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Productive Performance and Feed Cost Benefits of Broiler Chickens Fed with Unpeeled Yellow Cassava Root Meal

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ABSTRACT: The productive performance and feed cost benefits of broiler chickens fed unpeeled yellow cassava root meal (UYCRM) was investigated in this experiment. One hundred and twenty unsexed day old Ross 308 broiler chicks were randomly assigned to four dietary treatments in a Completely Randomized Design with 0% (control), 25%, 50% and 75% inclusion levels of UYCRM designated as T1, T2, T3 and T4 respectively. Each treatment was made up of 30 birds, divided into three replicates with ten birds per replicate. Feed and water were supplied ad libitum throughout the 8 weeks of the experiment. All growth parameters studied were significantly (P<0.05) affected by the dietary treatments. Birds fed control diet had higher final body weight (2798.81g), average daily weight gain (49.01g) and lower feed intake (38.02g) followed by those on 25% UYCRM diet. Birds on T1 also had a superior feed conversion ratio of 0.78 which was followed closely by birds on T2 (0.80). The cut parts (breast, back cut, thigh and wings) as well gizzard, crop and intestine weights differed significantly (P<0.05) among the treatments. Cost of feed decreased significantly (P<0.05) with the increasing level of UYCRM. The study showed that the UYCRM has considerable potential as components of broiler chickens diets in developing countries. It was therefore concluded that unpeeled yellow cassava root meal could be included at 25% (T2) in broiler chicken diet without any adverse effect on the performance or at 50% (T3) when the gross margin (gain) was considered.

Keywords: Unpeeled yellow cassava root meal, growth performance, feed-cost benefit
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INTRODUCTION

In intensive poultry enterprise, feed is the major component cost and the ultimate challenge is to reduce cost of input to a minimum without compromising the quality of the products (Adedokun, *et al.,* 2020). Feed formulation involves combining different ingredients (i.e. protein and energy sources, vitamins and minerals) in proportions necessary to provide the animal with proper amounts of nutrients needed at a particular growth stage. From market survey as at January, 2022 it was discovered that commercial broiler feed is very expensive. Maize, the main ingredient in poultry feed which is usually included at the rate of 40 to 60% of the formulated diet for broiler chickens is expensive or at times scarce. The cost of production could be reduced to a reasonable level if alternative but locally available feed ingredients are judiciously used in place of these commercial feedstuffs. This in turn will significantly reduce the cost of producing monogastrics' diets and increase meat and egg production in Nigeria.

Sauvant *et al*. (2019) reported the metabolizable energy value of cassava meal (70% starch) is equivalent to that of maize. Cassava (*Manihot esculenta* Crantz) root is a cheap and sustainable energy feedstuff with potential to replace most conventional cereal grains in the tropics (Putri *et al*., 2022). Cassava root is rich in digestible starch, gross energy content (Putri *et al*., 2022) and has been used to a limited extent in poultry nutrition (Oso *et al*., 2014).

Cassava is not only high in energy but also available in large quantity in Nigeria and has been investigated to serve as alternative main energy source in broiler rations. Cassava root meals have been substituted for maize at 0, 50, 70 and100% in the diets for layers, broilers and breeder stock. A substitution level of up to 25% was recommended by Adedokun *et al.* (2018).

Conventional cassava roots and products are known to be deficient in β-carotene and other carotenoids which could consequently lead to nutritional deficiencies and also cause in vivo oxidative stress with the attendant effects on animal products (Ngiki *et al*., 2014). The new bio-fortified cassava varieties from HarvestPlus (2020) aside from its high yielding are also innately rich in β-carotene. These varieties could serve as alternative energy source to broilers and supply the much desired pro-vitamin A, thereby providing cost effective way of combating vitamin A nutritional deficiency (Afolami *et al*., 2021).

Previous studies on the practical inclusion of unpeeled cassava root meal as energy feedstuff in feed for poultry (Oso *et al*., 2014), have limited information on the use of bio-fortified (yellow) cassava in the feed of poultry. Therefore the aim of this study was to investigate how broiler chickens can utilize unpeeled yellow cassava root meal and its effect on reducing cost of production.

MATERIALS AND METHODS

Experimental location

This research was conducted at the Poultry Unit of the Teaching and Research Farm of the College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, Abia State. The area is located in the South-Eastern part of Nigeria on latitude $5^{0}27^{!}$ North, longitude 7^{0} 32' East, an altitude of 123m above sea level with an annual rainfall of 2177mm, temperature of 22^{0}C – 36^{0}C and relative humidity of 50 – 90% (NRCRI, 2022).

