Performance and Egg Quality Characteristics of Layers Fed Diets Containing Combinations of Brewers Dried Grains, Jack Bean and Cassava Root Meal

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Abstract: The performance, egg quality characteristics and feed cost of layers fed combinations of maize/sorghum-based brewers dried grains (MSBDG), jack bean (JB) and cassava root meal (CRM) in replacement of maize. Four treatment diets: LD_1, LD_2, LD_3 and LD_4 were formulated such that they contained maize, MSBDG, JB and CRM in the following proportions: 50, 0, 0, 0%; 0, 10, 15, 25%; 0, 10, 20, 20% and 0, 10, 25, 15% respectively. Ninety six Shika brown layers were divided into 4 treatment groups of 24 birds each and each group subdivided into 3 replicates of 8 birds. The birds were randomly assigned to the diets in a completely randomized design experiment. Nine eggs were selected from each treatment group on the last day of the 4^{th}, 8^{th}, 12^{th} and 16^{th} week for egg quality analysis. The egg weight of LD_2 birds was significantly ($p<0.05$) higher than that of LD_3 birds. The birds on LD_1 had superior feed conversion ratio value which was significantly ($p<0.05$) lower than those of LD_2 and LD_3 birds. The Haugh unit for LD_1 and LD_2 birds were significantly ($p<0.05$) higher than that of LD_3. The shell thickness value for LD_1 birds differed significantly ($p<0.05$) with that of LD_4 birds. All the other parameters measured were similar among the groups. In terms of cost of feed required to produce 1kg egg, MSBDG/JB/CRM diets were cheaper, being 6.27%, 5.59% and 14.42% lower than the cost of feed required to produce 1kg egg for LD_1 diet. [Report and Opinion. 2010;2(1):33-37]. (ISSN: 1553-9873).

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1. Introduction

As human population continues to grow, there is need to ensure food safety for all, especially the more susceptible sector of human population. There is increasing need for land for development of new neighbourhood, industries, recreational parks and other facilities. The consequence of this is a gaping need for food of both plant and animal origin, thereby increasing the cost of food and feedstuffs, hence driving food out of reach of most people (Adeola and Olukosi, 2009).

There is therefore need to reduce the competition between man and livestock for the same feedstuffs by turning to unconventional feedstuffs in the short run while plant breeders work towards obtaining high yielding varieties of crop which will ensure adequate surplus and quality feed for livestock (Uchegbu, 2005). It had earlier been reported that future expansion and sustenance of poultry industry depend on availability of grains above that required for human consumption (Patrick and Shaible, 1980).

Most poultry feeds are cereal-based, as cereals often comprise between 50-75% of the diet. These cereals supply a high proportion of starch which provides the dietary energy. Cereal grains (e.g. maize, sorghum, wheat and barley) contribute most of the carbohydrates to poultry diets. The majority of carbohydrates of cereal grains occur as starch, which is readily digested by poultry (Moran, 1985). Other carbohydrates which occur in varying concentrations in cereal grains and protein supplements include polysaccharides and oligosaccharides all of which are poorly digested by poultry. It has been reported that the pentosans and beta glucan of some cereals increase the viscosity of digesta, and therefore interferes with nutrient utilization of poultry (Wagner and Thomas, 1978; Antonio and Marquardt, 1981; Bedfor *et al*., 1981).

The question now is how we simulate the cereal component of the diet (maize) with unconventional feed ingredients using maize/sorghum based brewers dried grains, jack bean and cassava root meal bearing in mind their peculiarities (Uchegbu 1995; Udedibie, 1990; Aduku, 1993; MacDonald *et al*., 1988; Ogbonna, 1991; Udedibie *et al*., 2004).

The objective of this study is to assess the performance and egg quality values of laying hens fed combinations of brewers dried grains, jackbean and cassava root meal as the major dietary energy sources; and investigate the feed cost implications of these combination products in layer production.

2. Materials and Methods

2.1 Experimental location

This research was carried out in the poultry unit of the Teaching and Research Farm of the Department of Animal Science and Technology, Federal University of Technology, Owerri, Imo State. Imo state ($4^o4'$ - $6^o3'$ N, $6^o15'$ - $8^o15'$ E) is situated in south-eastern agro-ecological zone of Nigeria. The mean annual rainfall, temperature range and humidity range of the area were 2500 mm, 26.5 - 27.5 ^{0}C and 70 - 80 %, respectively

2.2 Sources and processing of test ingredients

The Consolidated Breweries Plc, Awo-omamma, Imo State, the brewers of '33' Export Larger Beer, was where the maize/sorghum-based brewers' grains used for this experiment was obtained. The wet grains were sun-dried for 5 days and then run through hammer mill to break its lumps before use in the ration formulation.

