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Biologic and management effects of feeding laying birds unpeeled yellow cassava (*Manihot esculenta Crantz)* root meal

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ABSTRACT: Ninety-four Points of lay Rhode Island Red layers were used to evaluate the performance of laying birds fed unpeeled yellow cassava root meal (UYCRM) as a replacement for maize. The yellow cassava was harvested, washed, ground, drained and toasted to form the UYCRM. Four diets were formulated replacing maize with UYCRM at 0% (T1), 25% (T2), 50% (T3) and 75% (T4). The study used 4 treatments each consisting of 24 birds, replicated three times with 8 birds per replicate in a Completely Randomized Design. The experiment lasted for 8 weeks. The birds on diet T4 showed superiority in the final weight (1685.50 g), total weight gain (715.50 g) and feed conversion ratio (2.44) but birds on T1 ate the most (183.94 g/day). There were no significant (p>0.05) in all the external egg traits considered. Birds on the control diet had the best yolk weight (17.59 g) and Haugh unit (95.11). It can be concluded that dietary inclusion of unpeeled yellow cassava root meal can replaced maize up to 75% without adverse effect on the performance and egg qualities of laying birds, and it is therefore recommended.

Keywords: Rhode Island Red layers, feed conversion ratio, Egg qualities, maize, unpeeled yellow cassava root meal.

INTRODUCTION

The poultry industry has become the predominant supplier of protein in the diets of populations of most developing countries. Maize, a major source of energy in poultry and can be used in up to 60% of poultry diets. However, the poultry industry faces challenges due to inadequate maize supply, high prices, and the diversion of maize for biofuel production (Adekanye *et al.,* 2013). These issues necessitate the search for alternative, cost-effective energy sources for poultry and other non-ruminant species (Munyaka *et al*., 2015). One promising alternative is cassava (*Manihot esculenta*), which is abundant and readily available in many production areas (Nsa et al., 2016). Research indicates that cassava can effectively replace conventional energy feedstuffs like maize, potentially reducing livestock and poultry feed costs (Adedokun *et al*., 2018; Nsa *et al*., 2016).

Cassava is a highly productive crop in terms of energy yield per unit land area and has been shown to support satisfactory performance when fed as a replacement to maize in poultry diet (Adedokun *et al*., 2017). Its use is not only beneficial for performance but is also cost-effective (Adedokun *et al*., 2018). Khempaka *et al*. (2016) observed improved performance in laying hens fed 200 g/kg sun-dried cassava meal diet and found a further improvement following enzyme addition Khempaka *et al*. (2018). During microbial fermentation, the protein content of cassava meal increases and the fibre is broken down and this enables its utilization by poultry. Udedibie *et al*. (2009) in two separate experiments observed that low dietary levels of cassava meal (5%, 10%) had no deleterious effect on egg production and efficiency of feed conversion, but 50% or 60% levels of cassava root meal tended to decrease production and feed efficiency. They further observed that the depressing effect of high dietary levels of cassava meal could be overcome by supplementing with a protein source. Cassava, however, contains cyanogenic glucosides of which its hydrolysis yields hydrocyanic (HCN) and this component is toxic to poultry (Udedibie *et al*., 2008). These anti-nutritional factors (ANF) can be reduced through several physical processing methods, including soaking, sun-drying, boiling, toasting and ensiling (Omede *et al*., 2018). Yellow cassava is a newly improved variety of cassava with high content of carotene a precursor of vitamin A (HarvestPlus, 2015). Adedokun *et al*. (2017) reported the gross energy of yellow cassava (umucass 36) meal ranged between 2.89 kcal/g in cassava tender stem meal and 3.77 kcal/g in cassava composite meal on a dry matter basis. The high energy values obtained by these authors showed that cassava meal can comfortably replace maize in broiler diet. On the average, Adedokun *et al*. (2017) postulated that cassava root meal can replace maize in broiler diet but will have to be fortified with other sources of crude protein while cassava composite meal can perfectly replace maize in the broiler diet while cassava foliage meal with a crude protein content of 21.79% can as well partially replace soybean in diet formulation. This study therefore was aimed at assessing the performance of laying birds fed unpeeled yellow cassava root meal as replacement for maize.

