

## Nutritive value of unripe and ripe plantain (*Musa paradisiaca*) peels for weanling rabbits

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### Abstract

Dried plantain (*Musa paradisiaca*) peels (DPP), either ripe or unripe (green), were given to weaned rabbits to replace maize at 0, 10, 20 and 30% levels in isonitrogenous (18% crude protein) diets for 56 days in a 2 x 4 factorial experiment. The 30% inclusion level of DPP depressed ( $P < 0.05$ ) the final weight gain, daily weight gains, and feed conversion efficiency. Ripe or unripe DPP had no significant ( $P < 0.05$ ) effect on the performance parameters except feed intake, which was improved ( $P < 0.05$ ). The interaction between ripe or unripe DPP and inclusion levels significantly ( $P < 0.05$ ) affected weight gain and feed conversion efficiency. Inclusion of DPP depressed ( $P < 0.05$ ) dressing percentage and lumbar and limbs weights while the viscera weight was increased. Ripeness the plantain peels had no significant effect ( $P < 0.05$ ) on the carcass yield. There was also increase in profit margin expressed in terms of feed cost/ kg liveweight gain with inclusion of plantain peel in the diet. The results of this study showed that ripeness slightly improved the nutritive value of DPP which can be included at 20% in weaned rabbits' diet to replace maize.

**Keywords:** Nutritive value; Ripe and unripe plantain peels; Weight gain; Weaned rabbits

### Introduction

Great emphasis continues to be placed on research into the use of alternative feedstuffs in livestock production, more so with the ever increasing price of maize, the main energy source in livestock feeds. Agro by-products and wastes have been identified as alternative feedstuffs and can form a major source of energy in animal feeds (Fanimó, 1991).

Plantain (*Musa paradisiaca*) pulp is an important source of carbohydrate to man. The dry matter (DM) consists mainly of starch most of which is found in the peel (Ketiku, 1973). Seventy-two percent of this starch is converted to simple sugars (glucose and fructose) on ripening (Ketiku, 1973). Omuaru and Izonfuo

(1988) reported that nutrients and minerals increased during ripening both in the peel and the pulp of plantain. They estimated a higher amount of nutrients in the peel than in the pulp at all stages of ripening. Oyenuga (1968) stressed that ripe plantain peel is more readily digested than green peels. Omole *et al.* (2004) reported the composition of ripe plantain peel to be (% in DM): 7.82 crude protein, 5.81 crude fibre, 1.24 ether extract, 5.62 ash and 65.4 nitrogen free extract while the dry matter was 10.1% fresh basis.

Ketiku (1973) and Adeola (1988) reported that dried plantain peels can replace maize in the diet of rabbits without affecting their efficiency of growth. Dairo *et al.* (1987) observed that there is optimum production with 5%

replacement value of plantain peels for maize on layers performance. Fanimo *et al.* (1999) reported that DPP could be included in broiler diet up to 15% while ripeness improved the performance of the birds. Plantain peel has been used successfully for snail production (Omole *et al.*, 2004). The objective of this experiment was to determine the effects of dried ripe or unripe plantain peel meal as replacement for maize on the performance and carcass characteristics of weaned rabbits.

## Materials and Methods

### Experimental site

The study was carried out in the College of Animal Science and Livestock Production Farm, University of Agriculture, Abeokuta, Nigeria (latitude 7°5.5'N, longitude 3°11.2'E, altitude 76 MASL) situated in the Rain Forest vegetation zone. The area has a humid climate with mean annual rainfall and temperature of 1037mm and 34.7°C, respectively. Relative humidity average 82% throughout the year.

### Diets

Plantain peels collected 24 hrs after peeling from a plantain chip factory in Lagos, were sun-dried for five days and ground in a hammer mill. Samples of the dried plantain peel meal were analysed for proximate chemical composition (AOAC, 1990). Based on the results of the chemical analysis, seven weaned rabbit experimental diets were formulated such that unripe (green) and ripe plantain peel meal were

included at 0, 10, 20, and 30% to replace maize. The composition of the DPP is shown in Table 1 while that of the diets is shown in Table 2. The experiment was a 2 x 4 factorial experiment with two levels of ripeness (ripe and unripe) and four inclusion levels (0, 10, 20 and 30%). Feed was supplied as mash and water was available *ad libitum*.

### Animals

A total of 63 six-week-old weaner rabbits (New Zealand White x Flemish Giant) with a mean initial weight of 0.58 kg, were randomly assigned to seven dietary treatments (Table 2) on the basis of initial weight and sex. There were nine rabbits per treatment. Each treatment was replicated thrice and each replicate group of three rabbits were housed in a hutch of 180 x 45 x 45 cm. Rabbit weight and feed consumption were recorded weekly. The experiment lasted eight weeks. At the end of the trial, three animals per treatment (one per replicate) were weighed, slaughtered, and their viscera removed. The weights of liver, heart, kidneys, and cut parts were determined.

