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A note on the nutritive value of dry ripe plantain peels as a replacement of maize for goats

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ABSTRACT

Twenty-four West African Dwarf (WAD) goats with a mean liveweight of 2.88 ± 0.08 kg, 9-12 months old were randomly divided according to sex and weight into 4 groups of 6 animals each. Plantain peels (DMRPP) replaced maize at 0, 60, 80 and 100% levels in the concentrates that were fed *ad libitum* for 84 days. Voluntary concentrate intakes decreased linearly, but not at a significant level ($P>0.05$) as the substitution of maize with plantain peels increased in the diet. Forage intake among the four groups remained within the same limits. Daily liveweight gains were higher ($P<0.05$) at the 60 and 80 % replacement levels with values of 73 and 74 g/head/day, respectively, compared to 70 and 68 g/head/day for the 0 and 100% replacement levels. There was no significant difference ($P>0.05$) between diets 1 (0%, only maize) and 4 (100%, only plantain peels) in daily liveweight gains. Dry matter, starch and energy were digested better ($P<0.05$) in diet 1 but crude protein and crude fibre fractions were digested worse ($P<0.05$) than in the other diets. Cost/kg of diet and of liveweight gain declined in descending order of maize replacement with DMRPP. Results of the trial indicated that DMRPP is acceptable and can substitute for maize for goats without adverse effects on growth and animal performance. Plantain peels also proved to be an economical source of carbohydrate in goat nutrition, especially in areas where plantain abounds.

KEY WORDS: maize, dry ripe plantain peels, nutrition, serum glucose, plasma urea-N, goats

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INTRODUCTION

Plantain (*Musa sapientum* Var. *Paradisiaca*, L.) is grown in many tropical countries as an important source of carbohydrate for humans (Oyenuga, 1968; Ketiku, 1973; Swennen, 1990). Several researchers have used different parts of plantain/banana in the nutrition of ruminants (Ffoulkes et al., 1978; Geoffroy and Despois, 1978; Ohide et al., 1979; Pezo and Fanola, 1980; Poyyamozhi and Kadirvel, 1986; Subramanian et al., 1988), however, little data are available on the utilization of the peels as a carbohydrate source in ruminant nutrition (Aregheore and Aluyi, 1989). While it is not advisable to feed the pulp, the peels could be processed and used as a cheap source of carbohydrate in the diets of sheep and goats (Oyenuga, 1968; Ankrah, 1974).

Ripe plantain peels are low in crude fibre, but rich in mineral matter, carbohydrate and certain vitamins (Ketiku, 1973; Ankrah, 1974), therefore, if well preserved and processed they can be incorporated into livestock rations (Aregheore, 1994).

The objectives of this work are to 1. determine the effect of processing on the acceptance of ripe peels, 2. determine the optimal level at which ripe processed peels could be used to replace maize in the concentrate supplements of goats in confinement and 3. determine the economics of production with such concentrates in small ruminant (goats) rations.

MATERIAL AND METHODS

Plantain peels were gathered from different restaurants until a large enough quantity was assembled. The peels were spread on a concrete floor and dried on a continuous basis in the sun for at least 3 weeks to a constant weight and colour, and later

TABLE I

Nutrient composition of maize, plantain peels and forage – Guinea grass (*Panicum maxima*)

	Feeds		
Nutrient,s %	maize	plantain peels	forage
Dry matter	90.38	64.14	55.62
In DM			
crude protein	9.00	9.04	12.80
crude fibre	2.30	6.38	34.80
ether extract	3.82	5.58	1.06
ash	3.62	7.19	3.58
N-free extractives	81.26	71.81	46.76
starch	70.30	61.81	25.87
Gross energy, MJ/kg	17.06	15.56	12.58

TABLE 2

Ingredients and composition of the diets, %, air dry basis

Ingredients	Diets			
	1	2	3	4
Maize, milled	50.00	20.00	10.00	00.00
Plantain peels, milled	00.00	30.00	40.00	50.00
Wheat offals	10.00	10.00	10.00	10.00
Brewers'dried grains	36.45	36.45	36.45	36.45
Urea (46%-N)	2.80	2.80	2.80	2.80
Mineral-vitamin mixture*	0.50	0.50	0.50	0.50
Salt	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00

