00	30.00	30.00	30.00
Oyster shell	60.00	60.00	60.00	60.00	60.00	60.00
*Premix	2.50	2.00	1.50	1.00	0.50	0.00
Composite mix	0.00	10.00	20.00	30.00	40.00	50.00
Methionine	1.00	1.00	1.00	1.00	1.00	1.00
Lysine	1.00	1.00	1.00	1.00	1.00	1.00
Salt	3.00	3.00	3.00	3.00	3.00	3.00
Vegetable oil	0.00	5.00	10.00	15.00	20.00	25.00
Total	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
Calculated analysis						
Crude Protein (g/kg)	170.80	172.50	174.20	176.90	177.60	180.10
Metabolizable energy (MJ/kg)	10.94	10.92	10.90	10.87	10.85	10.83
Calcium (g/kg)	34.40	34.40	34.40	34.40	34.40	34.40
Available Phosphorus (g/kg)	7.10	7.10	7.10	7.10	7.10	7.00

* Contained vitamins A (8,500,000 IU); D3 (1,500,000 IU); E (10,000mg); K3 (1,500mg); B1 (1,600mg); B2 (4,000mg); B6 (1,500mg); B12 (10mg); Niacin (20,000mg); Pantothenic acid (5,000mg); Folic acid (500mg); Biotin H2 (750mg); Choline chloride (175,000mg); Cobalt (200mg); Copper (3,000mg); Iodine (1,000mg); Iron (20,000mg); Manganese (40,000mg); Selenium (200mg); Zinc (30,000mg); and Antioxidant (1,250mg) per 2.5kg

Experimental birds and design

A total number of two hundred and forty (240) Isa-Brown pullets were procured at point of lay (POL) from Synermight Farms, Ibadan, Nigeria were used for this study. The birds were housed in a 3tier California type colony cages (43×41cm), 2 birds per cage unit, 5 cage units per replicate, and 4 replicates per treatment making a total of 60 birds per treatment in an open-sided, naturally ventilated experimental hen house. The cages were equipped with open galvanized feeders and aluminium water troughs. The experimental design was a Complete Randomized Design. The duration of the experiment was 112 days. The 112 days was subdivided into 4 phases of 28 days per phase. Each bird was given 110g/day of the treatment diets. Water was provided *ad libitum* throughout the experimental period.

Egg collection

The egg collection periods were tagged morning (7:00am – 8:00am), afternoon (1:00pm – 2:00pm) and evening (4:00pm – 5:00pm). Eggs collected were labelled with the aid of a permanent marker and sealed up in transparent white polythene nylon and then taken to Nutrition Laboratory of the Department of Animal Production and Health, Federal University of Technology, Akure, Nigeria for the egg proximate analysis.

Egg proximate analysis

Thirty (30) fresh good quality shell eggs were obtained from each treatment and were divided into three (3) of ten (10) eggs per egg white, yolk and whole egg. They were carefully deshelled and homogenized. The samples were oven-dried at 40°C using (UNISCOPE Oven, SM 9052 Laboratory Incubator, Surgifriend Medicals, England) and allowed to cool. The egg flakes were scooped, milled and then sieved. The nutritional quality of the egg and its components were assessed using their proximate compositions as a guide. The AOAC (2005) methods were used in determining the moisture content, while the ash content was determined by the furnance method. The crude protein content was determined using the Kjeldahl method. The fat content was determined using ether extraction by reflux soxhlet method, while the carbohydrate was calculated by difference and the food energy values (FEV) estimated by the method described by Osuagwu (2008). The graphical description of the whole study is presented in Plate 1.

Statistical Analysis

Data collected were subjected to one-way analysis of variance using SPSS version 13 package and where significant differences are found; the means were compared using Duncan Multiple Range Test of the same package.

Graphical Abstract of Nutritional Composition of Oven Dried Eggs Produced from Isa-Brown Hens Fed Composite Leaf Meal-Based Diets



Plate 1: Graphical description of the whole study

RESULTS AND DISCUSSION

Tables 2, 3 and 4 shows the analyzed proximate properties of egg white powder, egg yolk powder and whole egg powder, respectively. The moisture content of the egg white powder varied from $4.09 \pm 0.67\%$ in eggs collected from birds fed 1% composite leaf meal to $5.94 \pm 0.67\%$ in eggs from birds fed 0% composite leaf meal. Values recorded for Ash followed a particular trend. As the level of composite leaf meal increased, the values for the ash increased. Ash content ranged from $1.21 \pm 1.40\%$ in eggs from birds fed 0% composite

leaf meal to $4.93\pm 1.40\%$ in eggs collected from birds fed 5% composite leaf meal. The crude protein of the egg white powder varied from $62.88\pm 3.27\%$ in eggs obtained from birds fed 0% composite leaf meal to $71.83\pm 3.27\%$ eggs from birds fed 5% composite leaf meal. The ether extract reduced as the levels of the composite leaf meal increased; $5.78\pm 1.39\%$ in eggs from birds fed 0% composite leaf meal and $2.11\pm 1.39\%$ in eggs from birds fed 5% composite leaf meal. The carbohydrate also reduced as the level of composite leaf meal increased. Highest carbohydrate value ($24.40\pm 3.02\%$) was recorded in eggs from birds fed 0% composite leaf meal while the lowest carbohydrate value ($16.60\pm 3.02\%$) was recorded in birds fed 5% composite leaf meal. Highest food energy value ($400.30\pm 11.45\text{g/Cal}$) was recorded in eggs from birds fed 0% composite leaf meal while lowest ($372.12\pm 11.45\text{g/Cal}$) was observed in eggs from birds fed 4% composite leaf meal.