### Chemical analysis

The proximate composition of the plantain peels and diets were determined by the AOAC (1990) while the gross energy of combustion was as described by Harris (1970). Mineral analysis was according to Grueling (1966).

**Table 1. Proximate composition of dried plantain peels (g kg<sup>-1</sup>)**

	Ripe	Unripe
Moisture	78.0	75.4
Crude protein	98.3	101.0
Crude fibre	56.3	55.3
Ether extract	142.3	134.5
Ash	131.6	127.6
Calcium	9.6	8.0
Phosphorus	3.2	2.9
Gross energy (MJ)	14.54	14.16

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### Statistical analysis

The results of all the parameters were subjected to a 2 x 4 factorial analysis. The analysis of variance was conducted according to the method of Snedecor and Cochran (1978) while Duncan's Multiple Range Test was used to test significant differences among means.

### Results

Ripe DPP increased ( $P < 0.05$ ) the feed intake of the rabbits (Table 3). Total replacement of maize with dried plantain peels (30% inclusion level) significantly ( $P < 0.05$ ) depressed weight gain and increased the feed: gain ratio.

Ripeness of DPP had no significant ( $P > 0.05$ ) effect on carcass characteristics of the rabbits (Table 4). Carcass dressing percentage increased ( $P < 0.05$ ) with increased inclusion level of dried plantain peels. Inclusion of DPP in the diet to replace maize lowered ( $P < 0.05$ ) the weight of the lumbar region, and hind and forelimbs while it increased ( $P < 0.05$ ) the viscera weight. The interaction between inclusion level and ripeness significantly ( $P < 0.05$ ) affected body weight changes, daily weight gain, feed:gain ratio, dressing percent, viscera, lumbar region, forelimbs and hindlimbs weights.

**Table 2:** Formulation and composition of dried plantain peel (DPP) diets ( $g\ kg^{-1}$ ).

Diet	Level of dried plantain peel in diets (%)						
	0	10		20		30	
		Unripe	Ripe	Unripe	Ripe	Unripe	Ripe
Maize	300	200	200	100	100	-	-
Dried plantain peel	-	100	100	200	200	300	300
Full-fat soybean	150	150	150	150	150	150	150
Palm kernel meal	100	100	100	100	100	100	100
Dried brewer's grain	430	430	430	430	430	430	430
Bone meal	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Oyster shell	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Salt	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Premix <sup>1</sup>	2.5	2.5	2.5	2.5	2.5	2.5	2.5
<b>Chemical analysis</b>							
<b>(Fresh weight basis)</b>							
Dry matter	906.0	867.0	865.0	897.0	800.0	891.0	898.0
Crude protein	178.5	178.6	180.0	181.6	180.6	182.6	181.4
Ether extract	79.6	80.5	84.6	96.8	99.4	109.5	110.2
Crude fibre	123.6	126.4	130.5	139.5	125.5	132.1	139.5
Gross energy ( $MJ\ kg^{-1}$ )	16.6	16.5	16.5	16.3	16.3	16.1	16.2

<sup>1</sup>Supplied per kilogramme of diet: Vitamin A, 10,000 IU; D<sub>3</sub>, 2,000 IU; B<sub>1</sub>, 0.75 g; B<sub>2</sub>, 5 g; Nicotinic acid, 25 g; Calcium, 0.05 g; Pantothenate, 12.5 g; B<sub>12</sub>, 0.015 g; K<sub>3</sub>, 2.5 g; E, 25 g; Biotin, 0.050 g; Folic acid, 1 g; Choline chloride, 250 g; Cobalt, 0.400 g; Copper, 8 g; Manganese, 64 g; Iron, 32 g; Zn, 40 g; Iodine, 0.8 g; Flavomycin, 1,000 g; Spiramycin, 5 g; DL-Methionine, 50 g; Selenium, 0.6 g; Lysine, 120 g; BHT, 5 g