Proximate analysis of maize/sorghum-based brewers' dried grains was conducted using standard methods (A.O.A.C., 1995) to determine its content of crude protein, crude fibre, ether extract, total ash and nitrogen free extract.

The jack bean which was grown in Jos, Plateau state, Nigeria, was cracked and soaked in water for 2 days, boiled for 1 hour and then sundried and milled before use in ration formulation.

The cassava tubers used for this experiment were produced at Mgbirichi, Imo State, Nigeria. Whole fresh cassava tubers were cut into small slices of about 0.1-0.2cm and then spread on a platform under the sun to dry within 5 days. The dried cassava chips were then milled to produce the cassava root meal (CRM). Proximate analysis of the cassava was also conducted (A.O.A.C., 1995).

2.3 Experimental diets

Four experimental diets were prepared in a way that Diet 1 (LD_1) (the control) contained no maize/sorghum-based brewers' dried grains, jackbean and cassava root meal. Diet 2 (LD_2), Diet 3 (LD_3) and Diet 4 (LD_4) contained varying combinations of MSBDG, jackbean and CRM which completely replaced maize. Other ingredients were included at the same level for the four experimental diets namely LD_1, LD_2, LD_3 and LD_4. The ingredient composition of the experimental diets is shown in Table 1.

Table 1: Ingredient composition of layer experimental diets (g/100g diet)

Ingredient	Diets (% inclusion levels of test ingredients)			
	T_1	**T_2**	**T_3**	**T_4**
White maize	50.00			
MSBDG	-	10.00	10.00	10.00
Jackbean	-	15.00	20.00	25.00
Cassava root meal	-	25.00	20.00	15.00
Alchornea leaf meal	7.00	2.00	2.00	2.00
Bone meal	4.00	7.00	7.00	7.00
Calculated nutrient analysis (%)				
Crude protein	17.65	19.37	20.33	21.29
Crude fibre	4.42	6.26	6.51	6.77
Ether extract	3.78	2.88	2.95	3.02
Calcium	4.19	4.27	4.26	4.26
Phosphorus	1.65	1.70	1.73	1.75
ME (Kcal/Kg)	2600.26	2241.71	2241.71	2514.88

Each data contained 15% soybean meal, 12% wheat offal, 5% palm kernel cake, 2% fishmeal, 2% blood meal, 4% bone meal, 0.25% methionine, 0.25% lysine, 0.25% vitamin / mineral premix, 0.25% common salt. Vitamin / mineral premix contributed the following per kg of feed: vitamin A, 10,000,000 I.U.; vitamin D_3, 2,000,000 I.U.; vitamin E, 16.0g; vitamin K, 1.0g; vitamin $B_{1,}$ 0.509 mg; Riboflavin, 2 - 4 mg; pyridoxine, 0.35 mg; niacin, 3.5 mg; biotin, 0.005 mg; choline chloride 30.0 mg; folic acid 0.1 mg; vitamin B_{12}, 0.002 mg; vitamin C, 2.50 mg; manganese, 10.0 mg; zinc, 4.5 mg; Copper 0.20 mg; iron 5.0 mg; methionine 2.0 mg; calcium panthothenate 1.0 mg; antioxidant 120,000mg; selenium, 120mg.

2.4 Experimental birds and design

Ninety six (96) Shika Brown layers which were in the 3rd month of laying life (i.e. 8 months old) were randomly divided into four treatment groups of 24 birds each. Each treatment group was further subdivided into 3 replicates of 8 birds. The birds were housed in a 2m x 2m compartment of cemented floor, covered with wood shavings as litter material. The design was a completely randomized design (CRD). Feed and water were provided *ad libitum*. Routine vaccination and necessary medication were administered to keep the birds healthy. The feeding trial lasted 16 weeks.

2.5 Data collection

The birds were weighed at the beginning and end of the trial. Eggs were collected twice daily, morning and evening. All the eggs collected during the period of the experiment were weighed. Feed intake was determined by obtaining the difference between the quantity of feed offered and the quantity of feed remaining in the morning of the following day.