MATERIALS AND METHODS

Experimental site

The research was conducted at the Poultry Unit of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Abia State. Umudike lies on latitude 05°29' N and longitude 07°33' E with an elevation of 122 m above sea level and is located in the tropical rainforest zone of Nigeria. This zone is characterized by annual rainfall of about 2177 mm, monthly ambient temperature range of 22°C - 36°C and relative humidity of 50-95% depending on the season and location (NRCRI, 2022).

Experimental birds and management

Ninety-four (94), 18 weeks old Rhode Island Red layers were purchased from a reputable source for this experiment. The birds were habituated until there was 5% egg lay before the feeding trial commenced. The experiment lasted for 8 weeks. Layers were fed twice a day and water was provided *ad libitum*. Proper sanitation and routine management were observed.

Experimental diets

One-year-old yellow cassava (Umucass-46 or TMS 01/0539) plant was harvested from Umudike Ikwuano Local Government Area of Abia State. The unpeeled cassava was washed, ground, and packed into a jute bag to allow water to drain. This was toasted within the range of 70 to 80°C and packaged in air tight bag after cooling.

Four diets were formulated, diet 1 which had 0% of unpeeled yellow cassava meal served as the control (T1), diets T2, T3 and T4 had the test ingredient unpeeled yellow cassava meal incorporated to replace the maize portion at graded levels of 25, 50 and 75%, respectively. Other ingredients were added to make a complete feed as represented in Table 1.

Experimental design

The study comprised 4 treatments of 24 birds per treatment with three replicates and 8 birds per replicate in a Completely Randomized Design. The model of the experiment was;

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where: Y_{ij} =Individual observation, μ = population mean, T_i = Treatment effect (effect of unpeeled yellow cassava root meal), and e_{ij} = random error, (iind $0,\sigma^2$) assumed to be independently, identically and normally distributed with zero means and constant variance.

Data collection

Feed intake was measured daily. Individual birds were weighed before the beginning of the experiment to obtain initial body weight, and weekly thereafter. Eggs were collected twice a day and recorded. Also, 12 eggs from each treatment were weighed weekly to obtain mean egg weight and external and internal egg traits were evaluated. Routine vaccination was carried out across treatments throughout the study.

Growth performance

The following growth parameters were measured: Initial body weight: this was assessed by weighing the birds at the beginning of the experiment using an Analogue Scale (up to 10 kg capacity) to weigh the pullets.

Table 1. Percentage Composition of Experimental Diets containing graded levels of unpeeled yellow cassava root meal fed to laying birds.

Ingredients (%)	Diets			
	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)
Maize	42.00	31.50	21.00	10.50
Unpeeled Yellow cassava meal	0	10.50	21.00	31.50
Soy bean meal	34.00	34.00	34.00	34.00
Maize offal	11.80	11.80	11.80	11.80
Palm kernel cake	6.00	6.00	6.00	6.00
Palm oil	0.50	0.50	0.50	0.50
Fish meal	2.00	2.00	2.00	2.00
Bone meal	3.00	3.00	3.00	3.00
Salt	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10
Total	100	100	100	100
Calculated Composition				
Metabolizable energy (Kcal/g)	2883.90	2859.33	2834.76	2810.19
Crude protein	22.22	21.54	20.85	20.17
Energy:Protein	130:1	133:1	136:1	139:1

*Composition per kg : Vitamin A 8.000 UI; Vitamin D3 2.300 UI; Vitamin E 15,00 UI; VitaminK3 1.000 µg; Vitamin B1 200 µg; Vitamin B2 3.000 µg; Vitamin B6 1.700 µg; Vitamin B12 10,00 µg; Folic acid 500 µg; Pantothenic acid6,44 mg; Niacin 20 mg; Selenium (Se) 250 µg; Manganese (Mn) 60 mg; Copper (Cu) 9 mg; Zinc (Zn) 60 mg; Iron (Fe) 30 mg; Iodine (I) 1,00 mg.