* Minovit super by Intervet International, BV Boxneer, Holland. Composition per 1000 g^{-1}; vitamin a, 7500000 IU; vitamin D_3, 1500000 IU; vitamin B_1, 1000 mg; vitamin B_2, 2750 mg; vitamin B_{12}, 5 mg; D-calcium panthethenate, 5000 mg; vitamin E, 2500 mg; vitamin K, 1500 mg, niacin, 12500 mg; choline chloride, 60000 mg; ethoxyquin, 5000 mg; manganese oxide, 16130 mg; potassium iodide, 353 mg; cobalt sulphate, 286 mg; zinc oxide, 125000; copper oxide, 1283; ferro-carbonate, 20323 mg

milled with a Willey mill. The milled product (referred to as dried milled ripe plantain peels, DMRPP) was used with other ingredients in the diets. DMRPP were incorporated at 0, 60, 80 and 100 % levels of the maize portion of concentrate diets.

Other feedstuffs and ingredients used were maize, wheat offals, brewers' dried grains, urea and a mineral-vitamin supplement. In diet 1 (0%) maize was the major carbohydrate source, while in diets 2, 3 and 4 the maize portions were replaced with plantain peels at 60, 80 and 100%. The rations were formulated to be isonitrogenous (Tables 1 and 2).

Twenty-four West African Dwarf goats, 9-12 months old with an average liveweight of 12.88±0.08 kg, were isolated for two months for observation against any disease manifestation. They were dewormed with thiabendazol and sprayed every fourth night with acaricide against tick infestation, and vaccinated against pests *des petits ruminant* (PPR) which is prevalent in the months of November and December when the experiment was conducted. The goats were allotted randomly according to age, sex and weight into the four diets which were fed *ad libitum* for 84 days with free access to fresh clean water. Six goats in each group made up the 6 replicates of the completely randomised design experiment. The goats were housed in groups according to treatments and all management practices of feeding and watering were observed. Daily refusals were collected and weighed. The concentrate ration was supplemented with chopped forage made up of guinea grass (*Panicum maxima*, Jacq.) and fed at 9.00 and 16.30 h. Average body weights at the beginning and at the end of the experiment were used for growth rate and feed efficiency evaluations.

On the 30th day of the trial, blood samples were collected 4 h after the morning feeding from the jugular vein, and analysed for glucose and urea-N.

At the end of the growth trial, 4 goats of similar body weight were harnessed for 7 days faecal collection. Faeces were dried in a forced-draught oven at 70°C for 24 h. The samples of concentrates, forage and faeces were analysed for chemical composition.

Analytical procedures

AOAC (1980) methods were used for the determination of dry matter (DM) and nutrient contents of maize, plantain peels, concentrate and faeces. Determination of the gross energy in the maize, plantain peels, concentrates and faeces was done by Adiabatic Bomb Calorimetry. From these determinations digestibility values were calculated by the methods for mixed diets outlined by Crampton (1956) as follows:

$$S = 100\ T\text{-}B/S\ +B$$

where:
S = digestibility of concentrate supplement
B = digestibility of basal diet – forage
T = digestibility of the mixed diet, i.e. concentrate supplement and forage basal diet
S = proportion of concentrate supplement in the mixed diet.

Blood glucose was determined according to Sigma Chemical Company (1976), and urea-N according to Gentzkow and Masen (1942). Quantitative analyses of starch in plantain peels, maize, concentrates, forage and faeces were carried out using the method of MacRae and Armstrong (1968).

All obtained data were subjected to analyses of variance, the procedures of Steel and Torrie (1960), and where significant differences occurred, Bonferroni t-statistics, were used for comparison among treatment means (Gill, 1978).

