Proximate Composition and Cholesterol Profile of Table Eggs from Hens Fed Different Proprietary Feeds in Ibadan, Nigeria

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Abstract.

Proprietary feed labels are by regulation tailored to the requirements of the target animal. However, different proprietors lay claim to equal efficacy of feed whilst there could be variations in the actual composition and claims on the labels. This study was aimed at investigating the effects of four proprietary commercial layer feeds in Ibadan, Nigeria on the proximate composition and cholesterol profile of laid eggs. Black Bovan Nera hens (n=96) aged 24-week, were randomly allotted to four different commercial feed A, B, C and D, respectively. Each treatment was in triplicates of eight birds. Hens were managed under a cage system with experimental diets and water provided ad-libitum. At day 56 of feeding the hens on experimental feeds, eggs were collected for proximate and cholesterol profile determinations. Feed type had significant effects ($P<0.05$) on total cholesterol and low density lipoproteins (LDL). Total cholesterol was higher ($P<0.05$) in eggs from hens on Feed-A (1195.98mg/dL) and lowest in those from Feed-C (685.07mg/dL). Also, higher ($P<0.05$) LDL was in eggs of hens on Feed-A (971.55 mg/dL) and least in those on Feed-C (173.71 mg/dL). There was no effect of feeding the different commercial feeds to hens on high density lipoprotein, triglycerides, very low density lipoprotein, metabolizable energy and proximate composition. True protein was however, higher ($P<0.05$) in eggs of hens on Feed-A (6.29%) than those on other feeds. Thus, nutrients composition and choice of feed for laying hens may greatly influence true protein, total cholesterol and LDL content of eggs.

Keywords: Cholesterol, Crude protein, Lipoprotein, Triglyceride, True protein

Introduction

Eggs constitute an important part of human diet because of its high quality protein (Forson *et al.,* 2011). Egg, a source of complete protein with good quality amino acid profile is one of the most frequently consumed foods in the world, with chicken egg being the highest consumed in western societies (Muller and Tobin, 1996). Keeping chickens for egg production has become one of the fastest ways of meeting the protein demands in a nation's population in that, no taboo or religion forbids its consumption. Also, eggs could be consumed absolutely when fresh without any need for refrigeration and storing the left-over (Farell, 2013; Ogunwole *et al.,* 2015a).

The nutrition of birds has direct effect on the quality of eggs (Cherian *et al.,* 2002). Insufficient levels of nutrients in hen diet could impair the efficiency of production, and eggs laid could be of inferior quality. Reports have shown that cholesterol and proximate composition of egg are affected by various factors such as breed, management and nutrition (Clum, 1996; Fakai *et al.,* 2015).

Developing countries have been reported to have reduced intake of eggs, a cheap animal source of balanced amino acids. The ascribed reason was that cholesterol and saturated fats especially from animal sources are bad (Rahimi, 2005; Mohsin, 2013). Whereas, polyunsaturated fatty acids which are abundant in animal products like egg, has been reported to reduce the chance of atherosclerosis and stroke (Lada and Rudel, 2003). Rahimi (2005) and Farell (2013) reported that most people, particularly, in developing countries believed in dangers of eating eggs due to erstwhile instinctive hype on saturated fats and cholesterol consumption. In the developing countries, diets are mainly plant-based with low cholesterol, except for the few affluent (FAO, 2007). Based on recent comprehensive study on cholesterol from more than a million patients, there was no evidence to prove that having high levels of cholesterol causes heart disease (Linnekin, 2018).

Nutritional strategies or dietary manipulations to reduce cholesterol concentration as well as to improve egg protein content has been advocated (NRC, 1994; Jurgens, 2002). Quality commercial feeds with appropriate nutritional values capable of achieving efficient performance and production without losing sight of the ensuing effects on functional composition of eggs is highly imperative in layers. This is in a quest to ensure that the health or nutrition concerns of egg consumers are properly taken into consideration. There is the need to investigate the effect of feeding different proprietary feeds to layers on the composition of eggs they produce.

Few reports have documented the effects of feeding different proprietary feeds on chemical composition of eggs in Nigeria. Earlier documentations were on supplemental effects of the different proprietary vitamin-mineral premixes under two rearing systems on the proximate composition (Yan *et al*., 2014; Ogunwole *et al.,* 2015a) and the lipids profile of eggs (Van *et al*., 2004; Ogunwole *et al.,* 2015b). The present study was therefore designed to evaluate the effect of feeding four proprietary commercial feed to laying hens on yolk cholesterol, proximate and true protein composition of eggs produced by commercial pullets.