2.6 Egg quality characteristics

Nine eggs from each experimental group (3 eggs per replicate) were collected on the last day of the 4th, 8th, 12th and 16th week of the experimental period for egg quality characteristics analysis. The quality parameters investigated include Haugh unit, yolk index, albumen index, shell thickness and yolk colour. The eggs were weighed after collection and average weight of each group determined.

2.7 Data analysis

Data collected on hen-day production, average feed intake and feed conversion ratio were subjected to one-way analysis of variance (ANOVA), and where significant treatment effects ere detected, Duncan's Multiple Range Test as outlined by Steel and Torrie (1980) was used to compare the treatment means.
Similarly, data on egg quality characteristics (Haugh unit, yolk index, albumen index, shell thickness, yolk colour) for the treatment groups were subjected to analysis of variance (ANOVA) and their means compared using Duncan's Multiple Range Test as outlined by Steel and Torrie (1980).

3. Results

The data on the performance of the experimental birds are shown in Table 2. The lowest feed intake value occurred in birds fed the control diet (LD_1) and this was similar to those fed LD_4. The birds on LD_2 and LD_3 had significantly ($p<0.05$) higher feed intake than those on LD_1. The egg weight for LD_2 birds was significantly ($p<0.05$) heavier than that of LD_3 birds. Birds on LD_1 and LD_4 diets recorded the best feed conversion ratio of 1.81 and 1.91 respectively, the values of which were not significantly ($p>0.05$) different. The birds on LD_2 and LD_3 diets had significantly higher ($p<0.05$) feed conversion ratio relative to LD_1 birds.

LD_3 birds gained significantly ($p<0.05$) more weight per day than LD_2 birds, but there was no other significant differences among treatments in daily weight gain. Hen day egg production for LD_1 was significantly ($p<0.05$) higher than that for LD_4 birds. LD_2 and LD_3 birds had similar ($p>0.05$) hen-day production, which compared favourably with that of LD_1 and LD_4.

Table 2: Effect of Combinations of maize/sorghum-based brewers' dried grains (MSBDG), jack bean (JB) and cassava root meal (CRM) on the production performance of laying hen.

Parameter	LD_1	LD_2	LD_3	LD_4	SEM
Hen day production (%)	68.39^{a}	64.59^{ab}	56.78^{ab}	51.86^{b}	3.74
Body weight change (kg)	0.37^{ab}	0.33^{a}	0.36^{b}	0.36^{ab}	0.01
Average egg weight (g)	60.59^{ab}	61.39^{a}	60.40^{b}	61.22^{ab}	0.24
Average feed intake (g/bird/day)	109.50^{b}	124.12^{a}	125.20^{a}	117.10^{ab}	3.64
Feed conversion ratio (kg feed/ kg egg)	1.81^{b}	2.02^{a}	2.07^{a}	1.91^{ab}	0.06
Mortality (absolute number)	-	-	-	-	-

^{a,b}Means in the same row bearing different superscripts are significantly ($p<0.05$) different; SEM-Standard error mean.

The effect of combinations of MSBDG, Jackbean and cassava root meal on egg quality characteristics of laying hens is presented in Table 3. Eggs from LD_1 and LD_2 birds had significantly ($p<0.05$) higher Haugh unit score than those from LD_3 birds which compared favourably with those from LD_4. The yolk index value of LD_1 was significantly ($p<0.05$) higher than that of LD_3 and LD_4, which were similar ($p>0.05$) to that of LD_2. The albumen index values of the eggs from LD_1 and LD_2 were similar ($p>0.05$) and these were significantly ($p<0.05$) higher than that of LD_3 birds which was similar to LD_4.

The shell thickness of LD_1 birds was significantly ($p < 0.05$) thicker than that of LD_4 birds, but there were no significant ($p>0.05$) differences among treatments in shell thickness. The yolk colour values of eggs from the four treatment groups were similar ($p>0.05$).

Table 3: Egg quality parameters of laying hens fed combinations of maize/sorghum-based brewers' dried grains (MSBDG), jack bean (JB) and cassava root meal (CRM).