TABLE 3

Chemical composition of the diets, % air dry basis

	Diets			
Nutriens	1	2	3	4
Dry matter	89.54	87.12	87.36	87.48
In DM				
crude protein	13.14	13.23	13.28	13.30
crude fibre	6.80	8.20	8.80	9.10
ether extract	4.40	4.45	4.45	4.38
ash	5.76	6.30	6.50	6.60
N-free extractives	69.90	67.82	66.97	66.62
starch	68.52	67.68	67.09	65.32
Gross energy MJ/kg	19.32	18.86	17.65	16.10

RESULTS AND DISCUSSION

The nutritive value of the maize used did not differ from the values reported by Oyenuga (1968) and Aregheore et al. (1988). Except for crude protein which was higher, other nutrient values of DMRPP were similar to those reported earlier by Ketiku (1973) and Ankrah (1974). Treatment means for all performance characteristics and blood metabolites are presented in Table 4.

Voluntary concentrate intake decreased linearly, but not at a significant level (P>0.05) with increases the levels of plantain peels in the concentrates. Forage intake in all groups was similar. Total voluntary feed intakes (concentrate + forage) did not differ significantly (P>0.05) among the groups.

Feeding the 100% DMRPP was found equivalent to that of the 100% maize (0% plantain peels) diet. The observed decrease in concentrate intake with increases in DMRPP may likely be due to an increased digestible energy (DE) intake from those diets (McCullogh, 1970). It has been observed that animals fed *ad libitum* attempt to equalize their DE intake (Montgomery and Baumgardt, 1965).

There were no significant differences between diets 1 and 4 in daily liveweight gain (P> 0.05) but the liveweight gains of goats fed rations 2 and 3 were better than diet 4. Body weight gains were low, however, the range of gain seems to be normal with the West African Dwarf goats owing to their small size (Williamson and Payne, 1978; Aregheore, 1994). Feed efficiency followed the pattern of concentrate intake and daily liveweight gains.

TABLE 4

Weight gain, feed intake, feed efficiency, blood indices and production cost

Parameters	Diets			
	1	2	3	4
Initial body weight, kg	12.80 ± 0.10	12.84 ± 0.06	12.82 ± 0.07	12.85±0.08
Final body weight, kg	18.48 ± 0.20	18.97 ± 0.82	19.04 ± 0.91	18.56±0.86
Body weight gain, g/day	70^{ab}	73^{a}	74a	$68b^{c}$
Forage intake, kg[1]	0.34	0.35	0.34	0.36
Concentrate intake, kg[2]	0.84^{a}	0.83^{ab}	0.82^{ab}	0.79^{bc}
Total feed intake, kg	1.18	1.18	1.16	1.15
Feed efficiency, feed/gain	16.86^{b}	16.16^{ab}	15.68^{a}	16.91^{b}
Blood glucose, mg/100ml	76.98 ± 1.08^{a}	73.09 ± 2.00^{a}	69.18 ± 1.96^{b}	64.21 ± 0.18^{c}
Blood urea-N, mg/100ml	33.92 ± 3.45^{a}	35.09 ± 0.08^{b}	35.18 ± 3.08^{b}	34.09 ± 1.08^{ab}
Cost/kg ration, N*	3.08 (100)	1.04 (34)	0.96 (31)	0.88 (29)
Cost/kg LWG, N*	17.00 (100)	15.91 (94)	15.51 (91)	14.00 (82)

a, b, c – P<0.05

* values in round parentheses are in N = Naira, Nigerian currency (USD 1 = 24N) and those on square parentheses are in relative ratio to diet 1 as per cent

