

Preference, Acceptability and Digestibility of Crop By-products Supplemented Diets Fed to West African Dwarf (WAD) Goats

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Nutritional evaluation using preference and acceptability and digestibility trials as criteria for investigating diets supplemented with Maize (T_M), Cassava (T_{CP}), Plantain (T_{PP}) and Yam (T_{YP}) peels was conducted with West African Dwarf (WAD) goats. The preference and acceptability trials of the formulated diets were carried out by using the 'cafeteria' method. The digestibility of the diets was conducted through the use of metabolic cages. The two trials lasted for 15 days (10 days of adjustment and 5 days of collection respectively). Results of the preference and acceptability of these diets by the WAD goats was in the order of $T_M > T_{CP} > T_{YP} > T_{PP}$ based on their behavioural patterns: number of visits, number of bites, time spent on feeding and the number

of bites per visit. The highly preferred T_M and T_{CP} supplemented diets had a higher preference ranking (PR) or higher coefficient of preference (COP). The cassava (T_{CP}) peel supplemented diets among the other experimental diets recorded the highest digestibility values. Consequently, based on the preference, feed intake and digestibility results of the experiment, the experimental diet supplemented with T_{CP} (cassava peels), is recommended for use by small ruminant animal producers.

Keywords: Acceptability, preference, crop by-products, formulated diets, digestibility, West African Dwarf goats

INTRODUCTION

In the dry season, the main problem of ruminant production in Nigeria is nutrition, especially the quality and quantity of roughage which has compelled small ruminant livestock farmers to use other resources as feed (Zarah *et al.*, 2013). Crop by-products such as cassava peels, cocoa husks, maize cobs, and wheat offals among others are now widely used as animal feed. The trend has changed from the situation in which these by-products were considered as waste and are now being converted to animal protein for human consumption (Onyeonagu and Njoku, 2010). The abundant supply of crop by-products at almost no cost can enhance production and reduce cost of compounded feeds while not adversely affecting the performance of the animals. However, because of increases in human population and consequent high cost and demand for conventional

feedstuffs such as maize, groundnut cake and soya bean meal, it has become increasingly necessary that alternative feed ingredients be found to reduce the competition between, man and livestock (Iyeghe-Erakpotobor *et al.*, 2002). The voluntary intake of feed is a major determinant of feed quality and is quite well accepted as an indicator of potential animal performance (Coleman and Moore, 2003). Furthermore, the consumption and utilization of any feed resource is influenced by the preference and acceptability of the feed, which is related to the animal's behavioral pattern (Kalio *et al.*, 2006). Therefore, the extent of preference and acceptability of a feed is one of the principal things to note when determining the best feed stuff (Ganskopp *et al.*, 1997). The potential value of a food for supplying a particular nutrient can be determined by chemical

analysis, but the actual value of the food to the animal for its performance can be arrived at only after making allowances for the inevitable losses that occur during its digestibility (McDonald *et al.*, 1995). The West African Dwarf (WAD) goat is highly prolific and has high adaptive potential in the agro-ecological zone, therefore improving their nutrition through locally available feed materials such as crop by-products could enhance their productivity at least cost to livestock farmers. Consequently, published information related to the preliminary investigation on the West African Dwarf (WAD) breed of goat fed with diets supplemented with different crop by-products is scarce. The objective of this study was to assess different crop by-products as readily available alternative energy feedstuff in the mixed diets of the West African Dwarf (WAD) goats in the humid tropics of Nigeria through their preference, acceptability and digestibility.

MATERIALS AND METHODS

Site of the experiment

The experiment was conducted at the Teaching and Research Farm of Ignatius Ajuru University of Education, Ndele Campus (Latitude 4°58' N and Longitude 6°48' E), Nigeria (Kalio *et al.*, 2009).

Source of feed materials and feed materials processing procedures

Different crop by-products: cassava peels, yam peels, and plantain peels were all collected from the rural women of Ndele Community and from fried/roasted yam and plantain vendors within Port Harcourt metropolis, who either dispose them at refuse dumps or as mere mulch materials on their crop farms. These peels were all sun-dried for the same period of two weeks. Similarly, maize used as the control energy feed ingredient was purchased from the market. A four (4) weeks re-growth of Guinea grass (*Panicum maximum*) was harvested within the premises of Ignatius Ajuru University of Education, Port Harcourt, Ndele Campus farm. The grasses were air dried for two (2) weeks to protect its nutritive content and later was chopped into smaller sizes using sharp machete. These feed materials were all grinded separately and used in combination with other ingredients for the formulation of the individual experimental diets. The diets were presented in pelleted forms to prevent wastage as well as to encourage intake.