Proximate analyses of the oven-dried egg yolk powder showed moisture content of the egg yolk powder to range from $2.43\pm 0.46\%$ in birds fed 4% composite leaf meal to $3.70\pm 0.46\%$ in birds fed 0% composite leaf meal. Values recorded for Ash followed a particular trend. Ash content ranged from $0.84\pm 0.43\%$ in eggs collected from birds fed 0% composite leaf meal to $2.01\pm 0.43\%$ in eggs collected from birds fed 5% composite leaf meal. Values for the protein content increased as the level of composite leaf meal increased and the values also followed a particular trend. The values for the protein content ranged from $26.09\pm 5.16\%$ in eggs collected from birds fed 0% composite leaf meal to $38.03\pm 5.16\%$ in eggs collected from birds fed 5% composite leaf meal. Highest carbohydrate value ($38.66\pm 5.82\%$) was recorded in eggs collected from birds fed Diet I while the lowest carbohydrate value ($25.50\pm 5.82\%$) was recorded in eggs collected from birds fed Diet VI. Highest food energy value ($544.56\pm 8.41\text{g/Cal}$) was observed in eggs collected from birds fed 1% composite leaf meal while lowest ($528.02\pm 8.41\text{g/Cal}$) was observed in eggs collected from birds fed 4% composite leaf meal.

The moisture content of the whole egg powder varied from $6.32\pm 0.58\%$ in eggs collected from birds fed 1% composite leaf meal to $7.69\pm 0.58\%$ in eggs collected from birds fed 0% composite leaf meal. Values recorded for ash content did not follow a particular trend. Ash content ranged from $1.42\pm 0.35\%$ in eggs collected from birds fed 4% composite leaf meal to $2.37\pm 0.35\%$ in eggs collected from birds fed 2% composite leaf meal. The crude protein of the whole egg powder varied from $48.40\pm 2.64\%$ in eggs collected from birds fed 0% composite leaf meal to $56.15\pm 2.64\%$ in eggs collected from birds fed 5% composite leaf meal. The ether extract varied from $9.07\pm 2.08\%$ in eggs collected from birds fed Diet VI and $13.97\pm 2.08\%$ in

eggs collected from birds fed Diet II. Highest carbohydrate value ($30.72 \pm 2.08\%$) was recorded in eggs collected from birds fed Diet I while the lowest carbohydrate value ($25.00 \pm 2.08\%$) was recorded in eggs collected from birds fed Diet VI. Highest food energy value ($438.49 \pm 12.40 \text{g/Cal}$) was observed in eggs collected from birds fed 1% composite leaf meal while lowest ($406.17 \pm 12.40 \text{g/Cal}$) was observed in eggs collected from birds fed 4% composite leaf meal.

Although dried egg products usually are not available to consumers at the retail level, they are widely used in mixes and in quantity food production. Removal of water retards chemical reactions that affect quality and inhibits the growth of microorganisms (Penfield and Campbell, 1990). The moisture contents for the egg white, egg yolk and whole egg are low enough to extend the shelf life of the egg powders in an environment of humidity. This is in agreement with the report of Ndife *et al.* (2010); (6.74, 3.88 and 4.42% for whole egg, egg yolk and egg white, respectively). The crude protein recorded in this study for the whole egg and egg yolk surpass that of reports by USDA (2016) (48.05 and 33.63%, respectively) and also surpass that of Ndife *et al.* (2010) for whole egg, egg white and egg yolk (45.21, 62.04 and 26.20%, respectively). The increase in the values of the crude protein in the egg powder, egg yolk and whole egg as the levels of the composite leaf meal increased may be due to the protein contents in those leaves that were used to produce the composite leaf meal. Relatively high ash content suggests that dehydrated egg white, egg yolk and whole egg are good sources of minerals. The nutritional composition determined, showed high values when compared to that of fresh eggs. This is an indication that the drying temperature of 44°C did not adversely affect the nutritional value of the oven-dried egg components. The high food energy value (FEV) recorded in egg yolk powder ($528.02 - 544.56 \pm 8.41 \text{g/cal}$) falls within the value obtained by Ndife *et al.* (2010)] and makes it particularly attractive for infant food formulae Krause and Mahan (1984). In all powdered eggs is a choice for vegetarians because they are one of the few non-meat options that are a complete protein. Powdered eggs can stay for 25 years and be used for a wide array of recipes. They can be used without rehydration when baking, or can be rehydrated to make dishes such as omelets. If you have ever complained about the messiness of using half an egg in a recipe, you certainly won't have that problem with powdered eggs.

