# Performance and egg quality characteristics of layers fed diets containing combinations of brewers dried grains, jack bean and cassava root meal

Rendimiento y características de la calidad del huevo de gallinas ponedoras alimentadas con dietas que contienen combinaciones de granos secos de cervecería, canavalia y harina de raíces de yuca

**Martins Chukwudi UCHEGBU, Udo HERBERT, Ifeanyi Princewill OGBUEWU ✉, Chibuzo Hope NWAODU, Babington Onyemaechi ESONU and Adive Boniface Ikeli UDEDIBIE**

Department of Animal Science and Technology, Federal University of Technology, P. M. B.1526, Owerri, Imo State, Nigeria. E-mail: princiano2001@yahoo.com ✉ Corresponding author

Received: 11/16/2009 First reviewing ending: 09/14/2010 First review received: 11/22/2010 Accepted: 01/15/2011

## 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 feed cost 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.

**Key words:** Laying birds, feedstuffs, egg, performance

## RESUMEN

El rendimiento, las características de la calidad del huevo y costos de alimentación de ponedoras alimentadas con combinaciones de granos secos de cervecería basados en maíz/sorgo (GSCMS), *Canavalia ensiformis* L. (CE) y harina de raíces de yuca (HRY) en reemplazo de maíz. Cuatro dietas de tratamiento: $LD_1$, $LD_2$, $LD_3$ y $LD_4$ se formularon de tal manera que contenían maíz, GSCMS, CE y HRY en las siguientes proporciones: 50, 0, 0, 0%, 0, 10, 15, 25%; 0, 10, 20, 20% y 0, 10, 25, 15%, respectivamente. Noventa y seis ponedoras Shika Brown se dividieron en 4 grupos de tratamiento de 24 aves cada uno y cada grupo subdividido en 3 repeticiones de 8 aves. Las aves fueron asignadas al azar a las dietas en un experimento de diseño completamente al azar. Nueve huevos se seleccionaron de cada grupo de tratamiento en el último día de la 4$^{ta}$, 8$^{va}$, 12$^{va}$ y 16$^{va}$ semana para el análisis de la calidad del huevo. El peso de los huevos de las aves del tratamiento $LD_2$ fue significativamente ($p < 0,05$) mayor que el de las aves del tratamiento $LD_3$. Las aves en $LD_1$ tuvieron un mayor valor de la relación de conversión del alimento, la cual fue significativamente ($p < 0,05$) menor que aquellas de las aves de $LD_2$ y $LD_3$. La unidad Haugh para la aves de $LD_1$ y $LD_2$ fue significativamente ($p < 0,05$) mayor que aquella de $LD_3$. El valor del grosor de la concha de la aves de $LD_1$ difirieron significativamente ($p < 0,05$) con aquella de la saves de $LD_4$. Todos los demás parámetros medidos fueron similares entre los grupos. En términos de costos del alimento necesario para producir 1 kg de huevo, las dietas con GSCMS/CE/HRY fueron más baratas, siendo 6,27, 5,59 y 14,42% menores que el costo del alimento necesario para producir 1 kg de huevo para la dieta $LD_1$.

**Palabras clave**: Aves ponedoras, alimento concentrado, huevo, rendimiento

## 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 Schaible, 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 glucans of some cereals increase the viscosity of digesta, and therefore interferes with nutrient utilization by poultry (Wagner and Thomas, 1978; Antoniou and Marquardt, 1981; Bedford *et al*., 1981). The question now is how to 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; Ogbonna, 1991; Udedibie *et al*., 2004).

The objectives of this study were 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 to investigate the feed cost implications of these combinations in layer production.

## MATERIALS AND METHODS

### 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

### 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 jackbean 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).

### 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.

### Experimental birds and design

Ninety six (96) Shika Brown layers which were in the 3$^{rd}$ 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. 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.

**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.

**Egg quality characteristics**

Nine eggs from each experimental group (3 eggs per replicate) were collected on the last day of the $4^{th}$, $8^{th}$, $12^{th}$ and $16^{th}$ 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.

**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 were 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).

## RESULTS AND DISCUSSION

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

Table 1. Ingredient composition of Shika Brown 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 |
| Metabolizable energy (Kcal/Kg) | 2600.26 | 2241.71 | 2241.71 | 2514.88 |

† MSBDG: Maize/sorghum-based brewers dried grains

Each data contained 15% soybean meal, 12% wheat offal, 5% palm kernel cake, 2% fish meal, 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 120,000 mg; selenium, 120mg.

