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Treated plantain peels in diet of broiler chickens

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Target Audience: Feed miller, Nutritionists, livestock Farmers

Abstract

Three hundred (300) one day old Arbor Acre broiler chicks were used in an 8-week study to determine the growth response and nutrient utilization of birds fed varied inclusion of differently treated plantain peel meals (PPM). The birds were randomly assigned to the 10 dietary treatments with three replicates of 10 birds each and arranged in 3x3 factorial layout plus a control. Treatment 1 is the control, diet without inclusion of PPM, Treatment 2, 3, 4 were sundried PPM at 25, 50 and 75% (replacement for maize) respectively; while treatments 5,6,7 and 8,9,10 were sun dried-lye treated and sundried plus phytase supplementation (1g/kg diet). Data were collected on some chemical profile of treated PPM, performance characteristics of broilers and nutrient digestibility of the diet. The results showed that nutrient composition of plantain peel appeared adequate to serve as a feed ingredient in poultry. Increased level of PPM in the diets however, lowered (P<0.05) all the performance traits and digestibility coefficients. Lye treatment and phytase supplementation had most profound effect on repressing the toxic component in PPM. Lye treatment also influenced fibre digestibility positively but depressed (P<0.05) ether extract digestibility. It was concluded that the use of treated PPM in broiler diet did not represent a perfect replacement for maize. However, 25% of lye and enzyme supplemented PPM replacement for maize proved adequate in broilers' diet.

Keyword: plantain peels, anti-metabolic compounds, digestibility, performance,

Description of Problem

Task Forces on Alternative Formulations of Livestock Feeds were set up a couple of years ago with the aim of producing cheaper, cost effective livestock feeds largely from the unconventional agro-industrial by-products in Nigeria. Among the notable crops mentioned that were frequently produced in quantities that exceeded either export or local demand and can be used as unconventional feeding systems were bananas (*Musa sapientum* L.) and plantains (*Musa paradisiaca L*.). Focus on unconventional feed resources that can meet the nutrient requirement of farm animals with little or no competition with man and industries (1) stemmed from the limitation imposed by increased prices and irregular supply of conventional feed ingredients. The search for alternatives against expensive components of feed demands consideration of by-products, even when efficiency of utilization is low (2). It was generally established that the use of agricultural by-products are often restricted by high fiber content and presence of anti-metabolic factors which limit their dietary inclusion at high levels (3).

Available data on the plantain peel as a promising feed ingredient showed that Nigeria produced 3.16 million tonnes of plantain in the

year 2016 from the 39.24 million world total (4) representing about 8% of the world total. This value is expected to double in the next 10 years. About 30% of the total production of bananas and plantains were potentially available for livestock feeding as a result of their rejection as export commodity, in this way, there may be no pressure of competition with man. Preliminary investigation reveals an abundant production of plantain peels in some designated parts of the country. For instance, Ajebamidele Area of Aramoko Ekiti, Ekiti State, turned out substantial quantity of these by-products because the dwellers mainly engaged in processing of plantains into plantain powder. Heaps of discarded plantain peels after processing the pulp into flour constitute disposal problems in this region. In terms of chemical composition, report shows that plantain peels are moderately balanced with regards to the ratio of protein to calories (5), containing about 12% crude protein, 16% crude fibre and conflicting metabolizable energy ranging from 1300-3,900mkcal/kg (6,7,8). Generally, plantain peel was reported to have better protein, energy, calcium and phosphorous composition than maize with more crude fibre and ether extract (9). This was a thrilling factor that motivates this study. Moreover, plantain peels contains some anti-nutritional factors like tannin 2.78mg/g, oxalate 1.04mg/g, saponin 0.38mg/g, alkaloids 0.24mg/g and phytate 35.02mg/g (10). Fibre and Phytate were notably present at an intolerable level for poultry. Other bioactive compounds like polyphenols, carotenoids etc in plantain peels are equally important in human and animal metabolism (11,12). Good processing techniques in handling the anti-nutritional and bioactive factors become necessary for optimal utilization of plantain peels in poultry diets.

