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RESEARCH ARTICLE

Effects of Inclusion of Unripe Plantain Peel Meal (*Musa paradisca)* on Carcass Quality, Performance and Internal Organ Weights in Finisher Broiler Birds

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ABSTRACT

A total number of 100 Anak broiler birds at 4 weeks of age were used to assess the effects of different inclusion levels of unripe plantain peel meal (UPPM) as a substitute for maize grain on carcass quality, performance and internal organ weights in finisher broiler birds. Five different replacement levels of UPPM (0%, 12.5%, 25.0%, 37.5% and 50%) were evaluated in our experiments as treatments T_1, T_2, T_3, T_4 and T_5, respectively. Measurements of body height, thigh length, leg length, live weight, heart girth, body length, shank length, wing length and head circumference were recorded on the first week of the experiment and weekly thereafter till the end of the experiment. Daily feed intake, feed conversion ratio, feed cost, body weight and organ weights were assessed in all the treatment groups. Our results showed that the mean daily feed intake (110.00g, 118.00g, 121.54g 121.90g and 122.09g) and mean daily weight gain (42.16, 41.08, 38.29, 38.20 and 38.08g) for diets T_1, T_2, T_3, T_4 and T_5, respectively differed between groups. T_1 differed significantly ($p<0.05$) from T_4 and T_5. The diet containing UPPM improved performance characteristics, carcass quality and organ weight. Our study showed that UPPM could economically replace maize grain, to a certain extent, in the broiler rations. Based on our results, the 37.50% (T_4) level of incorporation appeared to be the optimal replacement level of UPPM for maize grain, in daily weight gain because the performance indicators were significantly depressed when levels higher than 37.5% are included in the broiler diets.

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INTRODUCTION

The high cost of feed ingredients in most tropical countries clearly indicates that the production of cereal grains for livestock business in these countries is grossly inadequate (Ahaotu *et al.* 2010a, 2010b). Furthermore, the stiff competition existing between humans and animals over the limited supply of grains has resulted in a near collapse of the poultry industry in Nigeria (Ahaotu *et al*., 2009a). Thus, there is an urgent need to divert our attention toward exploitation of other tropical sources. One such potential source that is not realized to its fullest extent is unripe plantain peels which are generally not used for human consumption.

The use of plantain peels in poultry has been limited because of possible deleterious effects arising from the presence of *tannins*. *Tannins* exist in plantains in two different forms, (a) "free or active *tannins*" which impart a strong bitter taste and (b) "*bound* or vegetable *tannins*" which are insoluble, supposedly inert and which have little or no effect on the palatability (Makkar *et al.*, 2007, Montcel, 1987, Gomez, 1982, Oyen and Lemmens, 2002).

Through sun drying process, the level of free *tannins* decreases. Dupriez and De Leener, 2009). Though the level of free or active *tannins* is much higher in the peel than in the pulp, it is significantly reduced by time the peels are sun dried to reduce the total moisture content to 10% (Von Loesecke, 1990, Calles *et al*., 2000). Plantain peels are highly digested and are an excellent source of energy. Compared with other *Musa* species banana peels, crude protein level is high (Ahaotu, 2010). Methionine and cystine, the sulphur containing amino acids are present in moderate quantities in plantain protein (Nwifa and Hedo, 2010). However, plantain peels are well

balanced with regard to the ratio of protein to calories. For example, the plantain peel protein to calorie ratios is considerably higher than those of maize and other cereals (Asuquo et al., 1992).

Sun drying the unripe plantain peels prior to milling would immensely help in reducing the anti-nutritional toxic substances (tannins). Considering the problem of toxicity, there is a need to investigate the potential of unripe plantain peel meal as an alternative feed ingredient in the broiler rations.

MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research Farm of Imo State Polytechnic, Umuagwo, lmo State, Nigeria. The farm is situated in the South Eastern Zone of Nigeria with an annual rainfall of 2000mm – 2484mm and with an average temperature of 26^0C (Ofomata, 1975).

