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Replacement Value of Groundnut cake and Maize by Hatchery by-Product meal on Egg Quality and Quantity of Guinea Fowl (*Numida meleagris*) Hen

Belewu, M.A.
Microbial Biotechnology and Dairy Science Laboratory
Faculty of Agriculture
University of Ilorin, Nigeria
e-mail milkyinka@yahoo.com / milkyinka2014@gmail.com / mabel@unilorin.edu.ng
Research ID: Q-8926-2017

Phone: +24 803 581 7941 / +234 080 2125 1967

ABSTRACT

The study investigated the effect of replacement of Groundnut cake and Maize by Hatchery by-product meal (HBPM) at two levels (3% and 6%) on egg quality and egg yield of laying Guinea fowl (*Numida meleagris)*(n= 25). The diet composition based on maize, groundnut cake, palm kernel cake, mineral mixture, and salt with varying levels of Hatchery by-products meal at 3% and 6% to replace part of maize and groundnut cake were fed *ad libitum* to Guinea hens for an eight week period in a completely randomised design model. Treatments A (3% HBPM replacing maize); B (6% HBPM replacing maize); C (3% HBPM replacing groundnut cake); D (6% HBPM replacing groundnut cake) and Treatment E (Control, without HBPM inclusion). Similar environment and management were provided for every bird. Parameters evaluated during the study included feed consumption, egg yield, eggshell thickness, egg weight, and feed consumed per dozen eggs. The egg production of birds on Treatment A was significantly higher among all the diets and the least were birds on the Control diet ($p<0.05$). Egg weight followed a similar trend as egg production. Contrarily, birds on Treatment D consumed greater feed with higher eggshell thickness. Feed consumed per dozen eggs and Hen-Housed Egg Production (HHEP) were better and significantly superior ($p<0.05$) in birds fed Treatment A compared with other Treatments which are similar ($p>0.05$). The present study suggested that HBPM (3% HBPM replacing maize) is advantageous in terms of egg production, egg weight, feed consumed per dozen eggs and HHEP. Hence, the results of this study recommend the use of HBPM in Guinea fowl diet.

Keywords: Guinea fowl hen, egg production, egg weight and eggshell, feed consumption, feed consumed per dozen eggs

INTRODUCTION

Hatchery by-product meal results from the processing of poultry hatchery wastes such as shells of hatched eggs, infertile eggs, dead embryos and dead or culled chicks (Freeman, 2008, Al-Harthi *et al.*, 2010). It can be estimated that between 0.8 and 3.3 billion tons of hatchery wastes are generated every year, using a hatchability value of 50-80% (Al-Harthi *et al.*, 2010), with mean egg weight of 60 g.

The use of hatchery by-products like other animals by-products for animal feeding is often regulated and even prohibited in some countries due to concerns over the transfer of pathogens (Al-Harthi *et al.*, 2010) as well as environmental pollution.

The discarding of hatchery wastes can cause severe environmental distress. Huge quantities of hatchery wastes which are directly dumped into the soil cause pollution of the environment. It pollutes the groundwater, lakes or rivers, causes pathogens distribution, production of phytotoxic substances, air pollution and greenhouse gas emissions. Excessive application of organic waste as fertiliser into the soil causes nitrate (NO_3) accumulation and contamination of groundwater (Glatz and Miao., 2009). Therefore, processing hatchery wastes into viable animal feeds is a sure way to lessen environmental impact (Freeman, 2008)

The methods for processing and handling of hatchery wastes have been extensively reviewed by Glatz *et al*.(2011) who noted those finding practical techniques for recycling the nutrients in hatchery waste has become a high priority. However, rendering and heat treatments were proposed thus:

Heat treatment followed by adequate drying is effective ways of destroying pathogens in the wastes (Glatz *et al*., 2011). However, rendering is the most popular method used to process hatchery wastes into animal feed in which the wastes are cooked, the fat is removed (or not), and the resulting product is dried and milled. This method yields two products: the protein-rich hatchery by-product meal and poultry fat. Other heat treatments have been proposed, such as boiling, autoclaving or extruding with soybean meal, maize or eggshells (Lilburn *et al*., 1997; Glatz *et al*., 2011).

Heat treatments naturally require devoted facilities and transportation from the hatchery to the rendering plant. Other processing methods like ensiling can be useful at the hatchery site and may be more valuable in regions where rendering facilities are not accessible. Composition of Hatchery waste shows that dried and /or processed hatchery residue contained 22.5-44.25% crude protein, 14.4-30% crude fat, 0.9-1.9% crude fibre, 14-40% total ash, 7.26-22.6% calcium, 0.39-0.84% phosphorous, 2706-3600 Kcal/Kg ME (Rasool *et al*., 1999; Khan and Bhatti, 2001). The rich content of poultry waste makes it a good candidate for its inclusion in poultry birds like Guinea fowl hen.