Materials and Methods

Experimental site

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm, University of Ibadan, Ibadan. The farm is situated in the derived savanna vegetation belt of Nigeria. The study area lies between longitude 7°27.05 north and 3°53.74 of the Greenwich Meridian east at an altitude 200m above sea level. Average temperature and relative humidity of the location is between 23-42 °C and 60-80%, respectively (SMUI, 2018).

Experimental birds and management

A total of 96 Bovan Nera Black laying hens aged 24 weeks were randomly allotted to four treatments each in triplicate of eight birds per replicate in a completely randomized design. The hens were managed under battery system. The hens were offered their respective proprietary diets Feed-A, Feed-B, Feed-C and Feed-D all through with water *ad libitum* for eight weeks (56 days) of feeding trial.

Experimental diets

Four different proprietary (commercial) feed were used for the experiment. The four commercial feeds were purchased in Ibadan, Oyo state Nigeria. The feeds were tagged Feed-A, B, C and D, respectively. Feed-A had metabolisable energy and crude protein of 2700 Kcal/kg and 15.00%, respectively while B, C and D had 2500 Kcal/kg and 16.50%; 2500 Kcal/kg and 16.00%; 2500 Kcal/kg and 16.50% metabolisable energy and crude protein, respectively. Details of the gross composition of the commercial feeds as shown in the attached nutrients label of the Feed is shown in Table 1.

Table 1: Gross composition of commercial feed as shown in the attached nutrients label

Parameters	Feed Type			
	A	B	C	D
ME (Kcal/kg)	2700	2500	2500	2500
Crude protein (%)	15.00	16.50	16.00	16.50
Fat (%)	5.00	5.00	5.00	5.00
Crude fibre (%)	10.00	6.00	6.00	6.50
Calcium (mg)	3.50	3.60	3.50	3.50
Potassium (mg)	0.40	0.45	0.45	0.45
Lysine	0.75	0.80	0.80	0.80
Methionine	0.30	0.34	0.34	0.34
Salt (%)	0.30	0.30	0.30	0.30

Determination of cholesterol profile

On day 56, two eggs per replicate were randomly sampled for analyses. The total cholesterol (TC), Triglycerides, High Density Lipoprotein (HDL), Low Density Lipoprotein (LDL) and Very Low Density Lipoprotein (VLDL) were analyzed according to AOAC (2005).

Proximate and true protein composition

Two eggs were randomly sampled from each replicate. They were broken, homogenized and analyzed for proximate composition (AOAC, 2000).Metabolizable energy (kcal/kg) of the different feed samples was estimated according to the procedure of Pauzenga (1985). The true protein was determined by subtracting non protein nitrogen from the total nitrogen value of the diet and the residual nitrogen value multiplied by a factor of 6.38 (Sinaga *et al*., 2015)

Statistical analysis

Data were subjected to analysis of variance using the general linear procedure (SAS, 1999). The means were separated using Duncan's Multiple Range Test of the same software at $\alpha_{0.05}$.

Results

The metabolizable energy estimates and lipid profile of egg from hens on different proprietary feeds are shown in Table 2. There were no significant differences (P>0.05) in the metabolizable energy, high density lipoprotein, triglyceride and very low density lipoprotein contents of eggs from birds, fed the various proprietary diets. Metabolisable energy (ME kcal/kg) however ranged from 4056.32 (B) to 4110.79 (A), HDL from 192.45 (B) to 261.11 (A), triglyceride from 1204.80 (C) to 1483.20 (A) and VLDL from 240.96 (C) to 1483.20 (A). However, there were significant differences (P<0.05) in TC content of the eggs. The TC of eggs from hens onFeed-A (1195.98 mg/dL) was similar to Feed-B (941.55) but significantly higher (P<0.05) than those fromFeed-C (685.07 mg/dL) and Feed-D (722.59 mg/dL). The TC of eggs from hens on Feed-B, C and D however were similar (P>0.05). Significant differences (P<0.05) were also observed in the LDL content among treatments with eggs from hens on Feed-A (971.55 mg/dL) having significantly higher (P<0.05) LDL compared with those on Feed-B (454.551 mg/dL), C (173.71 mg/dL) and D (290.53 mg/dL).

