Evaluating the Performance Indices of Gold Neslink Egg-Type Chickens Fed with an Egg Enhancing Bio-Fortified Cassava (Mannihot esculenta Cranz) Root Meal

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Abstract

A 52-week study investigated the impact of incorporating an egg-enhancing supplement (Farmers Solution Provider: Multiple Dropping-FSPMD) as a bio-fortifier in a cassava-based diet on the performance of Gold Neslink egg-type chickens. The cassava root meal (CRM) replaced maize at graded levels (0, 25, 50, 75, and 100%), while FSPMD was added at 130g/100Kg feed for layers. Ten experimental diets were formulated, with five fortified with FSPMD and five without. Three hundred 12-week-old pullets were randomly assigned to ten dietary treatments (T1-T10), with thirty birds per treatment and three replicates in a 5 x 2 factorial arrangement in a Completely Randomized Design. The results from the laying stage (PHASE 2) showed significant differences (P < 0.05) in performance indices, including hen-day production, average egg weight, average daily feed intake, feed cost per dozen eggs, eggshell thickness, Haugh unit score, and incidence of cracked eggs. The bio-fortified treatment groups (T6-T10) outperformed the non-treated groups (T1-T5), with higher values for most production parameters. The inclusion of FSPMD in the diet did not affect mortality rates during the experiment.

INTRODUCTION

The scarcity of animal protein in developing countries is a pressing concern, with Nigerians consuming a mere 10g of protein per capita, of which only 3.2g comes from animal sources (FAO, 2006). This protein deficit has been exacerbated by poverty and the high cost of animal feed (Aderolu, 2003), leading to a decline in animal products in the average Nigerian diet. Poultry farming offers a solution to bridging this protein gap, but the high cost of feed, which accounts for 70-80% of production costs (Omeje et al., 1999; Ijaiya et al., 2004), poses a significant challenge. The limited availability and high demand for cereals in Nigeria further constrain the economic viability of poultry production (Adejumo, 2004). Addressing these challenges is crucial to enhancing animal protein intake and promoting sustainable poultry production in developing countries

Pressure from consumers for cheap animal products has necessitated the assessment of local feed ingredients in replacement of the conventional ingredients (Oluokun, 2001). One of the advocated alternatives for replacement of maize in poultry diet is the processed cassava root meal. Cassava (*Manihot esculenta*) is a very popular and abundantly produced tuber crop. It contains

2.66 percent crude protein, 77.13 Nitrogen Free Extract (NFE) and 2680 Kcal kg^{-1} Metabolizable energy (Aduku, 1993). Although it is low in protein, its energy content is high and its price relative to maize is competitive. However, **c**assava alone cannot replace maize in layer diets without adversely affecting the performance (Eruvbetine *et al*., 1994). The low protein content, essential vitamins and minerals of cassava tubers have been the major factor limiting its use in poultry diets; therefore nutrients' balance in cassava nutrition is inevitable. This can be achieved by incorporating cassava leaves, seeds, or cakes, which are richer in protein, into the diet (Ngika *et al*. 2014) or supplementing the diet with synthetic amino acids, through use of supplements and more than one source of protein. Oruwari *et al*. (2003) stated that with proper protein balance, cassava meal could completely replace maize in poultry diets. Cassava must also be subjected to biofortification of micronutrients, such as vitamin A, iron and Zinc, in areas where mineral and vitamin deficiencies are widespread (Montagnac *et al*. 2009). The use of cassava as an alternative to conventional energy feed stuffs like maize could help to reduce feed costs (Ukachukwu, 2005). Animal Feed Supplement Manufacturers are not relenting in their efforts to come up with new Products that will help improve performance of laying birds. Recently, a Company called Levjenau Agro & Electrical Company Limited introduced a supplement known as Farmers solution provider: multiple dropping (FSPMD). The Makers claim that the Product, which is completely organic, has the efficacy to promote early ovulation of the hen and makes them start laying eggs as soon as possible and triples the dropping of eggs per hen on daily basis. They also claim that it can increase the size of eggs. There is no literature evidence to support any of these claims. To verify these claims, an out station investigation was designed to evaluate the performance of egg type chicken fed with or without an egg enhancing bio-fortified cassava root meal.