The importance of Guinea fowl in improving nutritional requirements and standard of living among the most rural populace can never be over-emphasized. It is noteworthy that Guinea fowl has promising potentials as a global alternative poultry enterprise. The birds are hardy, less susceptible to predominant chicken diseases and their feeding and management inputs are less expensive compared to the chickens (Mwale *et al*., 2008). The potential of Guinea fowl for egg production is still at its infancy stage in the Nigerian poultry industry. Therefore, formulation of least-cost indigenous feed resources is paramount to enable farmers realize value on their production. Keeping the above points in view, the present study was conducted to evaluate the effect of feeding processed hatchery by-product (HBPM) on egg qualities and quantity potentials of Guinea fowl hens and to advocates the inclusion of hatchery by-product meal in the diet of the animal.

MATERIALS AND METHODS

The experiment was conducted in line with the guidelines of Animal Welfare at the Department of Animal Science, University of Ibadan, Nigeria. University of Ibadan is located five miles (8 kilometres) from the centre of the major city of Ibadan in Western Nigeria. It is of Latitude; 7° 23' 28.19" N and Longitude; 3° 54' 59.99" E.

Experimental Diets

Guinea hens were fed the experimental diets based on maize and groundnut cake while the content of other ingredients was identical among the five diets. The ingredients and nutrients composition of the experimental diets are shown in Table 1.

Table 1: Ingredients and Nutrient Composition of the Experimental Diets (as fed basis)

	% Replacement level of Maize with HBPM		% Replacement level of GNC with HBPM		Control
Ingredients / Treatment	(A) 3 %	(B) 6%	(C)3%	(D)6 %	(E)
Maize	58.40	55.40	61.40	61.40	61.40
Groundnut cake	16.59	16.59	13.59	10.59	16.59
Palm kernel meal	20.00	20.00	20.00	20.00	20.00
Bone meal	1.20	1.20	1.20	1.20	1.20
HBPM	3.00	6.00	3.00	6.00	0.00
Mineral – vitamin premix	0.50	0.50	0.50	0.50	0.50
Salt	0.30	0.30	0.30	0.30	0.30

- The trace element premix provided the followings/kg diet;Zn50mg, Mn 80mg,CO 0.20, Mg 0.30, Cu 2.00mg, Fe 25mg, Z cacitracin 510mg, antioxidant 125mg.
- Vitamin mixture provided the following per kg of diet. Vitamin A 8000iu., vit., D3 1200iu., Vit.,E 3 mg., Choline-chloride 150mg., Vit., B12 8mg., Nicotinic acid 10mg

Birds and Management

The Pearl Guinea hens used for the experiment were obtained from the Kanji Game Reserve, Nigeria and kept in an individual cage measuring 5.5 cm x 40 cm x 53cm in a tier of Israeli battery cages measuring 9.1 x 2.4 metres. The birds were dewormed and fed for a preliminary period of one week, to adapt them to the environment. The twenty-five Guinea hens were randomised against the five experimental diets, replicated five times in a completely randomised design model, for a ten-week period, including a two-week adaptation period and an eight-week experimental period. Feeding and watering were administered *ad ilbitum* throughout the study.

Laying Performance

Feed consumption was determined weekly by subtracting the ending feed weight of each treatment from the beginning feed weight. Other parameters are egg production, egg weight, eggshell thickness and feed consumed per dozen eggs.

Egg quality

Thirty eggs (six from each replicate) were randomly collected to assess eggshell quality, using a digital tester. Eggshell thickness (without the eggshell membrane) was measured at three sites (blunt, middle, and sharp) of the egg while the means were calculated.

Statistical analysis

All data collected were subjected to Analysis of Variance (ANOVA) of a Complete Randomised (Steel and Torrie, 1980) design model and a significant difference was separated using the Duncan Multiple Range test (1955).

RESULTS AND DISCUSSION

Table 2: Proximate Composition of the Hatchery by-Product Meal and the Experimental Diets

Parameters %	3%HBPM Replacing Maize	**6%HBPM Replacing Maize**	**3% HBPM Replacing GNC**	**6% HBPM Replacing GNC**	**Control Treatment (Without HBPM**	**HBPM**
Dry matter	89.96	87.90	88.70	89.95	88.29	95.80
Crude Protein	19.64	21.23	17.95	15.32	17.29	21.72
Crude fibre	3.41	7.20	8.80	11.30	1.70	35.90
Ether extra	1.00	2.50	2.00	4.50	2.00	2.50
Ash	5.06	5.11	7.91	6.74	1.69	25.50
NFE	60.85	51.86	52.04	51.99	65.61	10.18
Calcium	1.35	2.39	1.10	2.04	0.69	0.18
Phosphorus	0.15	0.14	0.13	0.13	0.17	2.68
ME (Kcal/Kg	2836.40	2756.00	2864.65	2813.02	2916.00	3.68

Results on dry matter composition showed that there were significant differences among the Treatments. The dry matter ranged from 88.29 to 89.96 and it agreed with the range reported by Adeniji and Adesiyun (2007). However, Treatment A recorded a higher dry matter value than any of the other Treatments (Table 2).