Few reports has indicated the use of lye water in food curing giving food their characteristic crunch, softening fibrous materials, preserving and preventing mold and bacteria from growing in food and their capacity to detoxify certain anti-metabolic compound in feed (13, 14, 15). Sun drying and enzyme supplementation are proven strategies that have been used in feed processing and development over the years. This study is therefore designed to evaluate the effect of plantain peels subjected to different treatment such as sun drying, lye water treatment and phytase supplementation on growth and nutrient utilization of broiler chickens fed such treated plantain peels based diets.

Materials and Methods

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm, Obafemi Awolowo University, Ile Ife, Osun State, Nigeria**.** The farm is situated in the South Western of Nigeria with temperature range of between 22.1 – 33.0^{o}C, annual rainfall of about 1000mm and relative humidity 80-90%.

Sample collection, preparation and processing

Lye water was obtained by passing hot water through wood ash in a plastic container. A 20 liter capacity plastic container was loaded with wood ash obtained from a bakery and boiled water (bore hole) at ratio of 1:2 (ash/water) was gently poured on the ash and the water leaching through the ash to produce brown liquid solution (called lye water largely contain potassium carbonate or potash) collected in a bowl through perforated holes at the base of the plastic. The pH of the solution obtained ranged from 10-12 but adjusted to 11 for a uniform solution. The lye water so produced was kept in plastic keg for subsequent use.

Two batches of 600kg and 300kg of fresh unripe plantain peels were collected from Ajebamidele, a village around Aramoko Ekiti, Ekiti State, Nigeria. The peels were carefully

sorted to remove unwanted materials and dirt. The first batch was sun dried on concrete floor for 5 days until it became crisp. During drying, the peels were flipped regularly to prevent mould growth. The dried sample was then milled using a hammer mill with a sieve size 0.5mm and stored in a plastic bag for subsequent use. The second batch was treated with lye solution by soaking for 6 hours, then rinsed with clean water, sun dried, milled and stored for further use. The enzyme supplemented group were sun dried peels plus phytase at 1g/kg diet.

Table 1: Dry Matter Yield of unripe plantain peels

Replicate	Fresh Sample (kg)	Dried Sample (kg)	Dry Matter Yield (%)
1	10.00	3.10	31.00
2	10.00	3.60	36.00
3	10.00	3.20	32.00
4	10.00	3.30	33.00
5	10.00	3.20	32.00

Average dry matter yield = 32.80%

Table 2: Chemical Composition of unripe plantain peel meal

Parameters	Sundried Uppm (%)	Lye Treated Uppm (%)
Dry Matter (DM %)	88.49	89.29
Ash (%)	8.48	8.67
Crude Fiber (CF %)	7.96	6.52
Crude Protein (CP %)	12.47	14.10
Ether Extract (EE %)	3.66	3.17
NFE (%)	55.92	56.83
ME (kcal/kg)	1850	1840
Phytic Acid (mg/g)	10.04	8.05

Metabolizable Energy was calculated using the formula of Pauzenga (1985*) ME = (37 x % CP) + (81 x % EE) + (35.5 x % NFE)*

Birds and Management

A total of 300 day old Arbor Acre Broiler chicks were procured from a reputable hatchery. The birds were fed a commercial starter feed to stabilize them for the first week of age before being introduced to experimental diets. Experimental birds were arranged in 3x3 factorial lay out plus a control and assigned the ten dietary treatments with three replicates of 10 birds each in a completely randomized design. Treatment 1 is the control standard diet without UPP, Treatments 2, 3, 4 consist of Sundried UPP at 25%, 50% and 75% respectively while Treatments 5, 6, 7 and Treatments 8, 9, 10 at 25%, 50% and 75% consist of lye treated UPP and sundried UPP + phytase supplementation at 1 g/ kg of feed respectively. The experiment lasted for 8 weeks. Lasota and Infectious Bursal Disease Vaccines were applied at 14 and 21 days of age respectively. Feed and water were made available *ad libitum.*