Procurement of experimental birds

A total of 124 broiler birds aged4-week and belonging to Anak strain procured from the Imo State Polytechnic Research Farms were used for this experiment. The birds were fed commercial finisher feed (livestock feeds) for stabilization. After the first week, 100 birds were selected based on apparent viability and good conformation and were assigned to five treatment groups such that each treatment comprised of 20 birds and reared on deep litter for three wee

Source and processing of unripe plantain peel meal

The unripe plantain peels used for this study were harvested from Oha Self Help Organization Farms in Atta West Autonomous Community in Ikeduru Local Government Council, lmo State, Nigeria. Atta lies between latitudes 5^0 36^1 00^{11} and 40^0 78^1 00^{11}N and longitudes 7^0 7^1 00^{11} and 39^0 55^1 00^{11}E at an elevation of about 90m above the sea level, within the South Eastern Agricultural zone of Nigeria. The average annual rainfall, temperature and humidity of Atta are 2500mm, 27^0C and 75% respectively (Ofomata, 1975). The unripe plantain peels were sun dried for 4 – 6 days depending on the intensity of sun by spreading them evenly on a cemented floor. During drying, the peels were flipped regularly to prevent uneven drying and possible decay of the peels. Once considerable dehydration has been achieved (as indicated by brittleness and crispiness of the peels), processing was done by grinding in a hammer mill to produce the unripe plantain peel meal.

Unripe plantain peel meal was subjected to proximate, mineral and vitamin analyses (Table 1) at the Imo State Polytechnic, Umuagwo, Nigeria, using the standards methods described earlier (AOAC, 2001). The mineral analysis was carried out using the methods mentioned by of Grueling (2000), while gross energy content was determined using a Gallenkamp Oxygen, Adiabatic bomb Calorimeter.

Formulation of the experimental diets

Five experimental broiler finisher diets containing 0, 12.5, 25, 37.5 and 50% unripe plantain peel meal (UPPM) for treatments 1, 2, 3, 4 and 5, respectively were formulated in which 0% UPPM; (T_1) was the control (Table 2). The ingredients were thoroughly mixed to ensure homogeneity and milled in a hammer mill. The feed was fortified with a vitamin premix and synthetic amino acids according the guidelines provided by the National Research Council recommendation (NRC, 2004).

Table 1: Chemical composition of unripe plantain peel meal

A	Chemical	Unripe plantain peel meal (%)
	Component	
	Crude Protein	10.64
	Crude Fiber	5.82
	Ether Extract	9.57
	Ash	12.82
	Metabolisable Energy (Kcal/kg)	3918.90
B	Minerals	mg per 100gm
	Calcium	10.00
	Phosphorus	34.00
	Sodium	35
	Magnesium	28
	Copper	2
	Iron	6.55
	Zinc	--
	Manganese	8
	Iodine	--
	Silica Free Ash	12.09
	Sulphur	10
	Potassium	401
	Chlorine	125
C	Vitamins I.U./g	
	Vitamin A	0.28
	Ascorbic Acid	11.00
	Thiamine	0.03
	Riboflavin	0.05
	Niacin	0.65

Feeding and brooding

The 100 experimental birds were divided into five groups of 20 birds each according to the five dietary treatments in a deep litter house and replicated five times in a completely randomized design. Adequate number of feeders and waterers were provided to the birds to achieve *ad libitum* access to feed and water. Regular observation and manipulation of the brooder facilities was used to control the room temperature.

Data collection and analyses

Initial weights of the birds were measured at the inception of the experiment (4-week old birds), while live weight was subsequently measured on a weekly basis to evaluate weight changes. The weight at the end of the experiment (8-week old birds) was measured as the final weight, while feed intake was measured by subtracting the feed remaining from that supplied the previous day. Data were also collected on weight gain by subtracting the initial weight from the final weight. Feed conversation ratio was obtained by dividing the average feed intake (kg) by weight gain (kg) and the feed cost was calculated as the sum of all the ingredients included in the diet. Data collected from each treatment groups were subjected to one-way analysis of variance according to Steel and Torrie (1980), while the post hoc tests were performed using the Duncan Multiple Range Test as outlined by