Preparation of cassava root meal

Cassava roots (Umucass-46 or TMS 01/0539) were harvested from Umudike, Ikwuano LGA of Abia state. The unpeeled roots were washed, chopped and dried until a constant weight was achieved; it was then ground with a hammer mill machine and packed in an air tight bag.

Experimental procedure

A total of one hundred and twenty Ross 308 broiler strain birds were used for the study and were purchased from a reputable hatchery in Ibadan, Oyo State. All the necessary vaccinations and medications were administered to the birds. The chicks were brooded for one week and reared to seven weeks of age by conforming to standard management procedures. The chicks were offered clean water and fed *ad libitum* with a commercial feed starter diet from day old to one week of age. After brooding, the birds were randomly assigned to four treatments with 30 birds per treatment which was divided into three replicates with 10 birds per replicate and fed the experimental diet. The percentage composition of the experimental diets (single diet) is shown in (Table 1).

Data collection

Growth performance parameters

The initial live weight of the broiler chicks at day old was recorded. The birds were weekly weighed to determine the live weight and weight gain. The quantity of feed offered to the birds daily and the left over the next morning were measured to ascertain feed intake using triple beam balance (Ohaus, New Jersey). The data obtained was used to obtain the following parameters.

Average Daily Feed Intake (g/bird/day) =

$$\frac{\text{Quantity of feed given} - \text{Quantity left over}}{\text{Number of birds x Number of days}}$$

Average Daily Weight Gain (g/bird/day) =

$$\frac{\text{Final live weight} - \text{Initial live weight}}{\text{Number of birds x Number of days}}$$

Feed Conversion Ratio (FCR) =

$$\frac{\text{Average daily feed intake pe bird}}{\text{Average daily weight gain per bird}}$$

Carcass characteristics and organ proportions

The carcass characteristics and organ proportions were determined by slaughtering three birds (birds that are

Table 1: Percentage composition of experimental diets containing graded levels of processed unpeeled yellow cassava root meal.

	Diets			
Ingredients	**T_1 (0%)**	**T_2 (25%)**	**T_3 (50%)**	**T_4 (75%)**
Maize	42.00	31.50	21.00	10.50
UYCRM	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

UYCRM: Unpeeled Yellow Cassava Root Meal

close to the average weight of each treatment) per treatment at the end of the feeding trial. The birds slaughtered (by severing the jugular vein) were fasted for 24 hours to empty the digestive tract but water was supplied *ad-libitum*. All the cut parts (breast, drumstick, thigh, wings and back of cut) were weighed and expressed as percentage dressed weight. Internal organs like liver, heart, gizzard, kidneys were also weighed and expressed as a percentage of live weight.

Feed cost benefit analysis

Feed cost benefit analysis was carried out at eight 8 weeks to evaluate the profitability of unpeeled yellow cassava root meal (UYCRM) in broiler diet. The following parameters were calculated as described by Sonaiya *et al.* (1986) as follows:

Cost/kg feed (₦): This was determined by calculating the proportion of each ingredient in the diet multiplied by the cost per kg of ingredients divided by hundred**:**

$$\frac{\text{Total cost of producing 100kg of feed}}{100}$$

Total feed cost per bird = Cost per kg feed x Total quantity of feed consumed.

Cost of production (₦): Cost of production was determined by calculating the total quantity of feed consumed multiplied by unit cost of feed.

Feed cost per weight gain (₦): This was determined by dividing the cost of feed consumed by weight gained.

Revenue (₦): This was determined by finding the market price of 1kg live weight of broiler chicken and then multiplied by the final live weight

Gross margin profit (₦): This was determined by finding the difference between Revenue and cost of feed consumed per bird**.**

Experimental design and statistical analysis

The experimental design was a Completely Randomized Design (CRD) using four treatments, three replicates and 10 birds per replicate with UYCRM as the only factor of interest.

The model of the design is shown below:

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

Where

Y_{ij} = single observation ie $_j$th observation on the $_i$th treatment.
μ =overall mean
T_i = the effect of the $_i$th level of treatment
e_{ij} = Random error, assumed to be independently, identically and normally distributed with zero mean and constant variance.

All data generated were subjected to analysis of variance (ANOVA) and treatment means that were significantly (P<0.05) different were separated using Duncan's Multiple Range Test (Duncan, 1955) according to Steel and Torrie (1980) using computer software IBM SPSS Statistic version 20 (SPSS, 2009).

Table 2: Proximate Composition and metabolizable energy of the Experimental Diets.