Final body weight: This was assessed by weighing the birds at the end of the experimental period using the same Analogue Scale (up to 10 kg capacity).

$$\text{Feed intake/bird/day (g)} = \frac{\text{QFG} - \text{QNE}}{\text{No. of birds x 56 days}}$$

$$\text{Daily weight gain/bird (g)} = \frac{\text{Final live weight} - \text{Initial weight}}{\text{No. of birds x 56 days}}$$

$$\text{Feed conversion ratio} = \frac{\text{Daily Feed intake (g)}}{\text{Egg weight (g)}}$$

$$\text{HDEP (\%)} = \frac{\text{Number of eggs collected per day}}{\text{Number of hens present}} \; x \; 100$$

Where: HDEP = Hen Day Egg Production, QFG = Quantity of Feed Given and QNE = Quantity Not Eaten

Egg quality traits

External egg quality

Egg weight was determined using a digital balance (Mettler-Toledo, manufactured in Germany) to the nearest 0.01 g accuracy. Other external egg qualities to be determined include;

- Egg length (along the longitudinal axis) and egg width (along the equatorial axis) were measured using vernier calliper to the nearest 0.01mm.
- Circumference length and circumference width were measured using measuring tape.
- The eggs were broken to determine the weight of the egg shell using a digital balance.
- Shell thickness along with membrane was measured at the broad end, narrow end and equatorial part of each egg to the nearest 0.001 mm with the help of a micrometre screw gauge (manufactured by Pratt & Whitney Systems, Inc. USA).
- Volume of egg was measured by liquid displacement technique using the 1 litre graduated cylinder setup.

Internal egg quality

- The albumen and egg yolk (g) were measured using a vernier calliper (made in India by Hoverlabs) in millimetre.
- The height of the thick albumen and yolk were measured at maximum height with a Spherometer to 0.001 mm accuracy.

- Albumen weight was calculated by subtracting the yolk and the shell weight from the egg weight.
- Haugh unit was calculated according to the formula of Haugh (1937).

HU = 100log (H + 7.57 – 1.7 x $W^{0.37}$).

Where, H is the albumin height (mm) and W is the egg weight (g).

Statistical analysis

Data collected were subjected to Analysis of Variance (ANOVA) and significant differences across treatment means were separated using the Tukey test as contained in the Minitab® software version 17.1.0 (Minitab, 2013).

RESULTS AND DISCUSSION

Growth performance of layer hens fed unpeeled yellow cassava root meal as a replacement for maize

The results on the growth performance of laying hens are seen in Table 2 which revealed that final weight and total weight gain increased when birds were supplied with diets containing unpeeled yellow cassava root meal.

The final weight of the birds showed that laying hens fed diet T3 (1638.55 g) and diet T4 (1685.50 g) were significantly ($p<0.05$) different from those fed diet T1 (1550.85 g) and diet T2 (1545.00 g). The result agreed with Asaniyan (2023) and Diarra and Devi (2015), who found that weight was significantly affected by a diet containing 50% cassava root meal. Many feeding experiments have shown that cassava provides a good quality carbohydrate which may be substituted for maize and that cassava rations are especially suitable for poultry. Total weight gain of layers on T4 (715.50 g) showed a significant ($p<0.05$) difference from those on diet T3 (683.55 g) while the least values were recorded by layers on diets T1 (595.85 g) and T2 (585.00 g). The result agreed with the report of Akapo *et al*. (2014) who fed 100g/kg of peeled cassava meal and observed higher weight gain in birds. Laying hens have lower energy requirements and for this reason, are able to utilize higher levels of cassava products compared to broilers. Feed intake significantly decreased ($p<0.05$) as the level of unpeeled yellow cassava root meal increased. Birds in the control diet consumed more feed than layers fed the unpeeled yellow cassava root meal diets. This disagreed with the observation of Asaniyan (2023) who said the laying birds fed maize-based diets ate less than birds on cassava plant-based diets. This could be because birds ate to satisfy their energy requirement and ate less of UYCRM due to the gut-fill effect. Also, the findings on feed intake which decreased as the level of unpeeled yellow cassava root meal inclusion increased was a likelihood of poor utilization of unpeeled yellow cassava root meal due to either high dietary fibre level.

