PERFORMANCE AND CARCASS EVALUATION OF BROILER CHICKENS FED GRADED LEVELS OF UNRIPE PLANTAIN (*MUSA PARADISIACA* L.) PEEL MEAL

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ABSTRACT

The ever-increasing price of feed ingredients especially the conventional energy sources is a great challenge to profitable poultry production. This predicament led to the search for unconventional energy sources for broilers' feed production. A total of eighty-four-day-old Arbor Acres broiler chicks were used in this feeding trial in a Completely Randomized Design (CRD). This encompasses four treatments replicated thrice for six weeks; two weeks of acclimatisation and four weeks of feeding trial. Seven birds were allotted to each of the replicates. Maize was partially replaced by unripe plantain peel meal (UPPM) at graded levels of 0, 5, 10 and 20%. The birds were served feed and water ad libitum. Data on performance, selected internal organs, cost of feed per treatment, carcasses and chicken parts taken were statistically analysed. The performance parameters showed no significant difference (p>0.05), while the cost of the diets reduced in a pattern of diet 1 > diet 2 > diet 3 > diet 4, showing the feed cost price lowering potential of UPPM. Significant differences (p<0.05) were observed in some of the selected organs and carcass parameters. The dressing percentage differs significantly (p<0.05), but the values from all the groups fall within the acceptable range of 65 to 70% recommended for broilers in the literature. It was concluded that UPPM has the potential to replace 5 to 10% maize in the diets of broiler chickens without any harmful effects.

Keywords: Feed cost, Maize, Broiler chickens, Plantain-peel-meal

INTRODUCTION

The global poultry industry over the years has been adversely affected by the high and increasing cost of feeds. Feed accounts for over 60% of the total cost of production in the livestock industry (Rafiu *et al*., 2017). The unavailability of sufficient quantities and the ever-increasing cost of many of the feed ingredients especially the conventional energy and protein feed ingredients for feed formulation (Omede *et al*., 2018) resulted in the high cost of feeds and animal products in Nigeria. According to Owosibo *et al.* (2017), Nigeria is currently faced with a short supply and high cost of conventional feed ingredients, especially for poultry feed formulation. If poultry production is to be sustainable and cost-effective, the cost of feed must be brought down to the barest minimum (Thirumalaisamy *et al*., 2016). Maize has been recognized as the major conventional source of energy in the diets of poultry

accounting for about 40 to 65% of the feed (Dei, 2017). Maize also faces stiffer competition between man and livestock which ultimately led to its high demand. The high demand has inadvertently led to high prices that have translated to high prices of animal products like meat, eggs, milk, etc. (Abdulrahman *et al*., 2022). The present scenario necessitates the search for unconventional energy feedstuff that has no competitive effect with man and will eventually help to bring down the high cost of poultry feed for the sustainability of poultry production. Unripe plantain peel is a potential non-conventional feedstuff that has been reported to contain about 12 – 13% crude protein, 1300 – 3900 kcal/kg metabolizable energy comparable to that of conventional maize (Akande and Agbetuyi, 2019; Agubosi *et al*., 2019; Odion *et al*., 2021). It was reported that plantain peel contains better protein, energy, calcium and phosphorous composition than maize with more crude fibre and ether extract (Omole *et al.,* 2008). It was reported that Nigeria is the world's largest cultivator and consumer of plantain producing approximately 10.5 million tonnes per annum. This quantity accounts for about 10% of total global production (Ayanwale *et al.,* 2016). This huge volume of production and consumption of plantain in Nigeria makes the peel abundant after the consumption of its pulp. It is well cultivated in many tropical (Brazil, Egypt, Nigeria, Japan, etc.) and non-tropical countries of the world, it is a close relative of banana, but with bigger, longer and thicker skin (Bhat *et al*., 2009; Lavanya *et al*., 2016). Plantain is a rhizomatous perennial crop that is very useful in the preparation of starch staples for millions of Nigerians. The International Institute of Tropical Agriculture also reported that bananas and plantains are a staple food for more than 70 million people in sub-Saharan Africa, and are good sources of starch (IITA, 2000). It is eaten all over Africa, Southern and Central America. Mature plantain fruit is a good source of energy, very low in protein but rich in vitamin A, vitamin C, iron and potassium. Unripe plantain is excellent for weight control, and slow energy release and is good for diabetic patients (Ajiboye *et al*., 2018). The fruit of *Musa paradisiaca* as reported by Khare (2008) is traditionally useful in treating dysentery, diarrhoea, intestinal lesions in ulcerative colitis, uraemia, nephritis, gout, diabetes, etc. It has therefore become indispensably essential to tap and harness the energy potential in the unripe peel of plantain as well as utilizing the same at graded levels to substitute for the costly and scarce conventional maize in poultry diets. This study was carried out sequel to our earlier research on plantain peel meal (Arogbodo *et al*., 2021) as well as seeking the possibility of reducing the cost of broiler feed emanating from incessant increases in the price of maize.

