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Performance and Egg Quality of Layers Fed Diets Containing Graded Levels of Cashew (*Anarcadium Occidentale* L.*)* Pulp Meal

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Abstract: *A feeding trial was conducted to determine the performance and egg quality characteristics of layers fed diets containing graded levels of cashew pulp meal. Cashew pulp meal (CPM) replaced 0, 4, 8, 16, and 32% of dietary maize the diets. Each treatment had 15 birds and 5 birds per replicate, in a Completely Randomized Design. Data collected were feed intake, weight change (final weight less initial weight) and feed conversion ratio (feed intake over dozen of eggs), hen-day production (HDP) and hen-house production (HHP). Egg quality characteristics measured were egg weight, egg shell thickness, egg shape index, shell weight, albumen weight, yolk weight, yolk diameter, yolk height, yolk index and Haugh unit. Results indicated CPM had crude protein and crude fibre values were 12.10% and 6.79% respectively, while energy value was 2870.09kcal/kg. Ether extract and ash values were 5.68% and 11.09%, respectively. Final body weight (FBW), daily weight gain (DWG), feed conversion ratio (FCR), daily feed intake (DFI), HHP, HDP, dozen egg production and egg number per bird were significantly different ($p<0.05$) among the treatments. FBW ranged from 1413 g (24%CPM) - 1500g (32%CPM). The body weight gain per bird ranged from 6.06 (32%CPM) - 8.32 (24%CPM). The feed conversion ratio ranged from 2.58 (0%CPM) - 3.03 (16%CPM). External egg quality parameters were significantly ($p<0.05$) different except for egg width, shell thickness and shape index. Internal egg quality parameters were significantly ($p<0.05$) different except for yolk height, yolk diameter, and yolk index. The values for albumen height (AH), yolk diameter (YD), yolk weight (YW), yolk index and Haugh unit (HU) ranged from 4.99-5.46cm, 1.65-1.75cm, 2.24-2.35cm, 11.22-13.03g, 0.71-0.75 and 106.27-107.93 respectively. Farmers may include CPM in layer rations, as its inclusion did not affect adversely egg production and optimum egg quality.*

Keyword: *Cashew pulp, egg quality, layers, proximate analysis, yolk index*

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I. Introduction

There is need to ameliorate the nutritionally deficient diets of Nigerians which has been consistently reported to deficient in animal protein. To arrest this unacceptable trend, efforts are being directed towards boosting the livestock industry with animals having prolific tendency, short gestation period, short generation interval and rapid growth (Esobhawan and Ikheloa, 2008), such as poultry. In the poultry production, feed with its cost remains the most important component of production. Atteh (2002) and Kehinde *et al.* (2006) opined that feed remains the most important cost in animal production. Hence, researchers are continually looking for ways to minimize feed cost without compromising performance. Unfortunately, in Nigeria, one of the major problems facing the livestock/poultry industry is the increasing unavailability of conventional feedstuffs due to their competitive uses. This further increases the price, thereby threatening the potential for increasing animal protein production which is in short supply (Bawa *et al.*, 2007). The continued search for alternative feedstuffs for livestock production, especially poultry becomes imperative.

Poultry supply proteins of high biological value in the form of egg and meat. The need for feed ingredients which will reduce the cost of production is the thrust of several research efforts into new ingredients (mostly agro-industrial by-products) that are being evaluated. One of such readily available and accessible agro-industrial by-product is cashew pulp. Cashew pulp is mostly left to constitute environmental pollution during its season. This is because most people prefer the seed to the cashew pulp (Okpanachi *et al.*, 2016). A few works (Oyewole *et al.*, 2017; 2018) have been reported on the use of cashew pulp. There was need to evaluate cashew pulp meal with layers.

II. Objective of the Study

The objectives of the study were to determine the performance of layers fed diets containing graded levels of cashew pulp meal. The feeding trial also sought to evaluate the effect of cashew pulp meal in the diet of layers on the internal and external egg characteristics of layers.

III. Materials And Methods

Experimental Site

The study was carried out in the Poultry Unit of the Teaching and Research Farm of the Department of Animal Production, Kogi State University, Anyigba. Anyigba is located on Latitude $7^0$30'N of the equator and Longitude $7^0$09'E of the Greenwich meridian and with an average altitude of 420metres above the sea level. The study area falls within tropical wet and dry climate region of the Guinea savanna, with average annual rainfall of 1600mm and daily temperature range of about 25^0C-35^0C (Ifatimehin *et al.*, 2011).