MATERIALS AND METHODS

The study was conducted at the Department of Animal Science Teaching and Research Farm, University of Nigeria, Nsukka. Nsukka lies in the Derived Savannah region, and is located on Longitude 6^{o} 25´ N and Latitude 7^{o} 24´ E (Ofomata, 1975).

Three hundred (300) 12-week old Gold Neslink pullets were used for the study. The birds were weighed and randomly assigned to the ten dietary treatments at thirty birds each. Each treatment had three replications of ten birds each. At the end of the Pullet Stage, mortalities were recorded; two hundred and forty (240) birds were then selected for the present study. The birds were weighed and randomly assigned to ten (ten) dietary treatments of twenty four (24) birds each. Each treatment had three replications of eight (8) birds each. Feed and water were provided *ad libitum*. Routine vaccination and necessary medication as usual were given to the experimental birds.

The cassava roots were purchased from the local market. The roots were peeled, washed, chopped and sun-dried. The dried chips were grounded in a hammer mill and the resulting meal was used in the experimental diet. An organic egg enhancing supplement – Farmers solution provider: multiple dropping (FSPMD) was purchased from Nia Agro Investment Nig. Limited located at Onitsha-Owerri Express Way, behind First City Monument Bank, Ihiala, Anambra State. This was used to fortify the cassava based diets. .

The cassava root meal was included in formulated experimental diets at graded levels of 0, 25, 50, 75, and 100% in replacement of maize while the FSPMD was included at the rate of 130g /100Kg feed for the layers as recommended by the manufacturer (Levjenau Agro & Electrical Co., Ltd.). The Company is based in Malaysia.Ten experimental diets were formulated. Five of the experimental diets were fortified with the organic supplement while the other five were not fortified. The diets were formulated to be isonitrogenous (18 % CP) for layers (Tables 1). The Proximate composition of experimental diets were as depicted in Table 3**.** This study lasted for fifty two (52) weeks (from 23rd - 74th week). During 21st - 22nd weeks, the birds were gradually being familiarized to the new diet (layer mash). Data obtained were subjected to analysis of variance (ANOVA) in a 5 x 2 factorial in Completely Randomized Design (CRD) as described in Statistix (2003) version 8.0. Means were separated using Duncan New Multiple Range Test (DNMRT) at $P < 0.05$.

Table 1: Percentage composition of the Layer diet containing cassava root meal with or without FSPMD- PHASE 2

	LAYER PHASE									
INGREDIENT	**T1 (0)**	**T2 (25)**	**T3 (50)**	**T4 (75)**	**T5 (100)**	**T6 (0)**	**T7 (25)**	**T8 (50)**	**T9 (75)**	**T10 (100)**
Maize	45	33.75	22.50	11.25	0	45	33.75	22.50	11.25	0
Cassava	0	9.25	18.50	27.75	37	0	9.25	18.50	27.75	37
Soybean meal	13	15	17	19	21	13	15	17	19	21
wheat offal	30	30	30	30	30	30	30	30	30	30
PKC	5	5	5	5	5	5	5	5	5	5
Fish meal	2	2	2	2	2	2	2	2	2	2
Bone meal	4	4	4	4	4	4	4	4	4	4
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
VMP	0.25	0.25	0.25	0.25	0.25	0.12	0.12	0.12	0.12	0.12
FSPMD	0	0	0	0	0	0.13	0.13	0.13	0.13	0.13
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
CP(%)	17.99	18.10	18.21	18.20	18.20	17.99	18.10	18.21	18.21	18.20
CF(%)	5.98	5.86	5.76	5.55	5.55	5.98	5.86	5.76	5.76	5.55
ME(kcal/kg)	2587	2583	2579	2575	2572	2587	2583	2579	2575	2572
Cost of feed per kg (₦)	96.20	91.60	90.61	81.61	88.61	95.30	94.30	93.31	92.31	91.31

The organic bio-fortifier- Farmers Solution Provider: Multiple Dropping, an egg enhancing supplement furnished the following amounts of other ingredients per kilogramme of feed: Vitamin A-125000µ ; Vitamin E-4000µ ; Vitamin B2-50mg ; Vitamin B6-10mg ; Vitamin D-15000µ ; Herba epimedii-20mg ; Motherwort-100g ; Isatis root-50g ; Astragalus mongholicus-50g ; Adenophora stricta-50g ; Medicated leaven-200mg and Desert cistanche-50g.