Table 2: Composition of Experimental Broiler Finisher Diets

Ingredients	T_1	T_2	T_3	T_4	T_5
Unripe plantain peel meal	0	12.5	25	37.5	50
Maize grain	50	37.5	25	12.5	0
Fish meal	5	5	5	5	5
Soybean meal	14	14	14	14	14
Wheat offal	10	10	10	10	10
Palm kernel meal	5	5	5	5	5
Spent grain	6	6	6	6	6
Bone meal	9.15	9.15	9.15	9.15	9.15
Vitamin/mineral premix	0.4	0.4	0.4	0.4	0.4
DL-methionine HCL	0.2	0.2	0.2	0.2	0.2
Common salt	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated Nutrient Composition of the Experimental Diets					
Nutrients (%)	T_1	T_2	T_3	T_4	T_5
Crude protein	17.90	18.01	18.21	18.28	18.64
Ether extract	1.92	2.43	2.87	3.30	3.50
Crude fiber	3.83	3.96	4.08	4.24	5.02
Dry matter	80.30	68.20	62.05	56.24	41.96
Calcium	3.77	3.84	3.95	3.99	4.06
Phosphorus	1.85	1.94	2.20	2.45	2.62
Lysine	0.88	0.70	0.65	0.52	0.41
Crude fiber %	3.83	3.96	4.08	4.24	5.02
Dry matter %	80.30	68.20	62.05	56.24	41.96
Calcium %	3.77	3.84	3.95	3.99	4.06
Phosphorus %	1.85	1.94	2.20	2.45	2.62
Lysine %	0.88	0.70	0.65	0.52	0.41
Methionine+ Cystine %	0.33	0.31	0.30	0.27	0.26
ME (Kcal/kg)	2425.50	2487.80	2498.20	2589.50	2688.60

2.5kg of premix/ton contains: Vitamin A10, 000 I.U; Vitamin D_3 20,000 I.U; Vitamin E 12,000 I.U; Vitamin K 2.5g; Thiamine 1.5 g; Riboflavin 5g; Pyriboflavin (B_6) 1.5g; Vitamin B_{12} 1.0mg; Biotin 2mg; Niacin 15g; Panthothenic acid 5g; Zinc 50g; Iron 25g; Copper 5g; Iodine 1.4g; Selenium 100mg; Cobalt 300mg; B.H.T. 25g

Table 3: Performance Characteristics of Broiler Finisher Birds Fed on Unripe Plantain Peel Diets

Parameters	T_1	T_2	T_3	T_4	T_5	SEM
Initial live weight (g)at 5^{th} week	700.12	699.4	698.96	697.56	696.28	1.90^{ns}
Mean live weight at 9week old (g)	1450^a	1476^b	1520^c	1680^d	1740^e	0.06^*
Mean daily weight gain (g)	42.16^a	41.08^a	38.29^b	38.20^b	38.08^a	0.01*
Mean daily feed intake (g)	110.00^a	118.0	121.54^b	121.90^b	122.00^b	0.02^*
Feed conversion ratio	2.61	2.87	3.17	3.19	3.2	0.05^*
Feed cost/kg weight gain	156.12^a	150.56^b	145	141.88^d	73.88^e	1.51^*
Mortality	1.00^a	1.00^a	1.00^a	1.00^a	4.00^b	0.04^*

Abcde within same row; values bearing different superscripts are significantly different (P<0.05).

Table 4: Carcass Evaluation of Broiler Finisher Birds Fed with various Replacement levels of Unripe Plantain Peel Meal as a substitute for Maize Grains

Parameters	T_1	T_2	T_3	T_4	T_5	SEM
Drum Stick (cm)*	13.8^a	12.8^a	12.0^b	11.5^b	11.3^b	1.22*
Wing length (cm)*	20.8^a	20.5^a	20.4^a	119.5^b	19.2^b	0.30^*
Body length (cm)*	27.7^a	26.4^a	25.9^b	24.8^b	24.8^a	0.21*
Thigh length (cm)*	15.8^a	13.0^c	12.5^c	11.48^c	11.40^c	1.24^*
Hearth Girth (cm)*	26.23^a	26.00^a	24.32^b	22.64^c	22.64^c	0.44^*
Live weight at 9^{th} week (gm)*	1836^a	1390^c	1380^c	1299^b	1099^d	0.32^*
Dress carcass weight (gm)*	1100^a	1200^b	1245^b	1396^c	1480^d	0.11^*
Eviscerated weight (gm)*	590^a	$796^{b`}$	800^b	986^c	1200^d	0.09*

Abcde within same row; values with different superscripts are significantly different (P<0.05); *: Significant (P<0.05); NS: Not significant (P>0.05)