Egg quality parameters	LD_1	LD_2	LD_3	LD_4	SEM
Haugh unit	87.12^{a}	86.44^{a}	80.47^{b}	83.20^{ab}	1.54
Yolk index	0.48^{a}	0.44^{ab}	0.41^{b}	0.42^{b}	0.02
Albumin index	0.09^{a}	0.08^{a}	0.07^{b}	0.08^{ab}	0.01

Shell thickness (mm)	0.37^{a}	0.36^{ab}	0.34^{ab}	0.33^{b}	0.01
Yolk colour	2.60	2.70	2.90	2.70	0.06

^{a,b}Means in the same row bearing different superscripts are significantly ($p<0.05$) different; SEM-Standard error mean.

The control (LD_1) group recorded the highest cost of feed required to produce 1kg of egg. In the various combinations of MSBDG/JB/CRM diets, it cost 6.27%; 5.59% and 14.42% for LD_2, LD_3 and LD_4 less to produce 1kg of egg than it will cost the control diet (maize-based diet) (Table 4).

Table 4: Feed Cost Evaluation of Combinations of MSBDG, JB and CRM in Layer diets

Economic consideration	LD_1	LD_2	LD_3	LD_4
Kg feed / kg egg produced	1.81	2.02	2.07	1.91
Cost of feed (US$ / Kg)$^{+}$	0.50	0.42	0.41	0.40
Cost of feed / kg egg (US$)	2.31	2.44	2.48	2.31
Cost reduction (%)$^{++}$	0.00	6.27	5.59	14.42

$^{+}$Cost of feed was calculated based on the prevailing ingredient cost.
$^{++}$Relative to the control (LD_1)

4. Discussion

There was a marked inconsistency in feed intake as the energy value of the diet decreased and the fibre content of the diet increased. This was attributed to limitation imposed by bulk as a result of high fibre content. In all the treatments, the average sizes ranged from 60 – 61g, thereby tending toward extra - large size (≥ 63g) (Aduku, 1991). In Nigeria, most commercial egg producers often emphasize more egg size as a measure of profit at the expense of other parameters. This could partly explain the greater emphasis by poultry breeders on the development and improvement of this trait (egg size) in chicken (Essien, 1989).

It was generally observed that all the four treatment diets favoured body weight gain. Thus the farmer (producer) would gain from the sale of his spent layers (old layers) as their selling price is usually based on their live weight. There was no mortality among the treatment birds throughout the 4 month duration of the experiment. The zero mortality suggests that the various combinations of MSBDG/Jackbean/CRM produced products that were not deleterious to the health of the laying hens.

The Haugh unit values recorded for the four treatment groups were within the range of freshly-laid eggs (Olomu, 1975; Essien 1990). Haugh units of 72 and above are indication of freshness in eggs – an index of ability of albumen to remain viscous. The yolk index is a measure of the standing-up quality of the yolk; and the range of values (0.41 – 0.48) observed for the four treatments were similar to that reported by Olomu (1975) and Essien (1990). Other reports of yolk index values of fresh eggs vary between 0.33 and 0.50 (Card and Neshien, 1996). The albumen index values recorded here were in line with the values in literature for fresh eggs (Essien *et al.*, 1996).

Numerically, the shell thickness appeared to be decreasing with increasing replacement level of cassava root meal with jackbean. This could be linked with the high fibre content of jackbean which tends to interfere with mineral absorption. Going by the report by Stadelma (1986), the four treatment diets met the requirement of at least 0.33mm shell thickness if the egg were to have more than 50% chance of moving through market handling without breaking.

The yolk colour range of 2.6 – 2.9 showed that the 2% dietary level inclusion of *alchonia* leaf meal in each meal in each of the treatment diet was not high enough to increase the yolk score, and thus had little effect on yolk colour.

Replacement of maize with various combinations of MSBDG/Jackbean/CRM produced diets that were cheaper relative to the control diet. When the cost of production was evaluated based on kg feed required to produce 1kg egg, it was observed that LD_4 was the most economical diet in terms of the cost of feed required to produce 1kg egg.

5. Conclusion

With regard to egg quality, the trial showed that the fresh eggs produced by each of the four treatment diets fell within the range of normal egg sizes; the yolk index values of the eggs from the various treatment groups were within the reported range of 0.33 – 0.50 for fresh eggs; and their shell thickness values of ≥ 0.33mm, indicating that the eggs will not crack easily during handling / transportation.

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