Composition of experimental West African Dwarf (WAD) Goats diets

The experimental diets of maize (T_M) and different crop by-products used as the basal energy sources: cassava (T_{CP}), yam (T_{YP}), and plantain (T_{PP}) peels were formulated

in the ratio of 40%:60% (40% of concentrates including the basal energy sources and 60% of a roughage base - *Panicum maximum*) as adopted from the works of Kalio, (2017).

Source of experimental West African Dwarf (WAD) goats

Matured (7 months – 1 year old) experimental West African Dwarf (WAD) does and bucks with average weight of 8.39 ± 0.0043 kg were obtained from the households of small holder WAD goat owners residing in Fimie-ama and Ndele villages in Port Harcourt and Emohua Local Government Areas of Rivers State respectively.

Experiment 1

Preference and acceptability of experimental diets

Management of experimental animals

Sixteen matured (7 months – 1 year old) mixed sexes of West African Dwarf (WAD) goats (12 Bucks and 4 Does) were used for the study. Prior to the commencement of the experiment, the animals were dewormed using Albendazole oral suspensions for the prevention against internal parasites. The prevention against possible attacks of ectoparasites was carried out using Ivomec injected subcutaneously. Each day during the experimental period, animals were kept in an open fenced area of size 25 x 25 m within the periods of data collection, and retired into their individual pens at the end of the experiment.

Feeding management of experimental animals with their experimental diets

The feeding of the WAD goats to determine relative preference, acceptability or selectivity of the experimental diets was carried out by the cafeteria method (Larbi *et al.*, 1993) while the animals' behavioural pattern and dry matter intake of the crop by-products were determined as described by Mtenga *et al.* (1992). Measured quantities of the experimental diets were placed in plastic feeding troughs of 30 cm in diameter. Water and mineral licks (TANLICK®- 35.96% Na, 0.25% Zn, 0.30% Fe, 0.20% Mn, 0.003% I, 0.002% Co, 0.10% Cu, and 0.05% Mg) were provided *ad libitum*. There were 4 troughs per feed. The feeding troughs were randomly placed in four locations within the open fenced area. The order of placement of the test feed in the fenced area was randomized every day to avoid "habit reflex" (Kaitho *et al.*, 1996).

Feeding behaviour, preference, acceptability and intake of experimental diets

The preference and acceptability trial lasted for 15 days with 10- day adjustment and 5- day collection periods, respectively. The animals were exposed to the experimental diet for 4 h each day between 08:00- 12:00 noon. Feed refused after 4 h was weighed at the end of each day. The difference between the feed offered and feed refused was used to determine feed intake of each experimental diet in g/day. The coefficient of preference (COP) of each experimental diet was determined by the procedure described by Karbo *et al.* (1996) as the ratio between the intakes of each experimental feed divided by the total intake on dry matter basis. A particular diet was said to be preferred by animals to the others when calculated COP is more than unity. The results from these were used to rank the various diets. The number of visits, number of bites and the time spent (sec) per visit eating the randomly placed diets were recorded by using a stop watch.

Chemical analysis

Daily representative grab samples of the feed and refusals within the 5-day collection period were collected in a sample bag and kept in a Gallenkamp moisture extraction oven for 48 h at 60°C for dry matter determination.

Statistical analysis

Data were analyzed using the analysis of variance (ANOVA) using general linear model (GLM) procedures (SAS, 1999) for Complete Randomized Design (CRD). The feed intake and number of visits, number of bites and time spent feeding on the experimental diets were determined. Means were separated by using Duncan Multiple Range Test (Steel and Torrie, 1980).

Experiment 2

Digestibility assessment

Management of experimental animals

The twelve matured (7 months – 1 year old) West African Dwarf (WAD) bucks intended for use in the experiment on arrival were dewormed and treated for possible attacks of ectoparasites and allowed to rest for one week. On the day of commencement of the experiment, the animals were randomly assigned to each dietary treatment groups. Three replicates of 4 bucks per treatment group were housed singly in an open pen (3 x 4 m) for the 15 day digestibility assessment in a Completely Randomized Design (CRD).