Laying hens fed diet T4 (2.44) gave the best feed conversion ratio. The replacement of 75% unpeeled yellow cassava meal with maize gave improvement of the feed conversion ratio. The feed conversion ratio was depressed by the increased levels of cassava meal in the experiment-tal diets, this was contrary to the finding of Animasahun *et al.* (2023) who observed that laying birds fed enhanced cassava stump meal had a higher feed conversion ratio than the laying chickens on the control diet.

Hen day egg production (%) revealed that there were no significant ($p>0.05$) differences among layers fed experimental diets. This is in consonance with the report of Asaniyan (2023). This implied that cassava root meal could replace maize up to 75% in layers without adverse effect on egg production. The improved hen day egg production is related to the feed conversion efficiency of the birds. With an improved feed conversion ratio, the egg production of the layer hens was improved. Thus, data recorded from production performance parameters showed that the laying rate of hens fed unpeeled yellow cassava root meal diets led to improvement in egg production.

Egg weight values of the layer hens were not significantly ($p>0.05$) different among the treatments. This was also observed by Ogundeji and Akinfala (2020) who found that egg weights were not significantly ($p>0.05$) different when laying hens were fed diets containing cassava plant meal. The similarity recorded between layers on experimental diets is an indication that the inclusion of unpeeled yellow cassava meal in layer diets up to 75% adequately maintained egg weight, which helps in sustaining the efficiency of egg production. However, egg weight depends mainly on intrinsic factors, such as genetic origin, age of the bird and diet nutritional value during the production period.

Thus, from the study, dietary inclusion of unpeeled cassava root meal can replace maize up to 75% without adverse effects on weight gain, daily feed intake and feed conversion ratio and with improvement in egg production.

External egg quality traits of laying hens fed unpeeled yellow cassava root meal

Table 3 showed that the external egg quality traits of layer hens fed unpeeled yellow cassava root meal as replacement for maize was not significantly ($p>0.05$) affected by the different dietary treatments. The non-significance of shell thickness and weight implied all the dietary treatments were adequate in calcium which was similar to the findings of Animashahun *et al.* (2023) in feeding laying birds with enhanced cassava stump. Ogundeji and Akinfala (2020) observed no significant ($p>0.05$) difference in the values of egg width and a slight variation in egg length when they fed laying birds with a

Table 2. Growth performance of layer hens fed unpeeled yellow cassava root meal.

Parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	SEM
Initial weight g/hen	955.11	960.20	955.33	970.10	2.77
Final weight g/hen	1550.85^{b}	1545.00^{b}	1638.55^{a}	1685.50^{a}	10.88
Total Weight gain g/hen	585.85^{c}	585.00^{c}	683.55^{b}	715.50^{a}	11.45
Daily feed intake g/hen	183.94^{a}	182.57^{a}	154.70^{b}	150.10^{b}	10.50
Egg weight g/hen	60.12	61.14	60.95	61.35	1.09
Feed conversion ratio (FCR)	3.05^{a}	2.98^{b}	2.53^{b}	2.44^{c}	1.11
Hen day egg production (%)	61.83	62.78	61.77	62.62	3.12

^{ab} Means within the rows with different superscripts differ significantly P<0.05; SEM- Standard error of the mean.