CONCLUSION

This study showed that the whole egg powder, egg white powder and egg yolk powder can be produced using the oven drying method without affecting

Table 2: Proximate properties of oven-dried egg white powder

Parameters	0% CLM	1% CLM	2% CLM	3% CLM	4% CLM	5% CLM	± SEM
Moisture content (%)	5.94 ^c	4.09 ^a	4.34 ^{ab}	4.21 ^a	5.04 ^c	4.55 ^b	0.67
Ash (%)	1.21 ^e	2.55 ^d	3.40 ^c	4.54 ^b	4.71 ^b	4.93 ^a	1.40
Crude protein (%)	62.88 ^c	66.15 ^c	69.15 ^b	70.06 ^b	71.17 ^a	71.83 ^a	3.27
Ether extract (%)	5.78 ^d	4.41 ^c	3.57 ^b	2.61 ^a	2.22 ^a	2.11 ^a	1.39
Carbohydrate (%)	24.20 ^c	22.82 ^c	19.55 ^b	18.59 ^b	16.87 ^a	16.60 ^a	3.02
Food energy value (g/cal)	400.30 ^a	395.51 ^b	386.91 ^b	378.07 ^c	372.12 ^d	372.63 ^d	11.45

a-b: Mean within rows having different superscripts are significantly different (P<0.05)

Table 3: Proximate properties of oven-dried egg yolk powder

Parameters	0% CLM	1% CLM	2% CLM	3% CLM	4% CLM	5% CLM	± SEM
Moisture content (%)	3.70 ^b	2.59 ^a	2.52 ^a	2.61 ^a	2.43 ^a	2.75 ^a	0.46
Ash (%)	0.84 ^d	1.12 ^c	1.40 ^b	1.50 ^b	1.93 ^a	2.01 ^a	0.43
Crude protein (%)	26.09 ^d	26.20 ^d	31.18 ^c	34.21 ^b	37.93 ^a	38.03 ^a	5.16
Ether extract (%)	30.73	31.88	28.7 ⁴	29.57	32.21	31.72	1.74
Carbohydrate (%)	38.66 ^c	38.23 ^c	36.17 ^c	32.13 ^b	25.51 ^a	25.50 ^a	5.82
Food energy value (g/cal)	535.51	544.56	528.02	531.41	543.63	539.58	8.41

a-b: Mean within rows having different superscripts are significantly different (P<0.05)

Table 4: Proximate properties of oven-dried whole egg powder

Parameters	0% CLM	1% CLM	2% CLM	3% CLM	4% CLM	5% CLM	± SEM
Moisture content (%)	7.13 ^{ab}	6.32 ^a	6.42 ^a	6.62 ^a	6.42 ^a	7.69 ^b	0.58
Ash (%)	1.72 ^c	1.53 ^{cd}	2.37 ^a	1.71 ^c	1.42 ^d	2.11 ^b	0.35
Crude protein (%)	48.40 ^d	49.16 ^{cd}	49.98 ^{bc}	50.84 ^b	51.00 ^b	56.15 ^a	2.64
Ether extract (%)	13.58 ^c	13.97 ^c	11.56 ^{bc}	12.10 ^{ab}	13.52 ^c	9.07 ^a	2.08
Carbohydrate (%)	29.18 ^{bc}	29.03 ^{bc}	29.69 ^{bc}	30.72 ^c	27.65 ^{ab}	25.00 ^a	2.08
Food energy value (g/cal)	432.48 ^{ab}	438.49 ^a	422.66 ^b	417.30 ^{cd}	436.26 ^a	406.17 ^d	12.40

a-b: Mean within rows having different superscripts are significantly different (P<0.05)

the nutritional properties of the different parts of the egg. This will surely prevent egg spoilage when there is excess egg available in the circulation.

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REFERENCES

- Association of Official Analytical Chemists (2005). Official Methods of Analysis 18th edition, Washington D.C
- Jose M. Miranda, Xaquín Anton, Celia Redondo-Valbuena, Paula Roca-Saavedra, Jose A. Rodriguez, Alexandre Lamas, Carlos M. Franco, and Alberto Cepeda (2015). Egg and Egg-Derived Foods: Effects on Human Health and Use as Functional Foods. *Nutrients* 7 (1)
- Krause, M. V. and Mahan, L. K. (1984). Food and diet therapy. 7th ed. W. B. Saunders Press Coy., Portugal.
- Marjorie P. Penfield and Ada M. Campbell (1990). *Experimental Food Science (Third Edition)*
- Ndife, J., Udobi, Ejikeme C. and Amaechi N. (2010). Effect of oven drying on the functional and nutritional properties of whole egg and its components. *African Journal of Food Science* Vol. 4 (5) pp. 254 – 257.
- Osuagwu, G. E. (2008). Protein and Vitamin content of Four Nigerian Pterocarpus species. *Niger.Food J.* 26(1): 21-26.
- Pandey, D. (2015). Poultry farming and keeping. Page 269. ISBN 978-81-89922-83-2.
- USDA (2016). National Nutrients Database for standard references.
- Vaclavik, A. V. and Christian, W. E. (2008). Essentials of food science. Springer science Business Media, LLC, New York pp205-230.