MATERIALS AND METHODS

Experimental Site, Sourcing and Preparation of Unripe Plantain Peel Meal: This experiment was carried out at the Animal Production and Health Research Unit, Obakekere (South Gate) of the Federal University of Technology, Akure, Ondo State, Nigeria between April and May 2023. The site is located on Latitude: 7.29349, N $7^0$17′ 45.27312″, Longitude: 5.14989, E $5^0$8′ 59.58852″. Unripe plantain peels (UPP) were sourced from households within Akure metropolis, Ondo State, Nigeria. The sourced peels were rinsed in clean water to remove any adherent dirt. They were chopped into small sizes and sun-dried. After being sun-dried, the peels were ground with the aid of an electric blender into powder to form the unripe plantain peel meal (UPPM). The proximate analysis of the UPPM, the dietary ingredients and the produced diets was carried out three times in three batches following standard procedure (AOAC, 2006). The average of the three batches of the processed UPPM and the dietary ingredients was adopted in the diets' production.

Experimental Design and Preparation of Experimental Diets: One hundred (100) one-day-old Arbor Acres breed of broiler chicks were procured from CHI Farms, Ibadan, Oyo State, Nigeria, while eighty-four (84) were used for the experiment. The experiment was made up of four treatments in three replicates each. Seven birds were allotted into a replicate in a completely randomized design (CRD). Treatments 1, 2, 3 and 4 were 0, 5, 10 and 20% inclusion of UPPM in the diets respectively. The four iso-nitrogenous

and iso-caloric broiler starter diets were formulated with UPPM at 0, 5, 10 and 20% replacement values for maize (Table 1).

Table 1: Percentage composition of the experimental broiler starter diets

Ingredients	Diets			
	Diet 1	Diet 2	Diet 3	Diet 4
Maize	60.00	57.00	54.00	48.00
Soybean meal	9.00	9.00	9.00	7.00
Groundnut cake	24.00	24.00	24.00	26.00
Unripe plantain peel meal (UPPM)	0.00	3.00	6.00	12.00
Fish meal	4.00	4.00	4.00	4.00
Di-calcium phosphate	0.10	0.10	0.10	0.10
Bone meal	2.20	2.20	2.20	2.20
Vitamin-mineral premix*	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10
Salt	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated values				
Crude protein (%)	23.04	23.10	23.16	23.30
Metabolizable energy	3033.80	3024.92	3016.04	3001.08
Crude fat (%)	5.00	5.00	5.00	5.00
Crude fibre (%)	4.40	4.50	4.70	5.00
Calcium (%)	1.00	1.00	1.00	1.00
Phosphorus (%)	0.60	0.60	0.60	0.60
Lysine	0.94	0.93	0.92	0.90
Methionine	0.34	0.33	0.33	0.31