Table 3. External egg quality traits of laying hens fed unpeeled yellow cassava root meal.

Parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	SEM
Egg length (mm)	55.09	54.38	55.00	55.31	3.45
Egg width (mm)	44.15	44.35	45.10	44.80	2.01
Shell thickness (mm)	0.42	0.46	0.43	0.44	0.37
Shell weight (g)	8.30	8.17	8.40	8.45	2.45

^{ab} Means within the rows with different superscripts differ significantly p<0.05; SEM- Standard error of the mean.

Table 4. Internal egg quality traits of layer hens fed unpeeled yellow cassava root meal.

Parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	SEM
Egg volume (ml)	58.51	58.00	58.35	58.35	10.11
Albumen weight (g)	37.82	37.10	36.55	37.00	2.56
Albumen height (mm)	11.64	11.00	11.17	11.28	2.43
Albumen circumference (mm)	62.09	63.11	62.35	63.30	3.01
Yolk weight (g)	17.59^{a}	17.46^{a}	15.11^{b}	15.30^{b}	2.55
Yolk height (mm)	18.65	19.10	18.75	18.11	0.11
Yolk circumference (mm)	40.11	40.58	40.61	40.11	12.21
Haugh unit	95.11^{a}	91.90^{c}	93.61^{b}	93.97^{b}	10.21

^{ab} Means within the rows with different superscripts differ significantly p<0.05; SEM- Standard error of the mean.

cassava plant-based diet.

Shell thickness which is a function of the calcium and phosphorus levels in layers ration was not negatively affected as a result of the inclusion of unpeeled yellow cassava root meal. Egg shell thickness is also an indication of the specific gravity (relative density of eggs) since both are positively correlated (Oluyemi and Robberts 1979). However, the major concerns of shell quality are thickness and structure. Consumers desire an egg that is resistant to breakage and penetration by microorganisms.

Internal egg quality traits of laying hens fed unpeeled yellow cassava root meal

The internal egg quality traits of laying hens fed unpeeled yellow cassava root meal as a replacement for maize showed that there were significant (p<0.05) differences in yolk weight and Haugh unit among the eggs of the layers fed the treatment diets as revealed in Table 4.

The yolk weight of the eggs of hens fed diet T1 (17.59 g) and diet T2 (17.46 g) are similar but significantly (p<0.05) different from those on diet T3 (15.11 g) and diet T4 (15.30 g) which are equally similar. There were significant (p<0.05) differences among the treatments in the Haugh unit value except for treatments T3 and T4 which are similar. Animashahun *et al*. (2023) did not observe any significant (p>0.05) difference in all the internal egg quality parameters considered. However, the yolk weight and Haugh unit value recorded for all treatments in this study were within the range of freshly laid eggs. In this way, it is possible to conclude that eggs can be considered of excellent quality even with the inclusion of unpeeled yellow cassava root meal levels in this study. There were no significant (p>0.05) differences among the treatments in the values of albumen weight, albumen height, albumen circumference, yolk height and yolk circumference. By implication, the inclusion of the unpeeled cassava root meal in layers diet did not have adverse nor depressing effects on these parameters. In consonance to the findings of present study, Saparattananan *et al*. (2005) reported that diets with maize or cassava had similar effects on egg quality traits of laying hens. In a 12-week feeding trial, Oladunjoye *et al*. (2010) also did not observe any significant (p>0.05) effect of dietary inclusion of sun-dried cassava peel meal (replacing 80% of maize in a control diet) and lye-treated cassava peel meal on their egg quality traits of laying hens.

Conclusion

In conclusion, unpeeled yellow cassava root meal can be incorporated into up to 75% of the diet of laying hens without adversely affecting egg production performance, external egg quality traits, or internal egg quality traits. This study demonstrates that such dietary inclusion supports sustainable poultry nutrition while maintaining excellent egg quality.

CONFLICT OF INTEREST

The authors declare that they have no conflict interest.

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