Procurement and Preparation of Research Materials

Fresh cashew pulps were obtained from Anyigba and environs. The pulps were rinsed, and juice expressed with the aid of mortar and pestle. The compressed pulps were thereafter spread on clean concrete floor, after decanting the juice, to dry until the pulp became crispy or brittle. The dried pulp was then milled such that the particles could pass through 2mm mesh (Oyewole *et al*., 2017). Other dietary ingredients were bought from the open market in Anyigba and environs. Cashew pulp meal replaced 0, 4, 8, 16, and 32% of dietary maize (Table 1) in the diets. Zero percent (0%) cashew pulp meal was the control. The study was conducted in a battery cage system in an open sided poultry house with elevated foundation. The space between the foundation and the roof is made of wire mesh. A total of 80 ISA brown 19 week old birds were procured for the experiment. The birds were fed with standard commercial layer diet for the first three weeks, within which, the birds were vaccinated against Newcastle disease with a Lentogenic strain of Newcastle disease vaccine (LaSota). The birds were also administered antibiotics before the commencement of the feeding trial. The feeding trial lasted for 8 weeks. At 22 weeks of age, 75 birds were selected and randomly assigned to the five dietary treatments. Each treatment had 15 birds and 5 birds per replicate. Birds were weighed at the beginning of the study. Weight gain was computed by subtracting initial weight from final weight. Data collected were feed intake, weight change (final weight less initial weight) and feed conversion ratio (feed intake over dozen of eggs). Egg production data included hen-day production (HDP) and hen-house production (HHP). HDP and HHP were computed as reported by Oyewole *et al.* (2011). Daily weight gain (DWG) was determined by dividing weight gain by the number of birds and number of days of the feeding trial. All birds in each replicate were served feed and water *ad libitum.* Left over feed was collected and weighed weekly. This was then subtracted from the quantity offered to obtain weekly feed intake per replicate. Daily feed intake (DFI) was obtained by dividing the weekly feed consumed by 7days and by the number of birds/replicate. Feed conversion ratio was computed for the trial as indicated below.

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Feed intake per kg}}{\text{Dozens of eggs}}$$

Egg Production Data

Eggs were collected daily and recorded against each treatment and replicate. Hen-Day Production (HDP) was computed by dividing the number of eggs produced, by the number of hen days and was expressed as a percentage. Hen-House Production (HHP) was computed by dividing the number of eggs produced, by the product of birds and number of days in lay and expressed as a percentage.

External and Internal Egg Quality Characteristics Data Collection

Egg weight was measured in gram (g) using a sensitive electronic scale. The eggs were picked cleaned thoroughly with a tissue paper to remove any faecal material before weighing.

Egg shell thickness (without the contents) was measured in millimeter (mm) using a micrometer screw gauge. The shell was cleaned with a tissue paper before reading was taken. Shell weight was measured in (g) using a sensitive electronic weighing scale. The shell was cleaned with a tissue paper to remove any trace of albumen before weighing. Egg albumen weight (g) was taken after the egg was broken open and egg content was poured into a flat plate of known weight and weighed (W_1). The yolk was then carefully removed. The new weight (W_2) was taken as albumen weight. Egg yolk weight was taken as W1-W_2. Egg yolk diameter (cm) was determined in cm by a vernier calliper as the distance between the opposite edges of the yolk. Egg yolk height (mm) was also measured by a vernier calliper. Egg yolk index was estimated using the formula below:

$$\text{Yolk index} = \frac{\text{Yolk height}}{\text{Yolk diameter}}$$

Haugh unit was estimated using the following equation by Haugh (1937):

$$HU = 100\text{Log}\,(H+7.57-1.70W^{0.37})$$

Proximate Composition Analysis

Samples of cashew pulp meal and the experimental diets were analyzed for crude protein (CP), crude fibre (CF), ether extract (EE) and ash according to AOAC (1995).

Table 1: Gross Composition of Experimental Diets for Layers (%)

Ingredient	Level of Cashew Pulp Meal %				
	T1 (0)	T2 (8)	T3 (16)	T4 (24)	T5 (32)
Maize	40.55	37.26	34.06	30.82	27.56
Full fat soybean	28.00	28.00	28.00	28.00	28.00
Cashew pulp meal	0.00	3.24	6.49	9.73	12.98
Maize offal	21.00	21.00	21.00	21.00	21.00
Bone meal	5.70	5.70	5.70	5.70	5.70
Limestone	4.00	4.00	4.00	4.00	4.00
Table salt	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Vitamin-Mineral premix	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Analyzed Nutrients (%)					
Crude protein	15.38	14.66	15.82	16.12	15.67
Crude fibre	5.19	5.09	5.32	4.18	4.06
Ether extract	6.68	6.32	6.91	6.67	6.29
Nitrogen free extract	57.23	58.40	56.17	57.08	58.40
Ash	7.75	7.56	8.09	7.15	7.11
Dry matter	92.23	92.04	92.33	91.84	91.53

Statistical Analysis

All data collected were statistically analyzed using the One Way Analysis of Variance (ANOVA) with the aid of SPSS Statistical Computer Software Package following the procedure for Completely Randomized Design. Significantly different means were separated with the aid of Duncan's New Multiple Range Test in the software.