$LD_4$. The birds on $LD_2$ and $LD_3$ had significantly ($p<0.05$) higher feed intake than those on $LD_1$. 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.

The egg weight for $LD_2$ birds was significantly ($p<0.05$) heavier than that of $LD_3$ birds. 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, 1990).

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 ratios 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. 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 prices were usually based on their live weight.

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 $LD_4$. 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 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 Haugh unit values recorded for the four treatment groups were within the range of freshly-laid eggs (Essien 1990). Haugh units of 72 and above are indications of freshness in eggs – an index of ability of albumen to remain viscous.

Table 2. Effect of combinations of maize/sorghum-based brewers' dried grains, jack bean and cassava root meal on the production performance of Shika Brown laying hens.

| 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.

Table 3. Egg quality parameters of Shika Brown laying hens fed combinations of maize/sorghum-based brewers' dried grains, jack bean and cassava root meal.

| 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 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 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 Essien (1990).

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 those of $LD_3$ birds which were similar to $LD_4$. The albumen index values recorded here were in line with the values in literature for fresh eggs (Essien, 1990).

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. 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 values of eggs from the four treatment groups were similar ($p>0.05$). 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. 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).

## 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.

## LITERATURE CITED

Adeola, O. and O. A. Olukosi. 2009. Opportunities and challenges in the use of alternative feedstuffs in poultry production. Proceedings of the 3rd Nigeria International Poultry Summit, 22-26 February 2009. Abeokuta, Ogun State, Nigeria. p 44-54.

Aduku, A. O. 1993. Tropical feedstuff analysis iable, Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Samaru, Zaria, Nigeria.

Aduku, J. O. 1991. Animal products handling and processing in the tropics, Living Book Series Publication, Abuja FCT, Nigeria.

Antoniou, T. and R. R. Marquardt. 1981. Influence of rye pentosans on the growth of chicks, Poultry Science. 60:1896

Table 4. Feed cost evaluation of combinations of maize/sorghum-based brewers' dried grains, jack bean and cassava root meal in Shika Brown 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 (LD1)

A.O.A.C. 1995. Official methods of analysis. 15th Edition Association of Official Analytical Chemists, Washington, D. C. United States of America.

Bedford, M. R.; H. L. Classen and G. L. Campbell. 1991. The effect of pelleting, salt and pentosanase on the viscosity of intestinal contents and the performance of broilers fed rye. Poultry Science 70 (7): 1571-1577.

Essien, A. I. 1990. Egg quality traits and their relationships as affected by storage method and duration of storage in the humid wet climate. Beitr. Trop. Landwitsch. Veterinary Medicine 28 H3: 345-353.

Moran, E. T. 1985. Digestion and absorption of carbohydrates in fowl and events through prenatal development. Journal of Nutrition 115: 665- 674.

Ogbonna, J. U. 1991. Studies on the value of processed cassava peels in the nutrition of cockerel, Ph.D Thesis, University of Ibadan, Ibadan, Nigeria.

Patrick, H. and P. J. Schaible. 1980. Poultry: Feed and Nutrition. AVI Publishing Co. Inc. West Port Connecticut. United States of America.

Stadelma, W. J. 1986. Quality identification of shell eggs. In: Egg science and technology, W. J. Stadelma and O. J. Colteria (eds.). 3rd Edition AVI publishing co. Inc Westport Connecticut, p. 39-42.

Steel, G. D. and J. H. Torrie. 1980. Principles and procedures of statistics. 2nd edition. McGraw Hill Book C. Inc. New York, United States of America.

Uchegbu, M. C. 1995. Studies on the nutritive value of maize/sorghum-based brewers dried grains for broilers. M.Sc. Thesis. Federal University of Technology Owerri. Nigeria.

Uchegbu, M. C. 2005. Combinations of brewer's grains, jackbean and cassava root meals as major energy sources for poultry. Ph.D Thesis, Department of Animal Science, Federal University of Technology Owerri. Nigeria.

Udedibie, A. B. I. 1990. Nutritional evaluation of jackbean (*C. ensiformis*) for the Nigeria poultry industry. AMBIO 19:361-365.

Udedibie, A. B. I.; B. C. Anyaegbu; G. C. Onyechekwa and O. C. Egbuokporo. 2004. Effect of feeding different levels of fermented and unfermented cassava tuber meals on performance of broilers. Nigerian Journal of Animal Production 31 (2): 211-219.

Wagner, D. D. and O. P. Thomas. 1978. Influence of diets containing rye or pectin or the intestinal flora of chicks. Poultry Science 57 (4): 971-975.