*Diet 1= 0% UPPM, Diet 2 = 5%, Diet 3 = 10%, and Diet 4 = 20% replacement value of maize with UPPM. UPPM = Unripe Plantain Peel Meal, *To provide the following per kg of feed (Vitamin A 10,000 IU, Vitamin D3 2000 IU, Vitamin E 12 mg, Vitamin K 2 mg, Vitamin B1 1.5 mg, Vitamin B2 4 mg, Vitamin B6 1.5 mg, Vitamin B12 12 mg, Niacin 15 mg, Pantothenic acid 5 mg, Folic acid 5 mg, Biotin 2 mg, Choline chloride 100 mg, Manganese 75 mg, Zinc 5 mg, Iron 2 mg, Copper 5 mg, Iodine 10 mg, Selenium 2.0 mg, Cobalt 5 mg, Anti-oxidant 125 mg)*

The diets were formulated to have metabolisable energy of 3000 – 3200 Kcal/kg, and crude protein 20 – 23, as recommended in the management guide of Arbor Acres broilers (Arbor Acres, 2014).

Management of Experimental Birds: Routine medications and vaccinations were administered to the broiler chickens at the appropriate time (Afrimash, 2024). Their feed intake and weight gain were determined on a daily and weekly basis respectively using a very sensitive digital scale. At termination, the birds were weighed to know their final weight per replicate. Three birds were sacrificed per replicate for carcass and selected organs' weight evaluation.

Data Collection and Collation: The weight of all the birds was taken every week from which the average weight was calculated. Live weight, plucked weight, eviscerated weight and the weights of the head, neck, chest (breast muscle), right lap, left lap, right drumstick, left drumstick, right-wing, left-wing and back were taken in gram (g). The weight of selected organs viz; gizzard, proventriculus, heart, lung, liver, kidney and spleen were also taken and recorded (g). Data on feed conversion ratio and dressing percentage were equally garnered.

Cost of Feed Assay: To ascertain the selling price of feed ingredients, four major feed mills in Akure were visited for data generation. The average of the prices got was used in the calculation of the broiler feed prepared in this study.

Analysis of Data: The data generated during the experiment were subjected to one-way analysis of variance (ANOVA) using SPSS Version 23 and significant means at $p<0.05$ were separated using Duncan's Multiple Range Test (DMRT) (SPSS, 2015).

RESULTS AND DISCUSSION

The average values of data obtained at three different times of processing UPPM are shown in Table 2. The average proximate composition values of the UPPM were lower than the values reported by Ibhadifon *et al*. (2020) for UPPM. The crude protein and carbohydrate in this experiment were higher than those reported by Ibhadifon *et al*. (2020). Agbabiaka *et al*. (2013) reported nearly similar values except that moisture, crude protein, fat and ash were higher than the results of this study, while the carbohydrate and fibre fractions were lower. Meanwhile, the report of Ogunsipe and Agbede (2010) agrees with the moisture content, crude protein and crude fibres obtained in this experiment.

Table 2: Average proximate composition of unripe plantain peel meal

Parameters	First	Second	Third	Average	Approximate value
Moisture (%)	8.98	6.00	5.05	6.67	7.00
Ash (%)	1.84	5.01	6.05	4.30	4.00
Crude fat (%)	1.22	4.78	4.00	3.33	3.00
Crude fibre (%)	6.86	8.54	10.65	8.69	9.00
CP (%)	9.01	11.28	12.09	10.79	11.00
CHO (%)	72.09	64.39	62.17	66.22	66.00
ME Kcal/Kg	2620.73	3457.28	3329.71	3135.91	3136.00

CP = Crude protein, CHO = Carbohydrates, ME = Metabolizable Energy

The crude fat of UPPM reported by Akande and Agbetuyi (2019) agrees with the range of values obtained in this study but recorded a lower value in metabolizable energy. However, the little variations in the findings may have been due to geographical locations and differential factors obtainable when and where the studies were carried out.