Data collection and Chemical Analysis

Data were obtained to determine dry matter yield from unripe plantain peels,

growth response of broilers fed differently treated UPP and some chemical constituents of treated PPM. Fifty kilogram of the fresh plantain peels collected was divided into five groups of 10kg each. Each group was placed in a stainless bowl and oven dried at 70^{o}C for 48 hours. The dried weights from different group were taken and the dried matter yield was calculated as average dried weight of the samples. The amount of moisture in the sample was the difference between the fresh weight and dried weight. For the growth performance characteristics, the feed intake and body weight were measured on weekly basis, thereafter Body Weight Gain (BWG) and Feed Conversion Ratio (FCR) were calculated.

Table 3a: Growth performance of broiler chickens fed varying inclusion of differently treated plantain peel meal based diets

		Sundried			Lye Treated			Sundried+ Phytase				P (value)		
	0%	25%	50%	75%	25%	50%	75%	25%	50%	75%				
Parameters	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	SEM	T	L	TXL
IBW (g)	253.7	248.2	244.4	244.4	244.4	238.0	238.0	240.7	244.4	252.8	1.40	0.163	0.316	0.175
FBW(g)	2210	1902	1542	1072	2072	1819	1382	2161	1843	1429	69.2	0.003	0.021	0.389
AWG (g)	1957	1653	1297	828.0	1827	1580	1144	1920	1598	1175	68.95	0.003	0.019	0.383
FI (g/b/d)	117.2	115.0	107.7	91.2	119.8	109.5	99.95	125.1	109.1	101.1	1.83	0.003	0.050	0.146
TFI (g/b)	4921	4831	4521	3829	4998	4588	4198	5254	4583	4247	76.91	0.003	0.050	0.146
FCR (g)	2.51	2.92	3.49	4.63	2.74	2.90	3.67	2.74	2.87	3.61	0.12	0.000	0.018	0.075

IBW = Initial Body Weight, AWG = Average Weight Gain, FI/B/D = Feed Intake/bird/day, TFI = Total feed Intake, FCR = Feed Conversion Ratio, F.WT = Final Body Weight, SEM = Standard Error of Mean, T = Treatment, L = Level, T x L = Treatment and Level Interaction.

Table 3b: Single effect of treatments on performance characteristics of broiler chickens fed varying inclusion of differently treated plantain peel meal based diets

Parameter	Control	Sundried	Lye Treated	Sundried-Phytase	SEM (±)
Initial Body Weight(g)	253.7	245.7	240.1	246.0	1.400
Average Body weight gain (g)	1957^{a}	1259^{c}	1510^{b}	1545^{b}	68.95
Feed Intake (g/b/d)	117.2^{a}	104.6^{c}	110.6^{b}	111.8^{b}	1.830
Total Feed Intake (g)	4921^{a}	4394^{c}	4598^{b}	4695^{b}	76.91
Feed Conversion Ratio	2.51^{d}	3.49^{a}	3.05^{b}	3.04^{b}	0.120
Final Weight (g)	2210^{a}	1505^{c}	1750^{c}	1791^{b}	69.24

Values with same superscripts along the row are not significant.

At the end of the 7th week, one bird per replicate was randomly selected into the metabolic cage for the determination of nutrient digestibility. The birds were allowed to acclimatize for three days before data collection. Each bird was fed with measured quantity of feed daily 120g thereafter total feaces were collected for the next four days at 08:00hrs each day. The faeces were oven dried immediately at 70 ^{0}C for 24 hours and representative samples were taken and analyzed for proximate composition. The

proximate composition of the diets and the feaces were used to calculate the apparent nutrient digestibility using the formula:

% Apparent Nutrient Digestibility = $\frac{\text{Nutrient intake – Nutrient in feaces}}{\text{Nutrient intake}} \times 100$

The proximate composition of the peels was determined using procedure described by (16) Phytate present in the unripe plantain peel was determined by anion exchange method as described by (17).