Digestibility assessment

The digestibility assessment lasted for 15 days (10 days

of adjustment and 5 days of collection). Three bucks after the first experiment were assigned per treatment into metabolic cages (2.5 x 1.5 x 4 m) in a completely randomized design (CRD). Daily feed given and feed left over were recorded. Representative samples of feed given and feed left over were put into sample bags and kept in a Gallenkamp moisture extraction oven for 48 h at 60°C for dry matter (DM) determination. The difference in feed given and feed left over for each animal was recorded as voluntary feed intake. At the end of the digestibility assessment, daily samples of feed given, and feed left over and faeces were bulked for the animals per treatment and a representative sample of the 5- day collection kept for chemical analysis. Total daily faecal output for the animals per treatment was collected using harness faecal collection bags and recorded. Samples of faeces were taken from the animals for each treatment and dried in the oven for 48 h at 60°C to determine faecal dry matter. The remainder was bulked for the animals per treatment over the 5 day collection and stored in the deep freezer for faecal chemical analysis (AOAC, 1990).

Statistical analysis

Analysis of variance (ANOVA) using general linear model (GLM) procedures (SAS, 1999) for Complete Randomized Design (CRD) was used to determine the treatment effects in the digestibility trial. Treatment means were separated using Duncan Multiple Range Test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Preference and acceptability of experimental diets by West African Dwarf (WAD) goats

The consumption and utilization of feed by animals is influenced by the preference and acceptability of the feed which is associated with the animal's pattern of behaviour (Mtenga *et al.*, 1992). Similarly, the preference and acceptability of a feed by an animal is a major component of voluntary intake (Ganskopp *et al.*, 1997). The proximate composition and *in vitro* metabolizable energy (ME) estimates of the experimental diets used for the preference, acceptability and digestibility trial is as presented in the works of Kalio, (2017). Table 1 shows the preference and acceptability of the experimental diets by mixed sexes of West African Dwarf (WAD) goats. The results show significant ($P < 0.05$) differences among the mixed sexes of WAD goats in their responses to the utilization of the experimental diets. The pattern of behaviour of the WAD goats as they relate to the number of visits, number of bites, the time spent feeding on the experimental diets and the number of bite per visit were significantly ($P < 0.05$) different. The number of visits the WAD goats made in trying to utilize a particular diet

Table 1. Preference, acceptability and digestibility of experimental diets by West African Dwarf (WAD) goats.

Experimental Diets	Acceptability parameters					
	NOOV	NOOBITS	TMSPOF (sec)	BITEPERV	FDMINT(g/day)	COP
T _M	36.00 ^a	78.00 ^a	84.00 ^a	2.16 ^a	288.00 ^a	0.30 ^a
T _{CP}	30.00 ^{ab}	72.00 ^a	80.00 ^a	2.40 ^a	260.00 ^a	0.27 ^{ab}
T _{PP}	24.00 ^{bc}	46.00 ^b	42.00 ^b	1.75 ^b	180.00 ^c	0.19 ^b
T _{YP}	28.00 ^c	60.00 ^c	59.00 ^c	2.14 ^a	220.00 ^{bc}	0.23 ^a
Total	118.00	256.00	265.00	8.45	948.00	1.00
Mean	29.50	64.00	66.25	2.11	237.00	0.25
SEM ±	5.98	8.15	10.90	0.309	74.86	0.106

Parameters	Feed Intake and Digestibility					
	T _M	T _{CP}	T _{PP}	T _{YP}	Mean	±SEM
Feed DM intake (g/day)	178.50 ^b	234.20 ^a	107.14 ^c	145.77 ^b	166.40	33.04
Dry matter digestibility (%)	53.98 ^{ab}	57.98 ^a	40.39 ^c	42.88 ^{bc}	45.56	13.75

^{a, b, c} Means bearing different superscripts along the same column (Top part of Table 1) and ^{a, b, c} Means bearing different superscripts along the same row (bottom part of Table 1) are significantly different ($P < 0.005$); T_M = Maize; T_{CP} = Cassava Peel; T_{PP} = Plantain Peels; T_{YP} = Yam Peels; NOOV = No of visits; NOOBITS = No of bites; TMSPOF = Time spent on feed; BITEPERV = Bite per visit; FDMINT = Feed dry matter intake; COP = Coefficient of preference; SEM = Standard error of mean.