TABLE 5

Nutrients digestibility by goats, %

Components	Diets			
	1	2	3	4
Dry matter	86.3 ± 1.20[a]	83.1 ± 1.08[b]	83.2 ± 0.98[b]	81.0 ± 1.06[c]
Crude protein	86.9 ± 0.84[b]	89.0 ± 0.98[ab]	88.1 ± 1.07[ab]	89.8 ± 0.86[a]
Crude fibre	72.8 ± 0.82[b]	78.0 ± 0.62[ab]	79.2 ± 0.38[a]	79.9 ± 0.58[a]
Ether extract	89.6 ± 0.12	89.0 ± 0.84	89.6 ± 1.00	89.0 ± 0.96
Starch	78.2 ± 0.86[a]	77.4 ± 0.90[ab]	77.1 + 0.98[ab]	75.7 ± 0.76[c]
Gross energy	86.7 ± 1.02[a]	86.7 ± 0.43[a]	74.2 ± 0.13[b]	64.1 ± 0.89[c]

a, b, c $P<0.05$

The concentrations of blood urea-N and glucose obtained in this trial (Table 4) are slightly higher than the values reported earlier (Aregheore, 1996) for goats and the differences may be attributed to the diets. The concentrations of plasma urea-N and serum glucose obtained in goats fed the different diets indicated that the diets were adequate in protein and readily available energy, and that these were efficiently utilized by the goats for growth.

Dry matter, starch and gross energy were better digested ($P<0.05$) in diet 1 (0% plantain peels), crude protein and crude fibre worse ($P<0.05$) than in the other diets (Table 5). The differences obtained between diets 1 and the others in the digestion of nutrients may be due to the levels of nutrients present in maize and plantain peels (Table 1) and subsequently in the diets (Table 3). The differences in gross energy and starch digestibility may be due to the fact that the starch in DMRPP was converted to sugars and this therefore resulted in loss in the digestibility of energy. The amount of starch in the different diets may have been responsible for the variations obtained in the level of serum glucose of the goats. Nutrients digestibility in this trial were higher than the values reported for other crop residue rations (Aregheore, 1995, 1996).

Compared to diet 1, the percentage cost/kg of concentrate diet and cost/kg liveweight gains were 100, 34, 31 and 29; 100, 94, 91 and 82 for diets 1, 2, 3 and 4, respectively. The DMRPP diets were more economical than the control diet.

In conclusion, the results of this trial indicated that DMRPP is acceptable to goats, and it can substitute partially or totally the maize in concentrate supplements for goats without adverse effects on their performance. Cost of production was reduced with substitution of maize with DMRPP in the diets. Finally, data on performance characteristics, blood indices, nutrients digestibility and economics of production, demonstrated the nutritional significance of plantain peels as a feed in ruminant nutrition and that DMRPP can be effectively used to replace maize at a level of 80 % in the concentrate supplements for goats.

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STRESZCZENIE

Wartość pokarmowa suszonych dojrzałych skórek bananowca jako zamiennika kukurydzy w żywieniu kóz

Dwadzieścia cztery wschodnio-afrykańskie kozy karłowe o średniej masie ciała 12,88±0,08 kg, 9-12 miesięczne, podzielono losowo na 4 grupy po 6 zwierząt każda z uwzględnieniem płci i wagi.

Skórkami bananowca zastąpiono kukurydzę w paszy treściwej w ilości 0, 60, 80 i 100% i podawano do woli przez 84 dni. Dowolne pobranie paszy treściwej zmniejszało się liniowo, lecz nieistotnie (P>0,05), w miarę zwiększania się skórek bananowca w dawce. Pobranie paszy objętościowej było podobne we wszystkich grupach. Przyrosty dzienne masy ciała były większe (P<0,05) u kóz otrzymujących 60 i 80% skórek bananowca i wynosiły po 73 i 74 g, odpowiednio, w porównaniu z 70 i 68 g dziennie w grupach otrzymujących 0 i 100% skórek. Różnice w przyrostach między grupą 1 (%) a 4 (100%) nie były istotne. Sucha masa, skrobia i energia dawki 1 były lepiej trawione (P<0,05), a białko ogólne i włókno gorzej (P<0,05) niż pozostałych dawek. Koszt kg dawki oraz przyrostu masy ciała obniżały się w miarę obniżania się udziału skórek bananowca w paszy.

Wyniki doświadczenia wskazują, że wysuszone skórki bananowca mogą zastępować kukurydzę w żywieniu kóz bez ujemnego wpływu na wzrost i wyniki produkcyjne. Są one także tanim źródłem węglowodanów dla kóz.