Parameters (%)	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)
Dry matter	90.84	90.68	90.65	90.61
Crude protein	21.85	21.00	20.45	19.85
Ether extract	4.50	4.38	4.30	4.26
Crude fibre	5.20	5.62	5.01	6.18
Ash	6.56	6.82	6.90	6.95
Nitrogen free extract	52.73	52.86	53.09	53.37
MEkcal/kg	2862.06	2839.08	2828.96	2820.51

NFE= Nitrogen free extract, ME= Metabolizable energy

Table 3: Growth performance of broiler chickens fed unpeeled yellow cassava root meal

Parameters	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	SEM
IBW(g/b)	54.58	47.86	57.78	60.00	2.27
AFI (g/b)	2129.13^{b}	2112.89^{b}	2160.83^{ab}	2189.49^{a}	1.03
ADFI (g/b/d)	38.02^{bc}	37.22^{c}	38.58^{ab}	39.09^{a}	0.24
FBW (g/b)	2798.81^{a}	2671.43^{b}	2651.99^{b}	2602.78^{b}	26.01
AWG (g/b)	2744.33^{a}	2623.67^{b}	2594.33^{b}	2542.67^{b}	25.98
ADWG (g/b/d)	49.01^{a}	46.85^{ab}	46.73^{ab}	45.40^{b}	0.56
FCR	0.78^{c}	0.80^{bc}	0.84^{ab}	0.86^{a}	0.01

$^{a\text{–}b\text{-}c}$ Means with different superscripts in the same row are significantly different (P<0.05), S.E.M: Standard Error of mean. IBW=Initial Body Weight, FBW=Final Body Weight, AWG=Average Weight Gain, ADWG=Average Daily Weight Gain, FI=Feed Intake, ADWG=Average Daily Weight Gain, FCR=Feed Conversion Ratio, ADFI-Average Daily Feed Intake, AFI- Average Feed Intake

RESULTS

The determined proximate composition of the experimental diets is as shown in (Table 2). The diets used was a single/straight phase diet. This meant that the diets were not split into starter and finisher phases. The values of the dry matter (90.84%), crude fibre (21.85%), ether extract (4.50%) and metabolisable energy (2862.06Kcal/kg) of the control diet were higher than the treatment diets which decreased as the level of UYCRM increased. The reverse was the case of ash and nitrogen fee extract. The ash (6.56%) and Nitrogen Free Extract (52.73%) in the control diet were lower than their counterpart values of the treatment diets which increased as the level of inclusion increased. The crude fibre did not follow a particular pattern.

Growth performance of broiler chickens fed unpeeled yellow cassava root meal

The growth performance of broiler chickens fed unpeeled yellow cassava root meal is shown in (Table 3). Significant (P<0.05) differences were observed in the parameters considered except initial body weight. The birds on treatment T_4 ate the most (2189.49g) which was significantly (P<0.05) higher than birds on treatments T_1 (2129.13g) and T_2 (2112.89g) but similar to birds that were on T_3 (2160.83g). Increased Average daily feed intake recorded with unpeeled yellow cassava root meal up to 75% confirmed that unpeeled yellow cassava root meal can be used to improve the feed consumption of broiler chickens. The lowest average daily feed intake were recorded for birds on diets T_1 (38.02g) and T_2 (37.22g) with 0% and 25% unpeeled yellow cassava root meal (UYCRM) inclusion. There were significant (P<0.05) differences in the final body weight across the treatments, T1 (2798.81g) being the highest while others were fed the treatment diets were similar. The average weight gain had the same trend as final body weight. However, the average daily weight gains of birds fed T_1 was statistically similar to birds fed T_2 and T_3 but significantly (P<0.05) different from birds fed T_4. Broiler chickens fed diet T_4 was significantly (P<0.05) higher in FCR, recording the highest value of 0.86. The lowest and best feed conversion ratio was seen in the birds that was fed the control diet (0.78) which was not significantly different (P>0.05) from those on T_2 (0.80).

Carcass yield and cut-parts of broiler chickens fed unpeeled yellow cassava root meal

The carcass characteristics of broiler chickens fed varying level of UYCRM were presented in (Table 4). It was observed that live weight at slaughter, dressed weight, dressing percentage, breast cut, back cut, thigh and wings were significantly (P<0.05) affected by dietary treatments. From the result of this study, birds on treatment T_1 had the highest live weight (3043.33g) which was significantly (P<0.05) different from the other treatments (T_2 – T_4) which were similar. Dressed weight followed the same trent as live weight. The dressing percentage of birds placed on T_1 (73.81%) was statistically similar to T_2 and T_3 but significantly (P<0.05) different from T_4. Breast cut values

Table 4: Carcass yield and cut-parts of broiler chickens fed unpeeled yellow cassava root meal.