**Table 3: The effects of dried plantain peels (DPP) on rabbit performance.**

Diets	DPP inclusion (%)							SEM	DPP	inclusion	level	level (%)	SEM	Level of ripeness	SEM
	0	2	3	4	5	6	7								
Initial weight (kg)	0.58	0.59	0.59	0.58	0.58	0.58	0.58	0.05	0.58	0.59	0.58	0.58	0.02	0.58	0.00
Final weight (kg)	1.38	1.48	1.48	1.37	1.37	1.39	1.18	0.06	1.38 <sup>a</sup>	1.48 <sup>a</sup>	1.38 <sup>a</sup>	1.19 <sup>b</sup>	0.04	1.36	1.34
Body weight changes (g)	830 <sup>a</sup>	890 <sup>a</sup>	890 <sup>a</sup>	790 <sup>a</sup>	790 <sup>a</sup>	810 <sup>a</sup>	650 <sup>b</sup>	19.80	850 <sup>a</sup>	890 <sup>a</sup>	800 <sup>a</sup>	670 <sup>b</sup>	12.98	796.7	776.7
Weight gain (g/d)	15.18 <sup>a</sup>	15.89 <sup>a</sup>	15.89 <sup>a</sup>	14.11 <sup>a</sup>	14.11 <sup>a</sup>	14.46 <sup>a</sup>	11.61 <sup>b</sup>	0.22	15.18 <sup>a</sup>	15.89 <sup>a</sup>	14.29 <sup>a</sup>	11.97 <sup>b</sup>	0.68	14.22	13.87
Feed intake (g/d)	61.83	60.67	62.82	61.16	61.16	63.18	63.70	1.30	61.88	61.75	62.17	64.55	0.33	63.79 <sup>a</sup>	61.84 <sup>b</sup>
Feed:gain ratio	4.08 <sup>b</sup>	3.82 <sup>b</sup>	3.95 <sup>b</sup>	4.38 <sup>b</sup>	4.38 <sup>b</sup>	4.37 <sup>b</sup>	5.47 <sup>a</sup>	0.34	4.08 <sup>b</sup>	3.89 <sup>b</sup>	4.38 <sup>b</sup>	5.39 <sup>a</sup>	0.24	4.54	4.56

<sup>a,b</sup>Means followed by the same superscripts are not significant (P>0.05)

**Table 4: Carcass yield (% liveweight) of rabbits fed plantain peels**

Diets	DPP inclusion (%)							SEM	DPP	inclusion	level	level (%)	SEM	Level of ripeness	SEM
	0	2	3	4	5	6	7								
Live weight (kg)	1100	1100	1050	1200	1200	1200	1000	20.27	1100	1075	1200	1000	20.35	1100	1083
Dressing (%)	68.18	59.09 <sup>ab</sup>	61.09 <sup>ab</sup>	62.50	63.33	63.33	56.00	1.35	68.18	60.50 <sup>b</sup>	62.92	55.50	0.99	59.19	60.08
Viscera	22.73	31.82 <sup>a</sup>	30.00 <sup>a</sup>	29.17	29.17	29.17	35.00	5.20	22.73	30.91 <sup>a</sup>	29.17	35.00	1.23	31.39	21.39
Lumbar region	9.09 <sup>a</sup>	6.36 <sup>b</sup>	8.00 <sup>a</sup>	6.67 <sup>a</sup>	7.50 <sup>a</sup>	7.50 <sup>a</sup>	6.00 <sup>b</sup>	0.34	9.09 <sup>a</sup>	7.18 <sup>b</sup>	7.09 <sup>b</sup>	6.50 <sup>b</sup>	0.50	6.34	6.83
Head	9.09	8.64	10.00	9.17	8.33	8.33	8.50	0.13	9.09	9.32	8.75	9.25	0.17	8.77	9.44
Hindlimbs	16.36	12.64 <sup>b</sup>	13.00 <sup>b</sup>	13.33	12.10	12.10	11.95	0.62	16.36	12.82 <sup>b</sup>	12.72	11.98	0.48	12.64	12.37
Forelimbs	9.09 <sup>a</sup>	6.27 <sup>b</sup>	8.00 <sup>a</sup>	6.67 <sup>b</sup>	6.67 <sup>b</sup>	6.67 <sup>b</sup>	6.20 <sup>b</sup>	0.11	9.09 <sup>a</sup>	7.14 <sup>b</sup>	6.67 <sup>b</sup>	7.10 <sup>b</sup>	0.21	6.38	7.56
Breast	4.55	3.27	4.00	3.50	3.92	3.92	3.31	0.42	4.55	3.64	3.71	3.16	0.09	3.36	3.92
Liver	3.28	3.45	3.10	3.29	3.01	2.9	2.79	0.06	3.28	3.28	3.15	2.85	0.04	3.21	2.97
Kidney	0.80	0.82	0.75	0.83	0.73	0.73	0.71	0.10	0.80	0.79	0.78	0.72	0.04	0.79	0.73
Heart	1.09	0.84	0.78	1.00	0.92	0.92	0.79	0.05	1.09	0.81	0.96	0.78	0.10	0.88	0.82

<sup>a,b</sup>Means followed by the same superscripts are not significant (P>0.05)