Table 3: Proximate composition of experimental layer diet with or without FSPMD (Dry matter basis)- PHASE 2

	Treatments									
Parameters (%)	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**T_9**	**T_{10}**
CP	18.47	17.88	18.05	18.27	18.04	17.98	18.36	18.52	17.74	17.96
CF	4.45	4.52	5.00	5.54	5.31	4.93	5.20	4.65	5.08	5.56
EE	3.02	2.59	3.19	2.84	3.25	3.15	2.82	2.98	3.07	3.22
Ash	3.87	4.55	4.00	4.32	3.90	4.05	3.73	4.17	3.68	4.20
NFE	70.19	70.46	69.76	69.03	69.50	69.89	69.89	69.68	70.43	69.02

RESULTS AND DISCUSSIONS – PHASE 2 (Laying stage)

Production attributes of the experimental birds during the grower phase are shown in Table 4 .

HEN DAY PRODUCTION, HDP (%)

Mean values of HDP range from 64.14 ± 0.24 - 77.72 ± 0.84. T_1 - T_5 had similar ($P > 0.05$) hen-day egg production values, which were however lower ($P < 0.01$) than the hen-day egg production values of T_6 - T_{10} whose values were similar ($P > 0.05$) among themselves. There were highly statistical differences ($P < 0.01$) between fortifier treated and non-treated groups for ADFI. Also, there were significant ($P < 0.01$) cassava level effects and fortifier by cassava interaction. It is strongly suspected that the organic supplement may have impacted positively on the ovarian follicles which in turn enhanced egg production (**Table 4**). The FSPMD contains herba epimedii and this herb has estrogenic property. This implies that it elevates estrogen level and improves lipid metabolism (Fang-Fang *et al*., 2008).The result of this study agrees with the findings of Nombor (2012) who found the range of hen-day production of laying birds to be 42.33±1.43 - 85.45±1.15% when fed dietary vitamins C and E.

AVERAGE DAILY FEED INTAKE, ADFI (g)

Mean values for ADFI range from 82.48 ± 1.08 - 106.15 ± 0.35. The highest values of 106.15 ± 0.35, 105.22 ± 1.10, 105.04 ± 0.38 and 104.42 ± 0.35 were recorded in T_9, T_8, T_7 and T_{10}. T_7 - T_{10} had similar ($P > 0.05$) ADFI values among themselves but were higher ($P < 0.01$) than ADFI values of T_1 - T_5 which are similar ($P > 0.05$) among themselves. T_6 differ significantly from the rest of the treatments. There were highly statistical differences ($P < 0.01$) between fortifier treated and non-treated groups. Equaly, significant ($P \leq 0.01$) cassava level effects and fortifier by cassava interaction were observed. The result of ADFI tends to follow the same trend as in the grower phase. The result of this study agrees with the findings of Nombor (2012) who reported the range of feed intake of birds to be 65.42 ± 0.61-113.15 ± 0.56 g/bird/day with vitamins C and E supplemented diets. It equally agrees with that of Bamgbose *et al*. (2007), Onifade and Babatunde (1997) and Nwokoro and Tewe (1995). The differences recorded between the non-treated group (T_1 - T_5) and that of the treated group (T_6 - T_{10}) may be due to the organic treatment of the diets in T_6 - T_{10} which may have increased palatability which resulted in significant feed intake values of birds on the test ingredient. Similar report was observed in Zeina *et al.* (2017) in an experiment "Nutritional quality of eggs of Amberlink and Hyline layers fed different levels of provitamin A-biofortified Maize". Feed consumption is a variable phenomenon and is influenced by several factors such as strain of the bird and nutrient content of the diet.