Table 5: Organ weights of Anak Broiler finisher birds fed with varying replacement levels of unripe plantain peel meal as a substitute for maize grain

Parameters	T_1	T_2	T_3	T_4	T_5	SEM
Weight of intestines (gm)	180^a	165^b	150^c	135^d	90^e	2.96^*
Heart weight (gm)	6.10^a	7.35^b	8.33^c	9.11^d	11.1^e	0.43^*
Gizzard and Proventriculus weights (gm)	40.1^a	45.2^b	45.1^b	60.3^c	65.4^a	0.01^*
Liver and spleen weights (gm)	20.3^a	28.9^b	30.1^b	31.3^b	35.4^c	0.39^*
Crop weight (gm)	8.5^a	9.3^a	9.3^a	9.9^b	12.8^b	1.65^*
Kidney weight (gm)	12.9^a	15.2^b	19.6^c	20.5^c	25.3	1.68^*

Gordon and Gordon, (2004) to analyze the differences in the mean values.

RESULTS AND DISCUSSION

The performance characteristics of the finisher broiler birds (Table 3) showed that significant differences ($P<0.05$) existed between birds in various treatments regarding daily weight gain, daily feed intake, feed cost per weight gain and mortality. Furthermore, carcass evaluation (Table 4) revealed that significant differences existed between birds in various treatments for shank length, wing length, body length, thigh length, hearth girth, leg length, eviscerated weight, live weight at 9th week and dressed carcass weight. Birds on the control diet (T_1) were significantly heavier than those of T_2 and T_3, which were significantly heavier than birds on T_5. Body conformations of broilers fed with the control diet (T_1) were similar to those on T_2 unripe plantain peel meal (UPPM)-containing diets. However, the 37.5% inclusion level of UPPM appeared to result in better dressed carcass weight than those of the lower inclusion levels. This superior performance can be attributed to a better balance of amino acids in the diet containing 37.5% level of UPPM. Differences in eviscerated weights can be attributed to differences in taste and levels of graded fibre content in the diets. These results agree with Asuquo *et al*. (1992), Mkeerebari and Hedo (2010) who reported that bulkiness of fiber yields higher eviscerated weights in birds. Clavijo and Maner, (2004); Ullman, (1998); Calles *et al*. (2000) and Celleri *et al*. (2001) reported anti-nutritional effects of UPPM arising from the presence of tannins, which lead to reduced availability, absorption and utilization of nutrients for productive purposes. Consequently, birds fed with 50% UPPM (T_5) consumed more feed than those that belong to other treatments in an attempt to meet their body requirements (Makkar *et al*. 2009; Bressani *et al*. 2001; Acharya and Kumar, 1984; Mkeerebari and Hedo 2010; Stratton and Von Loesecke, 2000; Swan and Lewis, 1994). The trend was that increasing the level of UPPM reduced nutrient availability and consequently led to a reduced weight gain. Bulkiness and semi powdery nature of UPPM diets appeared to be the major limiting factor in proper utilization of UPPM in broiler diets. Neshiem *et al*. (2009); Von Loesecke, 1990; Aittken and Hankein (2009) suggested that amino acids and fortified vitamins could be used to counteract the anti-nutritional effect of tannins and to improve the production efficiency.

The liver weight at the finisher phase increased with 37.5% (T_4) inclusion levels of UPPM for maize grain in the diets. Clavijo and Manner (2004), Bressani *et al*. (2001) reported that increasing the levels of UPPM to 37.5% improved crop, liver and spleen weights in broiler finishers.

The significantly larger weights of the heart, crop, gizzard and proventriculus of birds on diets T_2, T_3, T_4 and T_5 are in agreement with Celleri *et al.* (2001) and Calles *et al.* (2000) who also reported that monogastric animals fed on high fiber diets maintained on UPPM diets displayed increased size of these organs.

Conclusion

The eviscerated weights of birds maintained on higher levels of UPPM (50%) were higher than those on lower levels of UPPM. This agrees with the results reported by (Mkeerebari and Hedo 2010, Clavijo, 2002 and Bressani *et al.*, 2001) in which the utilization of various unripe plantains peels meals were compared and similar results obtained. Also increasing the levels of UPPM to 37.5% improved crop, liver, spleen weights and better dressed carcass weight in broiler finishers.

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