IV. Results And Discussion

Chemical Composition of Sun-Dried CPM

The chemical composition of CPM is shown in Table 2. The crude protein and crude fibre values were 12.10% and 6.79% respectively, while energy value was 2870.09kcal/kg. The observed crude protein and crude fibre were higher than 9.73% and 2.03% observed for maize, respectively (Oyewole *et al*., 2012). However, ME for CPM was lower than 3110.89kcal/kg observed for maize (Oyewole *et al*., 2012). Also ether extract and ash values of 5.68% and 11.09% were higher than those observed by Fanimo *et al*. (2003), who reported 2.40% ether extract and 5.40% ash. The differences in the values could be attributed to differences in processing methods, variety of cashew pulp used and harvesting time and probably drying methods employed.

Table 2: Proximate Analysis and Calculated Metabolizable Energy of Cashew Pulp Meal (%)

Parameter	Cashew Pulp Meal
Crude protein	12.10
Crude fibre	6.79
Ether extract	5.68
Nitrogen free extract	55.37
Ash	11.09
Moisture	8.97
*Kcal/kgME	2870.09

*Using Pauzenga (1985) Equation
ME=37% CP + 81 EE + 35.5NFE

Effect of Feeding Cashew Pulp Meal to Layers

The effect of feeding sun-dried cashew pulp meal Layers is presented in Table 3. Observed results show significant differences ($p<0.05$) in the final body weight (FBW), daily weight gain (DWG), feed conversion ratio (FCR), daily feed intake (DFI), HHP, HDP, dozen egg production and egg number per bird among the treatments. The FBW ranged from 1413 g (24%CPM) - 1500g (32%CPM). The FW values were adequate, an indication that the birds still had the capacity for egg production. The optimum weight required for egg production is reported to be 1360g - 1433.30g (Oyewole, 2011). Oyewole *et al*. (2018) reported FBW of similar strain of layers of similar age of 1360g - 1520g. The DFI values ranged from 63.21g (0%CPM) - 75.35g (24%CPM), and were lower than values reported in the literature (Oyewole *et al.*, 2011; 2018). This may be because great care was taken to prevent feed wastage. Feed intake seems to be adequate since the birds appreciated in weight and laid eggs. The birds consumed more of CPM based diets than the control, an indication that CPM based diets were palatable and acceptable to the birds (Oyewole *et al.*, 2017). The body weight gain per bird ranged from 6.06 (32%CPM) - 8.32 (24%CPM). The FCR ranged from 2.58 (0%CPM) -

3.03 (16%CPM). Observed results may indicate the degree of utilization of the various diets by the birds for weight gain and egg production as well. Hen house production, HDP, dozen egg production and egg number/bird seem to favour birds fed CPM than those on the control diet, except at 16%CPM. This may indicate that CPM favours egg production, by way of providing necessary nutrients such as protein, calcium and phosphorus required for egg formation.

Table 3: Effect of Feeding Cashew Pulp Meal Based Diets on Performance of Layers

Parameter	Level of Cashew Pulp Meal %						
	T1(0)	T2 (8)	T3 (16)	T4 (24)	T5 (32)	SEM	LOS
Initial weight/bird (g)	1053.33	1020.00	1073.33	1073.33	1033.33	22.24	NS
Final weight/bird (g)	1480.00^{a}	1440.00^{b}	1440.00^{b}	1413.33^{c}	1500.00^{a}	16.84	*
Daily feed intake/bird (g)	63.21^{c}	70.22^{b}	70.83^{b}	75.35^{a}	74.77^{a}	1.19	*
Daily weight gain (g)	7.61^{b}	7.49^{c}	6.60^{d}	6.06^{e}	8.32^{a}	0.35	*
Hen day production (%)	29.64^{d}	32.14^{b}	28.79^{e}	33.32^{a}	30.94^{c}	0.97	*
Hen house production (%)	29.64^{d}	32.14^{b}	28.79^{e}	33.32^{a}	30.94^{c}	0.97	*
Dozen egg production	6.94^{d}	7.50^{b}	6.66^{e}	7.77^{a}	7.22^{c}	0.22	*
Egg number/bird	16.67^{c}	18.00^{b}	16.00^{c}	18.67^{a}	17.33^{b}	0.54	*
Feed conversion ratio	2.58^{a}	2.66^{a}	3.03^{b}	2.71^{a}	2.91^{b}	0.09	*