Table 4: Production attributes of the experimental birds during the laying phase

		Cassava Levels					
Parameter	**Fortifier**	**0%**	**25%**	**50%**	**75%**	**100%**	**Mean**
ADFI (g/b/d)	Non fortified	85.91 ± 1.80	82.48 ± 1.08	86.68 ± 0.74	87.20 ± 1.24	83.14 ± 1.07[d]	**85.08 ± 1.19[b]**
	Fortified	97.94 ± 0.85	105.04 ± 0.38	105.22 ± 1.10	106.15 ± 0.35	104.42 ± 0.35	**103.75 ± 0.61[a]**
	Mean	**91.92 ± 1.33[b]**	**93.76 ± 0.73[b]**	**95.95 ± 0.92[a]**	**96.68 ± 0.80[a]**	**93.78 ± 0.71[b]**	**94.42 ± 0.90**
	Prob.: Fortifier (P<0.01); Cassava (P≤0.01); Fortifier*Cassava (P<0.01)						
HDP (%)	Non fortified	64.55 ± 1.31	65.31 ± 0.17	66.21 ± 0.50	65.94 ± 0.14	64.14 ± 0.24	**65.23 ± 0.47[b]**
	Fortified	77.48 ± 0.09	67.68 ± 0.59	77.72 ± 0.84	77.44 ± 0.22	77.58 ± 0.38	**75.58 ± 0.42a**
	Mean	**71.02 ± 0.70[a]**	**66.50 ± 0.38[b]**	**71.97 ± 0.67[a]**	**71.69 ± 0.18[a]**	**70.86 ± 0.31[a]**	**70.41 ± 0.45**
	Prob.: Fortifier (P<0.01); Cassava (P<0.01); Fortifier*Cassava (P<0.01)						
AEW (g)	Non fortified	51.85 ± 2.04	52.38 ± 1.98	53.58 ± 1.12	51.47 ± 1.96	54.45 ± 1.84	**52.75 ± 1.79[b]**
	Fortified	58.31 ± 0.26	58.06 ± 0.25	59.68 ± 0.31	61.69 ± 3.07	60.35 ± 1.38	**59.62 ± 1.05[a]**
	Mean	**55.08 ± 1.15**	**55.22 ± 1.12**	**56.63 ± 0.72**	**56.58 ± 2.52**	**57.40 ±1.61**	**56.18 ± 1.42**
	Prob.: Fortifier (P<0.01); Cassava (P>0.05); Fortifier*Cassava (P>0.05)						
EST (mm)	Non fortified	0.31 ± 0.02	0.31 ± 0.01	0.30 ± 0.01	0.30 ± 0.01	0.32 ± 0.01	**0.31 ± 0.01[b]**
	Fortified	0.32 ± 0.01	0.34 ± 0.01	0.33 ± 0.01	0.35 ± 0.01	0.34 ± 0.01	**0.34 ± 0.01[a]**
	Mean	**0.32 ± 0.02**	**0.33 ± 0.01**	**0.32 ± 0.01**	**0.33 ± 0.01**	**0.33 ± 0.01**	**0.32 ± 0.01**
	Prob.: Fortifier (P<0.01); Cassava (P>0.05); Fortifier*Cassava (P>0.05)						

Parameter	Fortifier	0%	25%	50%	75%	100%	Mean
Cracked egg (%)	Non fortified	1.00 ± 0.08	2.15 ± 0.54	1.57 ± 0.10	1.95 ± 0.12	2.23 ± 0.36	**1.78 ± 0.24**
	Fortified	1.03 ± 0.04	0.99 ± 0.08	0.95 ± 0.08	0.96 ± 0.07	0.97 ± 0.01	**0.98 ± 0.06**
	Mean	**1.01 ± 0.06^{b}**	**1.57 ± 0.31^{a}**	**1.26 ± 0.09^{ab}**	**1.46 ± 0.10^{ab}**	**1.60 ± 0.19^{a}**	**1.38 ± 0.15**
	Prob.: Fortifier (P<0.01); Cassava (P>0.05); Fortifier*Cassava (P<0.05)						
HUS	Non fortified	77.67 ± 1.45	81.67 ± 2.85	79.00 ± 2.65	77.67 ± 1.45	80.67 ± 0.88	**79.34 ± 1.86^{b}**
	Fortified	83.67 ± 3.38	82.33 ± 1.45	88.00 ± 2.08	86.33 ± 2.19	84.00 ± 2.52	**84.87 ± 2.32^{a}**
	Mean	**80.67 ± 2.24**	**82.00 ± 2.15**	**83.50 ± 2.37**	**82.00 ±1.82**	**82.36 ± 1.70**	**82.10 ± 2.09**
	Prob.: Fortifier (P≤0.001); Cassava (P>0.05); Fortifier*Cassava (P>0.05)						
Mortality (%)	Non fortified	0.80 ± 0.35	0.48 ± 0.14	0.32 ± 0.08	0.48 ± 0.00	0.40 ± 0.16	**0.50 ± 0.15**
	Fortified	0.48 ± 0.14	0.40 ± 0.16	0.32 ± 0.08	0.48 ± 0.14	0.40 ± 0.16	**0.42 ± 0.14**
	Mean	**0.64 ± 0.25**	**0.44 ± 0.15**	**0.32 ± 0.08**	**0.48 ± 0.07**	**0.40 ± 0.16**	**0.46 ± 0.15**
	Prob.: Fortifier (P>0.05); Cassava (P>0.05); Fortifier*Cassava (P>0.05)						