Table 4a: Apparent nutrient digestibility of differently treated unripe plantain peel meal based diets in broilers

	SUN DRIED			LYE TREATED-SD			SUNDRIED + PHYT.				P (value)		
PARAM.	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	SEM	T	L	TXL
DM (%)	72.32	64.09	56.83	57.03	65.92	64.35	62.98	66.73	60.67	57.23	1.06	0.35	0.34	0.75
ASH (%)	37.92	14.42	29.92	17.90	34.47	25.51	41.79	13.26	35.02	16.17	2.32	0.49	0.57	0.92
CF (%)	36.11	27.92	29.66	28.02	36.99	28.19	41.61	29.67	27.46	30.61	1.59	0.02	0.00	0.02
CP (%)	74.01	73.78	68.98	65.10	82.04	80.11	77.75	82.03	81.49	76.07	1.30	0.41	0.16	0.58
EE (%)	79.43	72.00	68.13	57.69	59.25	64.13	54.10	70.05	64.46	48.00	1.97	0.18	0.89	0.57
NFE (%)	71.41	54.73	48.00	55.20	63.16	70.46	47.01	58.36	51.48	54.05	1.70	0.13	0.52	0.50

Table 4b: Single effect of treatments on apparent nutrient digestibility of unripe plantain peel meals in broiler chickens

Parameter(%)	Control	Sundried	Lye Treated	Sundried + Phytase	Sem (±)
Dry Matter	72.32^{a}	59.33^{b}	64.42^{ab}	61.54^{b}	1.06
Ash	37.92^{a}	20.74^{b}	33.93^{a}	31.48^{a}	2.32
Crude Fibre	36.11^{a}	28.53^{b}	35.59^{a}	29.25^{b}	1.59
Crude Protein	74.01^{b}	69.29^{c}	79.97^{a}	79.86^{a}	1.30
Ether Extract	79.43^{a}	65.94^{ab}	59.16^{b}	61.17^{b}	1.97
NFE (%)	71.41^{a}	52.64^{b}	60.21^{ab}	54.63^{b}	1.70

Values with same superscripts along the row are not significant. DM = dry matter, CF = crude fiber, CP = crude protein, EE = Ether extract, NFE = Nitrogen Free Extract, SEM = Standard Error of Mean

Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA) and means were separated using Duncan's Multiple Range (DMR) Test.

Results and Discussion

Dry matter yield and chemical composition of plantain peels

The results of dry matter yield and chemical composition of Unripe Plantain Peel Meals are as shown in Tables 1 and 2 respectively. The average moisture content was about 67.2% while dry matter was 32.8%. On as fed basis, the moisture to dry matter will be about 50:50. This dry matter yield showcased one limitation of unripe plantain peels (UPP) as feedstuff for poultry. In this case, the cost of processing fresh UPP to dry material (in terms of energy cost) suitable for milling and blending with other feedstuffs will be a limiting factor that needs further assessment. It was noted that, if one tonne of UPP were carried from production site to where it is needed, only about 50% will be realized and available for feed. The bulkiness and semi – powdery nature of unripe plantain peel meal have also been mentioned to be the major limiting factor for its proper utilization in broiler diets (18,19).

The results of chemical compositions revealed that crude protein content of UPPM was higher compared to maize. The values obtained fell within the range of nutrients earlier reported for plantain peels (7,8,20,21). The energy and proximate values of the diets also fell within the recommended range of nutrients required by certain class of livestock such as rabbits for optimum growth performance (7,21). Both Sun-dried UPPM and lye treated UPPM are similar for all proximate composition determined except the crude protein which was slightly higher and ether extract which was lower in lye treated UPPM. This increase in crude protein may be based on the fact that lye water is capable of solubilizing plant cell thereby reducing plant fibrous tissues such as parenchyma, which often prevent digestibility in animals. According to (23), a 15-minute treatment of plantain peels with lye water was said to decapitate fibrous tissues to the depth of cambium and in some cases beneath it. According to (13), lye water causes the gelatinisation of starches and polysaccharide by providing hydrogen bonds to a mixture of starch and water to bind the much looser polymer chains of amylose and amylopectin suspended in the water, a property that soften and perhaps reduce the fibre content of feed. Lye water has been used to depolymerize the fibrous layer of tomato skin facilitating its splitting (24).