The performance parameters of the experimental chickens evaluated are shown in Table 3. Initial weight, final weight, feed intake, total weight gain, average weight gain, and feed conversion ratio of the birds per treatment showed no significant difference ($p>0.05$). The average weight of the experimental broiler chickens in all the groups shows no significant effect at the end of the experiment which probably suggests that the UPPM can be tolerated by broiler chickens. This agrees with the findings of Akande and Agbetuyi (2019). A similar trend was also observed by Agbabiaka *et al*. (2013) in the study of the effect of plantain peel on the diets of *Clarias gariepinus*. Though the type of plantain peel used was not specified, the weight of the fish did not differ significantly across the treatments. The reports of Ironkwe and Oruwari (2012) as well as Unah *et al*. (2022) did not tally with the present results from this study. Ironkwe and Oruwari (2012) reported the highest final weight in the broiler chicken fed 50% replacement of maize with plantain peel against the control diet. However, the report did not specify whether ripe or unripe peel of plantain was used in the experiment. The findings of Unah *et al*. (2022) agree with the pattern of weight obtained in this study with the birds in the control diet having the highest weight but their reported weights were significantly different from one another. The total weight gain of the broiler chickens in this study shows no significant difference. This is also in line with earlier reports by Akande and Agbetuyi (2019). Ironkwe and Oruwari (2012) observed a significant difference in weight gain of broiler chickens fed graded levels of plantain peel, also corroborated by Unah *et al*. (2022). Unah *et al*. (2022) recorded the highest weight gain in the control group and the lowest weight gain from the group in which maize was replaced by unripe plantain peels 100%. The total feed intake of the broiler chickens in the present study did not show any significant difference across the groups. However, the birds in the control group recorded the highest feed intake followed by birds in T3, T4 and T2. This pattern confirms the report of Agbabiaka *et al*. (2013) on the inclusion of plantain peel in the diet of *C. gariepinus*. The reports of Ironkwe and Oruwari (2012) and Unah *et al*. (2022) presented the control group had the highest feed intake and the feed intake continued to reduce as the percentage of UPPM inclusion in the diet increased. This may be due to the activity of anti-nutritional factors in plantain peels as reported by Agbabiaka *et al*. (2013). The feed conversion ratio of the experimental broiler chicken did not differ significantly. All the FCR values are within the acceptable values of FCR for broiler chickens of the experimented age. This validates the report of Ayeni *et al*. (2022) with an FCR range of 1.75 to 2.01 on experimental birds of similar age. The obtained FCR values in this study indicate that all the experimental diets are rich in nutrients, palatable, well-digested, utilized, and well-converted to flesh. However, the FCR did not follow a pattern as the FCR of T3 was better than T2.

Significant differences ($p<0.05$) were observed in the weight of the proventriculus, heart and liver (Table 4). The significant difference observed may be due to weight differential, while the lesser weight of the liver

Table 3: Performance of broiler chickens fed graded levels of unripe plantain peel meal (UPPM) inclusion in diets

Parameters	T1	T2	T3	T4
Initial WT (g)	329.90 ± 10.06	325.05 ± 12.00	330.37 ± 11.61	325.56 ± 2.70
Final WT (g)	1721.92 ± 127.68	1564.19 ± 165.14	1615.90 ± 56.20	1542.86 ± 46.64
Feed intake (g)	2572.37 ± 39.61	2451.80 ± 129.01	2534.99 ± 147.58	2515.44 ± 115.72
TWT gain (g)	1392.02 ± 125.62	1239.14 ± 167.12	1285.54 ± 67.82	1217.30 ± 46.46
AvDWG (g)	49.72 ± 4.49	44.26 ± 5.97	45.91 ± 2.42	43.47 ± 1.66
FCR	1.85 ± 0.16	1.98 ± 0.66	1.97 ± 0.05	2.07 ± 0.16

Means were not significantly different (p>0.05), WT= Weight, TWT = Total Weight, AvDWG= Average Daily Weight Gain, FCR = Feed Conversion Ratio

Table 4: Organs' weight and mortality of experimental broiler chickens fed graded levels of unripe plantain peel meal (UPPM) inclusion in diets