Table 2: Metabolizable energy and lipid profile of egg yolk from hens fed four different proprietary feeds in Ibadan, Nigeria

Parameters	Feed Type				
	A	**B**	**C**	**D**	**SEM**
ME (kcal/kg)	4110.79	4056.32	4108.58	4090.31	13.72^{NS}
Total cholesterol (mg/dL)	1195.98^{a}	941.55^{ab}	685.07^{b}	722.59^{b}	130.51
Low density lipoprotein (mg/dL)	971.55^{a}	454.44^{b}	173.71^{b}	290.53^{b}	153.82
High density lipoprotein (mg/dL)	261.11	192.45	270.39	253.78	89.85^{NS}
Triglyceride (mg/dL)	1483.20	1473.28	1204.80	1233.60	121.78^{NS}
Very Low density lipoprotein (mg/dL)	296.64	294.66	240.96	246.72	24.36^{NS}

Means with different superscripts along same row are significantly different (P<0.05) –Where, A = Hens fed commercial feed type A; B = Hens fed commercial feed type B; C = Hens fed commercial feed type C; D = Hens fed commercial feed type 4. ME= metabolizable energy; NS = Not significant (P>0.05)

The proximate composition of eggs (g/100g) from hens fed four different proprietary feed in Ibadan, Nigeria are shown in Table 3. There were no significant differences (P>0.05) in the proximate composition of eggs from hens on different commercial feeds. Moisture content ranged from 73.32 in Feed-B to 75.89% in Feed-C, crude protein from 10.14 (C) to 11.39% (B), ether extract from 13.09 (C) to 14.08% (B), ash 0.79 (A and D) to 1.18% (B) while NFE were 0.04, 0.03, 0.07 and 1.01% in Feed-A, B, C and D, respectively. True protein in Feed-A (6.29%) was similar to 5.24% in Feed D-4 but significantly higher than (P<0.05) 4.30 and 4.64% in Feed-B and C, respectively.

Table 3: Chemical composition of eggs fed four different proprietary feeds in Ibadan, Nigeria

Parameters (%)	**A**	**B**	**C**	**D**	**SEM**
Moisture content	74.95	73.32	75.89	74.73	0.22^{NS}
Crude protein	10.91	11.39	10.14	10.23	0.18^{NS}
True protein	6.29^{a}	4.30^{b}	4.64^{b}	5.24^{ab}	0.21
Ether extract	13.31	14.08	13.09	13.24	0.54^{NS}
Ash	0.79	1.18	0.81	0.79	0.09^{NS}
Nitrogen free extracts	0.04	0.03	0.07	1.01	0.02^{NS}

Mean values with different superscript in a row differ significantly (P<0.05)NFE: Nitrogen Free Extract;Where, 1 = Hens fed commercial feed type A, 2 = Hens fed commercial feed type B, 3 = Hens fed commercial feed type C, 4 = Hens fed commercial feed type 4; NS = Not significant (P>0.05)

Discussion

Cholesterol are naturally found in the cell walls structure and required in the production of the steroid hormone vitamin D and bile salts which helps digestion (Fakai *et al.,* 2015). The differences in the cholesterol profile of eggs could be attributed to the varying energy content of the feeds. Feed-A had relatively higher energy content of 2700 kcal/kg compared with B, C and D. Vargas and Naber (1984), earlier correlated yolk cholesterol content with dietary energy balance and asserted that excessive energy intake, beyond1 maintenance and production requirements, increased body weight and cholesterol synthesis. Therefore, reserve cholesterol would be transferred to the egg yolk since layers releases its excess cholesterol in the eggs. Conversely, Fennema (1993) reported that variations in total yolk lipid content are more influenced by bird genetics than diet. Differences observed in cholesterol concentration in the present study could be attributed to diet as the evaluation was undertaken with birds of the same genetic strain and age.