Parameters	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	SEM
Live weight (g)	3043.33^{a}	2638.33^{b}	2615.00^{b}	2605.00^{b}	62.00
Dressed weight (g)	2246.67^{a}	1966.67^{b}	1850.00^{b}	1823.33^{b}	54.70
Dressing percentage (%)	73.81^{a}	71.79^{ab}	70.76^{ab}	69.98^{b}	0.60
Breast cut (%)	30.10^{b}	33.18^{a}	33.78^{a}	33.78^{a}	0.80
Back cut (%)	11.62^{b}	12.62^{ab}	13.24^{a}	13.42^{a}	0.25
Drum stick (%)	13.82	14.75	14.71	14.27	0.19
Thigh (%)	15.05^{b}	16.26^{ab}	16.95^{a}	17.08^{a}	0.31
Wings (%)	9.64^{b}	10.47^{a}	10.61^{a}	10.96^{a}	0.17
Shank (%)	5.30	5.72	5.89	6.24	1.03

$^{a-b-c}$Means with different superscripts in the same row are significantly different (p<0.05), S.E.M: Standard Error of mean.

Table 5: Organ proportion of broiler chickens fed unpeeled yellow cassava root meal

Parameters	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	SEM
Heart	0.45	0.46	0.49	0.47	0.01
Gizzard	2.66^{b}	2.84^{ab}	3.07^{a}	3.03^{ab}	0.07
Proventriculus	0.42	0.43	0.46	0.46	0.01
Liver	2.22	2.41	2.49	2.36	0.06
Kidney	0.03	0.04	0.04	0.04	0.00
Crop	0.58^{c}	0.67^{b}	0.77^{a}	0.80^{a}	0.03
Spleen	0.11	0.17	0.17	0.16	0.01
Lungs	0.21	0.22	0.24	0.24	0.01
Intestines	5.03^{b}	5.60^{a}	5.80^{a}	5.75^{a}	0.11

$^{a-b-c}$ Means with different superscripts in the same row are significantly different (p<0.05), S.E.M: Standard Error of mean.

Table 6: Feed cost benefit analysis of broiler chickens fed unpeeled yellow cassava root meal.

Parameters	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	SEM
TFI (g/bird)	2129.13^{b}	2112.89^{b}	2160.83^{ab}	2189.94^{a}	39.86
Cost/100kg(₦)	32702.00^{a}	29657.00^{b}	26612.00^{c}	23422.00^{d}	28.43
Cost/kg (₦)	327.02^{a}	296.57^{b}	266.12^{c}	234.22^{d}	2.01
Feed Cost (₦)	696.27^{a}	625.15^{b}	574.56^{c}	512.23^{d}	4.19
WG (g/bird)	2744.33^{a}	2623.67^{b}	2594.33^{b}	2542.67^{b}	40.83
Cost/WG(₦)	0.25	0.24	0.22	0.20	0.00
Revenue (₦)	3704.40^{a}	3541.05^{b}	3502.35^{b}	3431.70^{c}	33.01
GM (₦)	3008.03^{a}	2915.85^{b}	2928.35^{a}	2919.70^{b}	44.13

$^{a-b-c}$ Means with different superscripts in the same row are significantly different (p<0.05), S.E.M: Standard Error of mean. TFI=Total Feed Intake WG= Weight Gain; Cost/WG: Cost per Weight Gain; GM=Gross Margin

increased with inclusion of UYCRM. The back cut values were higher in T_4 (13.42%), T_3 (13.24%) and T_2 (12.62%) which were not significantly (P>0.05) different form each other but significantly (P<0.05) different from the control T_1 (11.62%) which had the lowest value. The back cut of birds on T_1 was equally similar to the back cut of birds fed treatment T_2. Thigh weight of birds placed on T_4 (17.08%) was statistically similar to birds on T_3 (16.95%) and T_2 (16.26%) which was significantly higher (P<0.05) than those of T_1 (15.05%). However, thigh weight of birds on T_2 and T_1 did not differ significantly (P>0.05). The result for wings showed that birds fed diet T_4 (10.96%) was statistically similar to birds on T_3 (10.61%) and T_2 (10.47%) which was significantly (P<0.05) different from those on T_1 (9.64%).