Row and column means with different superscript are statistically different at 1% or 5%

AVERAGE EGG WEIGHT, AEW (g)

Mean values for AEW range from 51.47 ± 1.96 - 61.69 ± 3.07. T_1, T_2 and T_4 had similar ($P > 0.05$) average egg weight values, which were however lower ($P < 0.01$) than the average egg weight values of T_6 - T_{10} whose values were similar ($P > 0.05$) among themselves. T_3 and T_5 were statistically similar ($P > 0.05$). Even though improvement in egg weight is a factor of breed, type and strain (Nwosu *et al.*,1987), disease, nutrition, ambient temperature (Abutu and Ugwu, 2005), in the present study, the test ingredient appears to have improved the intake of nutrients such as mineral salts (Calcium and Phosphorus required for egg shell formation), proteins, carbohydrates, fats, other vitamins, and compounds required for synthesis of egg yolk, shell membranes and albumen which contribute directly to egg mass (Oguz *et al*., 2010; Smith, 2010; Whitehead and Mitchell, 2010). Total Egg weight comprises of 30-33% yolk and 60% albumen (Onyimonyi and Ugwu**,** 2007). The result of this study agree with the findings of Nombor (2012) who found the range of egg weights in laying hens fed diets supplemented with vitamins C and E to be 54.50 ±1.15 - 69.11±1.52 g.

Egg weight is one of the important traits that influence consumer's egg purchasing behaviour. One of the main factors influencing egg size is body size of the laying chicken (Robinson and Sheridan, 1971; Summer and Leeson, 1983). Heavy birds consume more feed and lay larger egg with large egg yolk than light hens. Even though, inclusion of supplement had no direct effect on egg weights and egg production, strain of the bird in combination with supplement inclusion might have significant effect on egg weights and egg production. Khurshid *et al*. (2003) reported that egg weight is positively related to egg shell weight and thickness, which was also in line with the result of this study.

EGG SHELL THICKNESS, EST (mm)