^{a,b,c} Means on the same row with different superscripts are significantly different ($p<0.05$)
LOS – level of significance
*- significance ($p<0.05$)
NS-Not significance ($p> 0.05$)
SEM- Standard error of means
Feed conversion ratio (FCR) = feed intake in kg/dozen egg production
CPM – Cashew pulp meal

Table 4 shows the external qualities of egg of birds fed diets containing graded levels of cashew pulp meal (CPM). All parameters observed were significantly ($p<0.05$) different except for egg width, shell thickness and shape index. Observed results indicate that CPM in the diet resulted in heavier and taller eggs with heavier shells. Table 5 shows the internal egg qualities of layer birds fed diets containing graded levels of cashew pulp meal (CPM). All parameters observed were significantly ($p<0.05$) different except for yolk height, yolk diameter, and yolk index. The values for albumen height (AH), yolk diameter (YD), yolk weight (YW), yolk index and Haugh unit (HU) ranged from 4.99-5.46cm, 1.65-1.75cm, 2.24-2.35cm, 11.22-13.03g, 0.71-0.75 and 106.27-107.93 respectively. Observed values for HU may suggest that CPM based diets promoted fresher eggs than maize based diet (control).

Table 4: External Quality of Eggs of Layers Fed Diets Containing Cashew Pulp **Meal Based Diets**

Parameter	Level of Cashew Pulp Meal %						
	T1(0)	T2(8)	T3(16)	T4 (24)	T5(32)	SEM	LOS
Average egg weight (g)	50.35^{d}	54.81^{a}	53.61^{b}	53.50^{bc}	51.57^{c}	0.79	*
Average egg height (cm)	3.75^{b}	3.98^{ab}	3.97^{ab}	3.99^{a}	3.96^{ab}	0.04	*
Average egg width (cm)	2.77	2.88	2.87	2.92	2.82	0.03	NS
Average shell weight (g)	6.25^{bd}	7.11^{b}	7.45^{a}	6.32^{bc}	6.35^{b}	0.21	*
Average shell thickness (mm)	0.58	0.57	0.56	0.57	0.59	0.01	NS
Average shape index	0.73	0.71	0.72	0.72	0.71	0.01	NS

abc= Means on the same row with different superscripts are significantly different ($P<0.05$) SEM= Standard error means, LOS= Level of significance, NS= Not significant ($P>0.05$), *= Significant ($P<0.05$)

Table 5: Internal Quality of Eggs of Layers Fed Diets Containing Cashew Pulp **Meal Based Diets**

Parameter	Level of Cashew Pulp Meal %						
	T1(0)	T2(8)	T3(16)	T4 (24)	T5(32)	SEM	LOS
Albumen height (cm)	4.99^{b}	5.46^{a}	5.33^{ab}	5.40^{ab}	5.25^{ab}	0.06	*
Yolk height (cm)	1.65	1.75	1.60	1.72	1.68	0.02	NS
Yolk diameter (cm)	2.24	2.41	2.28	2.28	2.35	0.04	NS
Yolk Weight (g)	11.22^{d}	11.33^{d}	12.03^{c}	12.64^{b}	13.03^{a}	0.37	*
Yolk index	0.73	0.73	0.71	0.75	0.71	0.01	NS
Haugh unit	106.27^{c}	107.93^{a}	107.66^{ab}	107.72^{ab}	107.22^{b}	0.21	*

abc= Means on the same row with different superscripts are significantly different ($P<0.05$) SEM= Standard error means, LOS= Level of significance, NS= Not significant ($P>0.05$), *= Significant ($P<0.05$)

V. Conclusion

The study revealed that CPM contains 12.10% crude protein and 6.79% crude fibre. The CPM was readily acceptable to the birds and they consumed their allocation of the diets. Diet 32%CPM gave the optimum growth performance. It was also observed that CPM inclusion in the diet resulted in better egg production and quality eggs in terms of external and internal characteristics. Hence from the foregoing, farmers may include CPM in layer rations for better egg production and optimum egg quality.

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