Organs	Treatments			
	T1	T2	T3	T4
Gizzard	48.04 ± 6.69	50.90 ± 7.49	51.57 ± 5.56	49.67 ± 7.61
Proventriculus	7.72 ± 1.24^{b}	7.08 ± 1.28^{ab}	8.13 ± 0.94^{b}	6.53 ± 0.99^{a}
Heart	8.74 ± 1.67^{b}	8.23 ± 1.31^{ab}	9.31 ± 0.86^{b}	7.27 ± 1.34^{a}
Lung	8.25 ± 1.72	9.20 ± 1.45	9.66 ± 1.97	8.67 ± 1.82
Liver	36.80 ± 4.35^{c}	31.11 ± 3.77^{b}	31.17 ± 4.11^{b}	26.70 ± 3.97^{a}
Kidney	11.73 ± 1.86	10.69 ± 2.56	11.90 ± 1.29	10.64 ± 1.20
Spleen	2.20 ± 0.94	2.01 ± 0.60	1.71 ± 0.64	1.51 ± 0.73
Mortality	1	0	0	0

T2= Treatment 2, T3= Treatment 3, T4=treatment 4, a-c = means with different superscripts along the same row are significantly different (p<0.05)

and spleen from the UPPM diets may be attributable to the hepatoprotective activity of plantain peel as corroborated by Nirmala *et al.* (2012). The liver and the spleen from the control group were slightly inflamed. Throughout the experiment, the death of only one broiler occurred in the last week from the control group. The absence of mortality in all the groups of broilers fed different levels of UPPM may be traceable to its richness in vitamins, macro minerals, and phytochemicals (Adeolu and Enesi, 2013). This corroborates its high antioxidant, antimicrobial and antifungal capacity as reported by Agama-Acevedo *et al.*, 2016; Lavanya *et al.*, 2016; Behiry *et al.*, 2019). The above properties of plantain peels must have enhanced disease prevention and promoted the wellness of the experimental broiler chickens. The antifungal and antibacterial properties of the extract of plantain peel were also reported (Okorondu *et al.*, 2012; Asoso *et al.*, 2016; Behiry *et al.*, 2019).

The differences in the price (Table 5) per 25 kg bag between the control diet and diets 2, 3 and 4 are ₦337.50, ₦675.00 and ₦1370.00 respectively. This indicates that ₦337.50 has been saved on diet 2, ₦675.00 on 3, and ₦1370.00 on 4 per 25 kg feed.

The price per 25 kg as well as per kg decreases as the inclusion of UPPM increases in the diets. This shows the price-reducing possibility of UPPM when utilized in broiler diet formulation (Ogunsipe and Agbede, 2010; Robert *et al.*, 2020).

The various parameters considered under carcass evaluation are shown in Table 6. A substantial number of the parts and dressing percentages differ ($p<0.05$) significantly while others did not ($p>0.05$). The dressing percentage falls within the recommended range of 65% to 70% for broilers (Lessler *et al.,* 2007; Okpe and Sule, 2022).

Conclusion: The UPPM's proximate composition compared well with maize, indicating that it has the potential to be used as an energy substitute in feed formulation for broiler chickens. The lowering cost effect in the diets due to the inclusion of UPPM is a plus in broiler chicken production. The average weight, feed intake, organs' weight, and dressing percentage compared well with the control. More importantly, the optimum inclusion rate of UPPM was realized at 5 to 10%. Further studies on the GC-MS of the bioactive compounds in UPPM, amino acids profile and feed processing methods like soaking,

Table 5: Cost of each of the experimental diets with graded levels of unripe plantain peel meal (UPPM) inclusions