From **Table 4**, mean values for EST range from 0.30 ± 0.01- 0.35 ± 0.01. The highest ($P < 0.01$) values of 0.35 ± 0.01, 0.34 ± 0.01, and 0.33 ± 0.01 were recorded in T_2, T_3, and T_4 had similar ($P > 0.05$) values among themselves but were higher ($P < 0.01$) than EST values of T_8 T_9 and T_{10} which were similar ($P > 0.05$) among themselves. $T_{1,}$ T_5 T_6 and T_7 were similar ($P > 0.05$). Calcium (Ca) and phosphorus (P) are the critical minerals required for egg shell deposition and quality (Smith, 2010), an indication that the bio-fortified diets were sufficient in this elements, which was responsible for the higher egg shell thickness in the treatments. Reduced feed intake as observed in the non-treated group may be responsible for the lower values of egg shell thickness in those treatments, in combination with some environmental factors since birds do not sweat (Holik, 2009). Under heat stressed conditions, they rely on evaporative cooling (panting) to keep themselves cool. This increased rate of panting produces what is called respiratory alkalosis of the blood (a physiological response characterized by an increase in blood pH along with a decrease in blood CO_2 concentration).The increased carbonate loss through renal excretion results in competition between the kidney and uterus for carbonate ions. Consequently, the blood acid-base balance is upset, producing a decrease in blood calcium and bicarbonate ions which are necessary for the production of strong egg shells. The test ingredient improved feed intake invariably increasing intake of minerals (Ca, P, and Mg) required for shell formation. Thus, the ultimate problem is oviposition of thin-shelled eggs produced by laying hens as observed by Nombor (2012) which were in accordance to the present research. Asli *et al.* (2007) working with single comb white leghorn (SCWL) hens, documented beneficial effects of dietary factor on egg quality (shell thickness, shell resistance, shell percent and haugh units). Khurshid *et al*. (2003) suggest that egg weight is positively related to egg shell weight and thickness. Results from this study support earlier reports by Nombor (2012), Asli *et al*. (2007), Puthpongsiriporn *et al*. (2001). It was, therefore, concluded in this research that layers fed cassava based diet supplemented with FSPMD had thicker egg shell and heavier weight than those on the unsupplemented diets. These findings suggest that when developing technologies to increase egg quality, the egg shell quality is of economic importance. For table eggs, the egg shell functions as a packaging material and its good quality is crucial to consumer selection and safety. Therefore, any intervention that is intended to improve the internal quality of eggs should not compromise the quality of the egg shell.

INCIDENCE OF CRACKED EGGS (%)

Mean values for percentage cracked egg range from 0.95 ± 0.08 - 2.23 ± 0.36. T_1, T_2, T_4 and T_5 had similar ($P > 0.05$) percentage cracked eggs values, which were however higher ($P < 0.01$) than cracked eggs values of T_6 - T_{10} whose values were similar ($P > 0.05$) among themselves. T_3 was statistically similar ($P > 0.05$) to the rest of the treatments. Significant ($P < 0.05$) effects of fortifier by cassava interaction were observed. Since feed intake seemed to be improved due to biofortification, it could thus be argued that Ca and P which are the raw materials for egg shell deposition in the shell gland were also ingested in sufficient quantities. McDowell and Ward (2010); Nombor (2012) had reported a high positive correlation between calcium and phosphorous intake and shell integrity. Based on the earlier evidence, it could, thus, be concluded that, an enabling environment for egg shell deposition was encouraged for the developing egg with the biofortified diets. The result of the present research shows that there is a positive relationship between the biofortifed diet and the incidence of cracked eggs as earlier reported by Sobayo *et al.* (2008).

HAUGH UNIT SCORE, HUS

Mean values for HUS range from 77.67 ± 1.45 - 88.00 ± 2.08. T_1, T_3 and T_4 had similar ($P > 0.05$) haugh unit values, which were however lower ($P \leq 0.01$) than haugh unit value of T_8 whose value was similar ($P > 0.05$) to T_6, T_7, T_9 and T_{10}. T_2 and T_5 were statistically similar ($P > 0.05$). Generaly, it appears that fortifying cassava root meal based diet with the organic supplement could improve haugh unit score significantly (**Table 4**). The results of this study agree with findings of Nombor (2012) who recorded a range of values of 75.50 ± 2.10 - 96.27 ± 0.47 in laying birds fed dietary vitamins C and E. In fact, the haugh unit score which is an indication of the egg quality, for this study agrees with standard values in most cited literature.

CONCLUSION/RECOMMENDATION

There are earlier literature evidences suggesting that cassava is a replacement for maize in ration for egg type chicken. The present study further verifies this claim and shows that the bio-fortification of cassava root meal with an egg enhancing supplement - Farmers olution provider: multiple dropping (FSPMD), results in significant improvement of egg production and egg quality indices as claimed by the manufacturer. For higher egg production, it is hereby recommended that poultry farmers may employ the use of Farmers solution provider: multiple dropping (FSPMD) at 100g/100kg feed for pullets and 130g/100kg feed for layers respectively and there should be advocacy for it. The manufacturer should as a matter of urgency be informed to increase the availability of Farmers solution provider: multiple dropping (FSPMD) to poultry farmers.

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