ranged from as high as 36.00 to as low as 24.00, for Maize (T_M) and Plantain peels (T_{PP}), respectively. Similarly, the numbers of bites on Maize (T_M) and the diets with crop by-products supplemented diets were significantly ($P < 0.05$) different, although those of Maize (T_M), Cassava peel (T_{CP}) were not statistically different. Thus the number of bites by the WAD goats utilizing the feed mixture with maize and the different crop by-products was 78.00, 72.00, 60.00 and 46.00 for Maize (T_M), Cassava peel (T_{CP}), Yam peel (T_{YP}) and Plantain peel (T_{PP}) respectively. Furthermore, the time spent on the various experimental diets by the WAD goats were significantly ($P < 0.05$) different. It was observed that the WAD goats spent more time feeding on Maize (T_M) (84.00 secs) and Cassava peel (T_{CP}) as opposed to feeding on Yam peel (T_{YP}) and Plantain peel (T_{PP}). The number of bites per visit was also significantly ($P < 0.05$) different with values as high as 2.40 for Cassava peel (T_{CP}) to as low as 1.75 for Plantain peel (T_{PP}). It was however, observed that the experimental diets that exhibited superior values in terms of the animals' behavioural patterns: the number of visits, number of bites, the time spent feeding on the crop by-products and the number of bite per visit gave a concurrent increase in feed intake and this was a criterion in assessing the preference and acceptability of the feed stuffs (Kalio *et al.*, 2006). Similarly, it was observed that the WAD goats preferred and therefore spent more time and had a higher intake feeding on the experimental diets containing Maize (T_M) and Cassava peel (T_{CP}) (288.00; 260.00 g/day respectively). The order of preference rankings (Table 2) for the control maize diet (T_M) and those containing the different crop by-products was in the order of Maize (T_M) > Cassava peel (T_{CP}) > Yam peels (T_{YP}) > Plantain peels (T_{PP}). The least acceptance of Plantain peels (T_{PP}) may be attributed to its very low crude protein value (Oyenuga, 1978). Furthermore, it was observed that, the highly preferred Maize (T_M) and Cassava peel (T_{CP})

mixed diets had a higher preference ranking (Larbi *et al.*, 1993) or higher coefficient of preference (Karbo *et al.*, 1996) (Table 2). In addition, the desire for the WAD goats to obtain adequate nutrients from the feed stuffs to contend with their daily bodily requirements may have resulted in making them prefer one feedstuff to the other. According to Steele, (2006) goats with free access to food will vary their intake depending on the energy available from the food.

Table 2. Coefficient of preference (COP) and preference ranking (PR) of the experimental diets fed to mixed sexes of West African Dwarf (WAD) goats.

Crop by-products	COP	PR
T _M (Maize)	0.30	1
T _{CP} (Cassava peels)	0.27	2
T _{PP} (Plantain peels)	0.19	4
T _{YP} (Yam peels)	0.23	3

Feed dry matter digestibility

The results in (Table 1) revealed that there were significant ($P < 0.05$) differences in the dry matter digestibility among the male WAD goats fed the different experimental diets. The dry matter digestibility of the experimental diets varied from as high as 57.98% to as low as 40.39% for the male WAD goats fed T_{CP} (cassava peels) and T_{PP} (plantain peels), respectively. Although animals fed experimental diets containing T_{CP} (cassava peels) possessed the highest digestibility value (57.98%), they were not statistically different from those of (%) T_M (maize - 53.98%). The high digestibility value recorded by WAD goats fed T_{CP} (cassava peels) could be attributed to

the high feed intake values recorded for the crop by-product. The observation was true and consistent with the other treatment groups. This is in support of the reports by Chesworth, (2006), who established a positive relationship between the digestibility of foods and their intake. Furthermore the result of this study corroborates a higher digestibility estimates in support of the use of T_{CP} (cassava peels) in mixed diets during an *in vitro* study conducted with similar feeds with a higher metabolizable energy (Kalio, 2017). This gives an indication that the T_{CP} (cassava peels) in mixed diets fulfils the recommended ME values (7.20 MJ/kg/DM) for an average diet (6 – 13 MJ/kg/DM) (Steele, 2006), hence can fulfill the energy requirements for WAD sheep and goats when utilized.

Conclusion and Recommendation

The preliminary nutritional evaluation of the experimental diets supplemented with Maize (T_M), Cassava (T_{CP}), Plantain (T_{PP}) and Yam (T_{YP}) peels through the preference and acceptability of the feedstuffs revealed the preference and acceptability of these feed stuffs by the animals in the order of $T_M > T_{CP} > T_{YP} > T_{PP}$. The intake of the diets which was observed as a major determinant for the preference and acceptability of the diets by the WAD goats was positively related to the number of visits, number of bites, time spent on feeding and the number of bites per visit. The highly preferred T_M (Maize) and T_{CP} (cassava peel) had a higher preference ranking or higher coefficient of preference. The high digestibility value recorded by WAD goats fed diets containing T_{CP} (cassava peels) was attributed to the high feed intake values recorded for the diet. Consequently, based on the preference, feed intake and digestibility results of the experiment, the experimental diet supplemented with T_{CP} (cassava peels), is recommended for use by small ruminant animal producers.

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