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**Table 5: Cost benefit analysis of feeding dried plantain peels to rabbits**

DPP inclusion (%) Level of ripeness <sup>1</sup>	0		10		20		30		SE		DPP		inclusion level (%)		SEM		
	U	R	U	R	U	R	U	R	M	M	0	10	20	30	R	U	
Cost of feed (\$/kg)	32.5	28.9	28.9	25.3	25.3	21.7	21.7	21.7	-	32.5	28.9	25.3	21.7	-	25.3	25.3	-
Feed intake (kg)	3.46	3.40	3.52	3.42	3.54	3.57	3.66	3.66	0.22	3.47	3.46	3.48	3.61	0.20	3.57 <sup>a</sup>	3.46 <sup>b</sup>	0.16
Cost of feed consumed (\$)	112.45 <sup>a</sup>	98.26 <sup>c</sup>	104.73 <sup>b</sup>	88.53 <sup>d</sup>	89.56 <sup>d</sup>	77.47 <sup>e</sup>	79.42 <sup>e</sup>	2.30	112.45 <sup>a</sup>	100.00 <sup>b</sup>	89.05 <sup>c</sup>	78.45 <sup>d</sup>	1.06	90.24 <sup>d</sup>	88.09 <sup>e</sup>	1.01	
Feed cost/kg weight gain (\$)	132.29 <sup>a</sup>	110.40 <sup>c</sup>	114.4 <sup>b</sup>	112.08 <sup>d</sup>	110.57 <sup>d</sup>	115.19 <sup>e</sup>	115.10 <sup>e</sup>	4.06	132.29 <sup>a</sup>	112.35 <sup>b</sup>	111.32 <sup>b</sup>	119.15 <sup>d</sup>	3.66	113.32 <sup>c</sup>	112.55 <sup>c</sup>	0.06	
Feed cost savings (\$)	-	14.19	10.72	23.92	22.89	34.98	33.03	-	-	-	12.46	23.41	34.01	-	31.62	37.98	-

U, unripe; R, ripe  
<sup>a,b,c,d,e</sup> Means followed by the same superscripts are not significant ( $P < 0.05$ )

## Discussion

The chemical composition of the dried plantain peels (Table 1) compared favorably with maize except in the crude fibre and ether extract. This is similar to the findings of Ketiku (1973). Plantain peel was higher than maize in Ca and P. The ripe DPP was higher than the unripe (green) DPP in all the nutrients except crude protein. This agrees with the finding of Omaru and Izonfuo (1988) that nutrients and minerals of plantain peel increased during ripening.

The inclusion at 30% dietary level of DPP significantly reduced weight gain and feed efficiency while feed intake increased with levels of DPP in the diets. Plantain peel is relatively fibrous and this could be responsible for depression in the weight gain as fibre impaired digestion and absorption of nutrients (Fernandez and Jorgensen, 1986). Also presence of tannin could possibly reduce nutrient digestibility at high levels (Bate-Smith, 1973; Kumar and Singh, 1984). The increased ( $P>0.05$ ) feed intake with increased level of DPP in the diets revealed the dilution effect of fibrous feedstuff on diets. Fibre increases the bulkiness of a diet and limits the weight of feed eaten by birds, thereby imposing a physical limitation upon the intake of digestible nutrients

Ripe DPP improved ( $P<0.05$ ) the feed intake. This collaborate earlier finding by Fanimo *et al* (1999). This may have been due to the high proportion of simple sugars in the ripe peel thereby improving the palatability (Ketiku, 1973), higher nutrients and minerals (Omaru and Izonfuo, 1988).

The lower dressing percentage with increased inclusion level may be due to the high viscera weight at these levels. The control diet with the least viscera weight had the highest dressing percentage. The non-significant difference between the organ weights indicated that the inclusion level of DPP, ripe or unripe had very little effect on the weight gain of these organs.

Similar result was reported by Fanimo *et al.* (1999) for broilers when DPP was fed. This can be explained by the findings of Hight and Barton (1965) that in goats, the heart being a vital organ, attained most of its mature weight during development of the foetus.

The inclusion of DPP in the diets led to a reduction in the cost of feed (Table 5). Also, the cost of feed consumed decreased as expected since DPP which is a waste replaced the more expensive maize. There was also increase in profit margin expressed in terms of feed cost/ kg liveweight gain and feed cost savings with increasing inclusion level of plantain peel in the diet. This is similar to the finding of Tewe (1983).

The overall results of the present study indicated that ripening slightly improved the nutritive value of DPP for weaned rabbit and that DPP (ripe or unripe) can replace maize at a level of 66% (20% inclusion level) in the diets of weaned rabbits without significantly affecting their performance and carcass characteristics.

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