Crude Protein content ranged from 15.32 to 21 23 (Table 2). The value reported herein were higher than the reported values of Adeniji and Adesiyun (2007). The variation could probably be due to what constitutes a hatchery by-product meal in the two studies. The proximate composition revealed a significantly (p<0.05) increased protein content in Treatments B>A>C>E, the least being D. The high crude protein value of Treatment B could be attributed to the contribution of the extra crude protein from HBPM (Adeniji and Adesiyun, 2007). The crude protein value in HBPM was higher (21.72 %) suggesting that HBPM may serve as good sources of protein for Guinea hens hence, protein is an essential component of the poultry diet needed for production and supply of the adequate amount of required amino acids.

Results on Ether extract content showed that the range was from 1.00 to 4.50 among the Treatments. The report ether extract value fell within the range of values noted by Adeniji and Adesiyun (2007) Ether extract content in Treatment A was the lowest (P<0.05) while Treatment D had the highest (P<0.05) ether extract contents. Interestingly, ether extract values in Treatment, D could be due probably to the fact that it is a Groundnut cake based diet.

Ash content was found to be highest (P<0.05) in Treatment C compared to the other Treatments. However, the ash contents in Treatments A, B, and D were equal (P>0.05) but significantly different (p<0.05) from that of Treatment E (Control). The high ash content of Treatment C showed it may have appreciable amounts of mineral elements and it agreed with the reported value of Adeniji and Adesiyun (2007).

The fibre content noted in this study was higher than the result of Adeniji and Adesiyun (2007). Besides, the crude fibre content was highest for Treatment D and least for Treatment E. The results showed that HBPM based diets (A-D) recorded significantly higher crude fibre values compared with the Control (Treatment)t due probably to the fact that HBPM contained dead embryos, unfertile eggs and eggshells. The higher crude fibre content of Treatment D as compared to the other counterpart Treatments indicated that it may aid digestion as well as absorption of water from the body.

Results on the Calcium and Phosphorus contents are presented in Table 2. Calcium content ranged from 0.69 to 2.39% (Treatments A-E). The Calcium content of Treatment B was higher than the value noted by Abiola *et al.* (2012). Phosphorus content (%) was A (0.15), B (0.14), C (0.13), D (0.13) and E (0.17). However, phosphorus content in Treatment E was significantly higher (P<0.05) than those of the other Treatments but lower than the result of Abiola *et al.* (2012).

Table 3: Average Egg Production, Egg and Qualities of the Experimental Animals

Parameters	**3%HBPM Replacing Maize**	**6%HBPM Replacing Maize**	**3%HBPM Replacing GNC**	**6% HBPM Replacing GNC**	**Control (Without HBPM)**	**±SEM**
Feed Consumption (g/b/d)	100.00	103.00	103.00	104.00	100.00	0.34
Egg Production (%)	67.10^{a}	59.40^{b}	46.40^{c}	53.20^{b}	43.60^{c}	1.28*
Egg weight (g)	50.10	49.20	48.90	48.50	47.60	2.64
Egg shell & egg content quality	0.36^{b}	0.35^{b}	0.45^{a}	0.48^{a}	0.27^{c}	0.02*
Feed consumed /dozen eggs	1.30^{d}	2.08^{c}	2.30^{b}	2.40^{a}	2.48^{a}	0.09*
Feed efficiency	**2.00^{c}**	**2.09^{ab}**	**2.10^{ab}**	**2.11^{b}**	**2.14^{a}**	**0.15***
Hen-House egg Production	**298.00^{c}**	**378.00^{a}**	**254.00^{d}**	**244.00^{e}**	**334.00^{b}**	**10.25***
Egg :Feed Price	**2.31^{a}**	**1.50^{c}**	**2.05^{b}**	**1.30^{d}**	**1.32^{d}**	**1.03***
Average Feed Cost/ Hen	**34.94**	**35.24**	**36.44**	**33.94**	**37.34**	**2.27**

Table 3 revealed significant feed consumption for Treatment D compared with Treatments B and C which are similar but varied from Treatments A and E which are related (P>0.05). However, birds on Treatments A and E consumed less feed per day whereas birds on Treatment D ate much more feed per day due probably to the low protein content of this diet. Additionally, birds on Treatment D consumed more feed so as to meet their protein and energy requirements for growth and development. The feed consumed reported herein was higher than the report of Agbolosu *et al.* (2012) for Guinea layers in Ghana due probably to variation in the environment and feed composition.