Low density lipoprotein are erroneously referred to as 'bad cholesterol' because of their perceived potential to block blood vessels, preventing the flow of blood and thus elicit various cardiovascular diseases (Howard *et al.,* 2000; Tall *et al.,* 2001). The higher level of yolk LDL produced by hens on Feed-A may be attributed to the reduced level of crude protein and higher level of energy compared to others. The higher LDL recorded in eggs of hens on Feed-A despite the higher fibre levels contradicts the submission of Biswas *et al.* (2011) that increased dietary fibre would reduce LDL. Increased HDL was an indication of good healthy condition (Gordon *et al.*, 1989), hygienic condition of the egg (Zemková *et al.,* 2007) and freedom from contaminants that might lead to increased peroxidation and deterioration (Blokhuis *et al*., 2007).

There was no observable difference in metabolisable energy of eggs obtained from hens on the different treatments. Similar results were also obtained by Costa *et al.* (2004), Wu *et al*. (2007), Jalal *et al*. (2007) and Costa *et al*. (2009) in layers fed different ME levels. The authors inferred that dietary energy levels did not have any significant effect ($P>0.05$) on egg production. However, Araújo and Peixoto (2005) observed a reduced egg production ($P<0.05$) as dietary energy levels increased, while Valkonen *et al*. (2008) obtained increased egg production with higher dietary energy levels. These contentions may be explained by the fact that the energy levels higher than those recommended did not increase production, while energy deficiency decreased production. Leeson and Summers (2000) showed that increased energy intake had positive significant effects on egg weight.

The insignificant variation in proximate composition of eggs in this study conforms to report of Nys (2004) that egg displays very consistent compositions with regard to its content of total proteins, essential amino acids, total lipids, phospholipids, phosphorus and iron. Proteins are essential component of living cell; they are polymers of amino acid and the nutrient needed by human body for growth and maintenance of body cells (Fakai *et al*., 2015). Egg provides means through which the protein needs of the populace could be met. Eggs has various use and contain many essential nutrients as it support life during embryonic growth and one of the nutritious and complete food known to man (Scott and

Ross, 2001). Gilbert (1979) reported that chicken egg generally contain about 12% by weight of protein. The result observed in this study however, was relatively lower compared to this but higher than values reported for Shika Brown (Fakai *et al.*, 2015)

The moisture content of a given sample simply refers to the water content of that sample (Fakai *et al.*, 2015). The amount of water in a food varies from low to high moisture levels in food (Elvan *et al.*, 2008). Fresh eggs were used in this analysis, and as such contained high amount of moisture. Moisture level in chicken eggs compared favourably to that obtained for duck (Fakai *et al.*, 2015) and laying chickens (Ogunwole *et al.*, 2015a, b). Hassan *et al.* (2008) stated that moisture contents of food above 15% would favour microbial activities which will result to food spoilage. Thus, moisture content of all the eggs exceeded 15% which indicated that eggs are highly perishable.

Lipids stored in the tissue are mobilized as a source of energy during stressful conditions, or during food deprivation (Gordon, 2002). The ether extracts ranged between 13.09 to 14.08%. The values obtained from this study were higher than those reported in literature for *Gallus domesticus*, *Numida melleagris* and *Columbia livia* (Adenowo *et al.*, 1999, Emmanuel *et al.*, 2011 and Fakai *et al.*, 2015) but comparable to that for local poultry eggs.

Ash represents the amount of mineral in a given sample (Fakai *et al.*, 2015). Samples with high concentration of various mineral elements were expected to speed up metabolic processes, improve growth and development (Muhammad, 2011). Ash contents of eggs obtained from hens on Feed-B were similar to reported 0.94% ash of eggs (Gordon, 2002). Values of NFE obtained from this study were lower than those earlier reported for eggs (Ogunwole *et al.,* 2015a) while high true protein of eggs from hens on Feed-A could be attributed to higher fibre content of the feed that would reduce passage time and increased time for absorption of nutrients during digestion in the gut of hens.

Conclusion

Feeding different proprietary feeds to laying chickens had varying effects on the total cholesterol and low density lipoprotein compositions of eggs. There was no observable effect of feeding the different commercial feed on proximate composition of eggs. However, the true protein composition of eggs varied with the type of feeds given to hens in this study. Therefore, adequate cautions must be exercised in the choice of any feed for laying chickens by Poultry Nutritionists.

Conflict of Interest

Authors hereby declare that this study was undertaken in best scientific tradition devoid of any conflict or special interest in any particular product. In line with this avowal, further details of the test feeds are obtainable on enquiry from the corresponding author.

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