Ingredients	Cost/Kg (₦)	Diet 1 (₦)	Diet 2 (₦)	Diet 3 (₦)	Diet 4 (₦)
Maize	550.00	33000.00	31350.00	29700.00	26400.00
Soybean meal	370.00	3330.00	3330.00	3330.00	2590.00
GNC	330.00	7920.00	7920.00	7920.00	8580.00
UPPM	100.00	0.00	300.00	600.00	1200.00
Fishmeal	2600.00	10400.00	10400.00	10400.00	10400.00
DCP	1000.00	100.00	100.00	100.00	100.00
Bone meal	110.00	242.00	242.00	242.00	242.00
Broiler premix	1500.00	375.00	375.00	375.00	375.00
Methionine	3500.00	350.00	350.00	350.00	350.00
Lysine	2600.00	260.00	260.00	260.00	260.00
Salt	300.00	75.00	75.00	75.00	75.00
Milling charge		912.50	912.50	912.50	912.50
Total		56964.5	55614.5	54264.5	51484.5
Price / 25 kg bag		14241.13	13903.63	13566.13	12871.13
Price/kg		569.65	556.15	542.65	514.85

UPPM = Unripe plantain peel meal, GNC= Groundnut cake, DCP = Di-calcium phosphate

Table 6: Carcass qualities of broiler chickens fed graded levels of unripe plantain peel meal (UPPM) inclusion in diets

Parameters (g)	Treatments			
	T1	**T2**	**T3**	**T4**
Live weight	1745.19 ± 159.70^{c}	1554.36 ± 144.06^{ab}	1593.81 ± 214.25^{bc}	1395.62 ± 198.59^{a}
Plucked weight	1630.13 ± 140.41^{c}	1432.28 ± 137.53^{ab}	1462.52 ± 183.72^{b}	1291.60 ± 190.65^{a}
Evis weight	1373.69 ± 128.22^{b}	1206.77 ± 124.77^{a}	1223.60 ± 173.44^{a}	1080.88 ± 162.73^{a}
Head	46.99 ± 7.04	42.60 ± 4.46	44.08 ± 5.95	42.12 ± 6.85
Neck	63.54 ± 9.58	55.18 ± 6.70	63.53 ± 12.40	55.23 ± 9.24
Chest	414.17 ± 9.58^{c}	363.13 ± 47.45^{b}	354.69 ± 59.14^{b}	304.19 ± 43.89^{a}
Right lap	108.07 ± 12.86^{b}	90.90 ± 11.55^{a}	92.79 ± 15.26^{a}	79.53 ± 12.60^{a}
Left lap	105.66 ± 15.11^{b}	91.59 ± 13.45^{a}	87.60 ± 15.06^{a}	78.78 ± 13.25^{a}
Right DS	92.70 ± 12.06^{b}	82.40 ± 8.32^{ab}	80.60 ± 13.51^{ab}	74.29 ± 14.56^{a}
Left DS	91.76 ± 12.64^{b}	81.32 ± 9.36^{ab}	83.43 ± 15.26^{ab}	75.07 ± 13.64^{a}
Right shank	35.92 ± 6.754	35.22 ± 5.39	36.10 ± 6.22	33.51 ± 5.67
Left shank	36.77 ± 6.71	34.73 ± 5.77	36.19 ± 5.91	33.62 ± 6.14
Right-wing	83.77 ± 10.89^{b}	61.72 ± 5.04^{a}	64.66 ± 9.05^{a}	58.06 ± 8.85^{a}
Left-wing	74.13 ± 9.84^{b}	62.84 ± 4.90^{a}	64.09 ± 7.31^{a}	59.02 ± 8.78^{a}
Back	220.22 ± 37.46^{b}	205.12 ± 25.11^{ab}	215.84 ± 26.36^{ab}	187.46 ± 32.99^{a}
Dressing (%)	68.24 ± 1.14^{b}	66.79 ± 1.88^{ab}	65.40 ± 1.89^{a}	65.58 ± 1.37^{a}

Evis = Eviscerated, Ds = Drum stick, a – c = Means with different superscripts along the same row are statistically the same ($p<0.05$)

lye treatment, fermentation, boiling, cooking, etc. that can reduce the level of its anti-nutritive factors are thus recommended.

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