Percentage egg production was significantly higher in Treatment A compared with Treatments B> D> C and E respectively. In addition, hens fed Treatments C and D had similar egg production (P>0.05) compared to the Control hens without HBPM supplementation. With the exception of Treatments C and E (Control). Treatments (A, B, and D) recorded egg production of between 54.2 and 67.1% and this agreed with the report of Bernacki *et al*.(2013) but lower than the reported values of Ayorinde (1991) (60–90 eggs); Bernacki and Heller (2003) and Nowaczewski *et al.* (2008).

Additionally, egg weight followed a similar trend as egg production. It is apparent from this study that the mean egg weight was higher than the reported values of 46.7 g in grey guinea fowl (Song *et al*., 2000), 40.8 g by Shahi *et al*. (2007). However, Nowaczewski *et al*. (2008) noted significantly higher egg weight (55.3g) in meat-type guinea fowl originating from France. The higher egg weight reported herein is a welcome development since egg weight weighing not less than 38g and not more than 51g resulted in best hatching when incubated (Royter, 1980).

Eggshell and egg content quality as well as the physical composition of the egg play a significant role in embryogenesis. Eggshell thickness was highest for Treatments D higher for C and high for B. Benton and Brake (1996); Narushin and Romanov (2002) observed that the hatchability principal depends on egg weight, shell thickness, shell porosity, egg shape index, physical composition of the egg, and albumen quality. The average shell thickness (0.27-0.48mm) found in this study fell between 0.30 mm and 0.55mm (Ayorinde, 1991; Kuzniacka *et al*., 2004; Nowaczewski *et al*., 2008; Ahmed *et al*., 2009; Wilkanowska and Kokoszynski, 2010). It is interesting to note that the highest shell thickness found in this study was 0.48mm which prevents hatching problems in chicks as well as reduction of mortality thereby compromising hatching success.

Feed consumed per dozen eggs / Feed efficiency per dozen eggs considered feed intake and egg production hence, it is the ratio between the feed consumed and the number of eggs produced. The result reported herein showed a significant difference (p<0.05) among all the Treatments with Treatment A recording a value of 1.30 which was found to be advantageous to the farmers (Table 3). This shows that Guinea hen on Treatment A consumed 1.30g of diet to produce a dozen eggs which is beneficial to poultry farmers.

Feed efficiency/kg egg mass: It takes into consideration feed intake, egg weight, and egg production. It is the ratio between the feed consumed and the egg mass. The results showed a significant trend as Treatments A (2.00) > B (2.09) > E (2.10), > C (2.11) > D (2.14). A value of 2.2 or less is advantageous (http://www.agritech.tnau.ac.in/expert_system/poultry/Layer) to the farm. All the Treatments are efficient but diet A was found to be more advantageous to the farmers.

Hen-Housed Egg Production (HHEP): It is calculated as the total number of eggs laid during the period / Total number of hens housed at the beginning of the laying period. It is usually expressed in numbers. HHEP is good as it measures the effects of both egg production and mortality. The values reported in this study showed that Treatments B (378) > E (334)> A (298) >C (254) and D (244). The results showed that Treatment B is desirable from the standpoint of the cost of egg production.

Egg: Feed Price Ratio (EFPR): It is used to report on the ratio between the receipts from egg and expenditure on feed. EFPR =Total value of egg produced /Total value of feed consumed. The values of EFPR reported herein were A (2.31); B (1.5); C (2.05); D (1.30) and E (1.32). It indicated that Treatments A and C were better compared with B, D, and E. The best desirable was Treatment A followed by Treatment C and the least was Treatment B. An EFPR ratio of 1.4 and above is desirable. (http://ecoursesonline.iasri.res.in/mod/page/view.php?id=61096).

Average Feed Cost/hen: Total Feed Cost divided by the Average number of hens gave the following results in this study: A (34.94); B (35.24); C (36.44); D (33.94) and E (37.34). The efficacy of Treatment D was the best followed by Treatment A and the least and poor feed cost/ hen was Treatment E (control).

Conclusion and Implications

It was observed from the study that Guinea fowl hens on Treatment A consumed less feed per dozen egg, recorded highest egg production as well as exhibited better feed efficiency/kilogram egg mass. Additionally, Egg: Feed price ratio was better and the average feed cost/hen was also better. It is suggested that farmers should include 3% Hatchery by-product meal to replace Groundnut cake in the diet of Guinea fowl laying hen based on better performance reported herein.

Conflict of Interest

The author certifies that there was no conflict of interest regarding financial, personal, or other affairs with some persons or society related to the materials discussed in this manuscript.

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