Growth performance and apparent nutrient digestibility in broiler fed differently treated plantain peel based diet

The result of growth performance of broiler chickens fed differently treated unripe plantain peel meal based diets was shown in Tables 3a and 3b. Generally, there was downward trend ($P<0.05$) in all performance traits measured as levels of PPM increased in the diets. Feed intake declined across the treatments, which were similar to report of (20,25). Birds on control diet consumed their feed better ($P<0.05$) than other treatments while lye treatment and enzyme supplementation were able to curb factors responsible for low acceptability of the material significantly ($P<0.05$). While feed intake declined by about 35% in birds fed sundried plantain peels, lye and enzyme supplementation reverted the depression to about 20%. The results of feed depression affected final body weight of the birds and consequently the conversion efficiency. The relatively high fibre content of plantain peels coupled with phytate and other unidentified factors were responsible for the low acceptability of the feed. The magnitude of responses to phytase may be more pronounced with increasing supplementation rate as earlier proposed by (26). Higher concentration of phytase per kg of feed and combined treatment with and phytase supplementation may be considered for future study.

The results of Nutrient Digestibility are as indicated in Tables 4a and 4b. Apparent dry matter and other nutrients digestibility decreased ($P<0.05$) as the level of inclusion increased in the diets. At 25% replacement levels, nutrient digestibility was comparable ($P>0.05$) with control and although superior for both crude protein and fibre digestibility. Generally, birds on lye treated and enzyme supplemented groups utilized all the nutrients better except ether extract compared with sundried treated group. Crude fibre digestibility was particularly higher ($P<0.05$) in lye treated compared to control. This corroborates the submissions of (13) that lye water has capacity to soften and reduce the fiber component of feed or food. Similarly, crude protein and ash digestibility were notably higher in both lye treated and phytase supplemented groups. The observation here was that processing methods (Lye treatment and phytase supplementation) weaken those tissues that form complex with nutrients present in the peels, therefore improved the

crude protein digestibility when fed to broiler chickens. This support earlier assertions on potency of the duo (lye water and phytase) in addressing fibre, phytic acid and other anti-metabolic components in animal feed (15,27). The reduced ash, crude protein and fibre digestibility in sundried group were due to the poor hydrolysis of phytate that bound minerals thereby, preventing their bioavailability and other nutrient in broiler chickens. It is clear that there is presence of phytic acid in plantain peels at toxic level which could not be sufficiently handled by sun drying processing technique. It also indicates the strong chelating property of phytate that formed protein and mineral-phytic acid complexes, the net result being reduced protein and possibly mineral bioavailability. For ether extract digestibility, birds placed on sun drying and control group showed higher ($P < 0.05$) values. The corrosive tendency of lye water possibly might have washed or leached part of the fat in the peel into the water during soaking process. This is important information that may be pointing attention to duration of soaking and concentration (pH) while treating food and feed material with lye water.

Conclusion and Application

This study has shown that:

i. It is logically sound to process the plantain peels at the production site before transportation to the farm site. This will help cut the cost of moving about 50% of its moisture that are not needed.
ii. Proximate composition of plantain peel appears adequate to serve as a feed ingredient in poultry feed if anti-metabolic factors could be efficiently managed.
iii. The depressed performance and poor nutrient digestibility of birds observed in this study clearly pointed out that plantain peels did not represent perfect replacement value for maize in broilers' diet.
iv. However, 25% of lye treated or enzyme supplemented PPM replacement for maize are appropriate in broiler feed.
v. The possible synergetic effect of combining lye treatment and enzyme supplementation is recommended for future assessment

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