Internal organ proportion of broiler chickens fed unpeeled yellow cassava root meal

The response on the internal organ proportion of broiler chickens fed UYCRM were presented in (Table 5). The heart, proven triculus, liver, kidney, spleen and lungs were not significantly (P>0.05) influenced by the dietary treatments. However, significant (P<0.05) differences were observed for the gizzard, crop and intestines. The values of gizzard did not follow a particular trend. The gizzard of birds fed treatment T3 were heaviest (3.07%) but similar to the birds on treatments T2 (2.84%) and T3 (3.03%) which were similar to birds on treatment T1 (2.66%). For the intestine the birds on the treatment diets had heavier intestinal weights when compared with those placed on the control diet.

Feed cost benefit analysis of broiler chickens broiler chickens fed unpeeled yellow cassava root meal

From the cost analysis, all the parameters differed (P<0.05) significantly with the exception of cost/Weight gain. The cost/100kg, cost/Kg and feed cost of the birds decreased as the level of UYCRM increased (Table 6). The cost per 100kg of feed differed significantly (P<0.05) across the treatments and the same trend was observed for cost per kilogramme of feed and the feed cost. The revenue was highest with the birds fed the control diet (₦ 3704.40) and reduced as the inclusion levels increased. The gross margin of birds fed both treatments T_1 and T_3 were similar while those of T_2 and T_4 which were equally similar.

DISCUSSION

All the values of the proximate composition of the diets of this experiment met the nutritional requirements for a single/straight diet for broiler chickens (NRC, 1984). Elnour *et al.* (2020) in their experiment reported that the heaviest body weight was found with birds fed on control diet, whereas the lowest one observed with birds fed with 40% cassava root, which was in line with the report of this work. On the contrary, Chang'a *et al*. (2020) found that body weight (BW) was highest in birds fed diets in which 50% of the maize was replaced by cassava flour meal compared with birds fed diets of 100% or 75% maize or 100% cassava flour meal. Also, Ironkwe and Ukanwoko (2012) found that final BW was significantly reduced and feed intake was increased when cassava leaves replaced over 50% of dietary maize which correspond with this study. Eruvbetine *et al*. (2003) found that broilers could be successfully fed a substitution of 10% half cassava root and half leaf meal. Elnour *et al.* (2020) reported that when the level of dietary inclusion of cassava roots exceeded 15%, the feed intake and weight gain decreased. This present work disagreed with the work of Uchegbu *et al.* (2011) who used cassava roots meal and maize/ sorghum brewers dried grains as replacement of maize at rates 15%, 30% and 45%, concluded that cassava root meal and maize/ sorghum brewers dried grains can be successfully incorporated in broiler starter diets up to 30% dietary level. Diarra *et al*. (2014) reported a value of 69.38% as the dressing percentage of birds fed cassava copra meal diet, which was similar to the values obtained in the birds fed 25%, 50% and 75% UYCRM. The dressing percentage observed in this study was seen to be decreasing as the level of UYCRM increases. The range of values obtained for breast cut, thigh and drum stick were higher than the values obtained by Oluyemi and Robert (2000) which were as follows: breast (17.40%), back cut (12.05%) and thighs (2.95%).

The results of this study agreed with Diarra *et al.* (2014) who used cassava roots meal at rate 34.0% and concluded that small intestine the weight of small intestine was affected by cassava meal. The increased in gizzard and intestine weights may be attributed to increased retention time of digesta on fibrous diets (Elnour *et al.,* 2020). Increased gizzard volume with increasing structural components in the diet has also been reported by Akinmutimi *et al*. (2006).

The lower cost of feed could be attributed to the cheaper cost of cassava over maize, which is in line with the observation by Nsa *et al.* (2016). This is lend support from the report of Nworgu *et al*. (2000) who stated that there is need for dietary incorporation of unconventional feed ingredient as alternative, non-competitive, readily available and cheap ingredients so as to reduce the cost of production and in the long run increase profit margin. However, the highest revenue was generated from birds maintained on 25% unpeeled yellow cassava root meal diet compare to other birds on diet T_3 and T_4. From the study, the best profits were obtained in birds fed T_1 and T_3 (0% and 50% unpeeled yellow cassava root meal inclusion level).

Conclusion and recommendation

From the outcome of the findings of this study, the best growth, final life weight and feed conversion ratio was obtained in birds fed T_2 (25%) among the treatment groups. The feed cost analysis showed that birds fed T_3 had a better profit when compared with the T_2 and T_4. It was recommended that unpeeled yellow cassava root meal could be included in broiler diets up to 25% without adverse effects in broiler chickens and up to 50% if the profit is considered.

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