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Full Length Research Paper

Performance and economics of production of West African Dwarf (WAD) bucks fed crop by-products as sole feed in Cross River State, Nigeria

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The performance and economics of production of West African Dwarf (WAD) bucks fed crop by-products: T_1 (yam peels), T_2 (cassava peels), T_3 (sweet potato peels) and T_4 (ripe plantain peels) in a completely randomized design was investigated. Four bucks were assigned to the crop by-products in four replicates for the growth and digestibility trials. The final weight and weight gain of the bucks were significantly ($P < 0.05$) different. The final weights in order of superiority were 10500, 10025, 9550 and 8050 g for T_2, T_1, T_3 and T_4. The weight gain varied from 3200 to 750 g for T_2 and T_4. The economics of production of the bucks revealed significant ($P < 0.05$) differences in the parameters investigated. Judging from the cost of utilizing the crop by-products the bucks fed T_2 with an affordable price portrayed higher weight gain despite the higher amounts of feed consumed. The dry matter digestibility among the bucks was significantly ($P < 0.05$) different. This was higher (57.98%) for the bucks fed T_2. Overall results show better performance and economic benefits in the utilization of T_2 by the bucks. Hence, T_2 as a basal feedstuff is recommended as a better dry season feed for Goats.

Key words: WAD bucks, performance, economics of production, crop by-products, Cross River State.

INTRODUCTION

The increase in the production levels of food crops in Nigeria has brought about an unprecedented amount of crop residues and by-products (e.g. straws, haulms, stovers, cobs, vines, peels, brans, leaves, chaff, etc) as left over after crop harvest (Alhassan, 1988). These potential feed resources described as non-conventional feeds (crop by-products) are fundamental to farming systems that produce both crops and livestock (Henning et al., 2006).

Crop by-products abound in the rural villages of Cross River State that are not efficiently utilized by livestock farmers as potential feed resources for feeding livestock (Ayuk et al., 2011). Some usually of crop origin has been classified as „kitchen wastes‟ (Adamu et al., 2010) or common „household wastes‟ (Ademosun, 1987).

Prominent among these are yam peels, sweet potato peels, Irish potato peels and cassava peels. Others may include cocoyam peels, rice bran, cowpea husk, rice husk, maize husk, banana peels and plantain peels. These household or kitchen waste could be used after processing as feed stuffs as they contain crude protein levels ranging from 1 to 23%, fibre levels ranging from 2

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to 52% and metabolizable energy as high as 20 MJ/kg DM. Hence, small ruminants fed with these feed stuffs are healthier and heavier (Onwuka et al., 1997). For instance, cassava peels and pulp are used in ruminant diets as an energy source (Therdachai and Choke, 2001). Reports revealed that 94% of cassava starch can be digested in the rumen, thus providing the energy required by the rumen microbial population (Therdachai and Choke, 2001).

Similarly, most small-scale farmers in Africa and Asia plant sweet potato for both tubers as source of energy, and/or fodder as a source of proteins and vitamins for livestock (Farrell et al., 2000). The peels of white yam which forms about 10% of the total root are a valuable food for ruminants especially sheep and goats and may even meet a good part of the production ration for these animals (Onwuka et al., 1997). They are a good source of feed for these animals because they are free from cyanogenetical glycosides (Oyenuga, 1978). Every part of plantain, except the roots and suckers, can be and have been used to feed livestock in various parts of the world (Babatunde, 1992).

The peels are low in crude fibre and are rich in mineral matter, carbohydrates and certain amounts of vitamins (Oyenuga, 1978).

Consequently, there is paucity of information on the performance (growth and digestibility) and economics of production of West African Dwarf (WAD) goats produced by small-holder goat producers in the rural villages of Cross River State, hence this study becomes imperative.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the sheep and goats unit of the Teaching and Research farm of the University of Calabar, Calabar, Nigeria. Calabar is located at about latitude 4°58�red"N and longitude 8°17‟E with an average annual temperature of 25 - 30°C and annual rainfall of 1,830 mm (Eze and Effiong, 2010).

Management of experimental animals

Sixteen (16) 20 weeks old weaner bucks of an average initial body weight of 7.305 ± 1.48 kg of the West African Dwarf (WAD) type known to be the predominant small ruminant species kept by small-holder crop-livestock owners in the zone were dewormed and treated for possible attacks of ectoparasites. The goats were randomly assigned to each crop by-products. They were allowed to come out on a daily basis to exercise them in an open palour (25 × 25 m) from 7.30 - 9.00 am and provided with *Penisetum purpureum* as roughage to facilitate effective rumen function.

Feeds and feeding management

Crop by-products (yam, cassava, sweet potato and ripe plantain peels) that abound in the zone classified as common house hold food wastes were used. The crop by-products were offered to the animals at 3% of their body weight (dry matter basis). The feed (crop by-products), water and mineral salt licks (TANLICK®) were provided *ad libitum*.

Growth trial

The growth trial involved the use sixteen (16) 20 weeks old weaner bucks of the West African Dwarf (WAD) type. Four (4) bucks were randomly assigned to each crop by-product. Four (4) replicates of 1 buck per crop by-product were housed singly in an open pen (3m x 4m) for the 90 days of the growth trial using the Complete Randomized Design (CRD). The animals were fed solely with each of the crop by-products *ad libitum* when retired into their individual pens. They had regular access to fresh clean water and commercial mineral-salt licks (TANLICK®). Feed offered and refused were recorded on a daily basis. Average weekly weight gains were computed.

Digestibility trial

The digestibility trial lasted for 12 days (7 days of adjustment and 5 days of collection). Sixteen (16) WAD bucks were utilized. Four (4) replicates of 1 buck per crop by-product were assigned into metabolic cages (2.5 × 1.5 × 4 m) in a Completely Randomized Design (CRD). Daily feed offered and refusals were recorded. Representative samples of feed offered and refused 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 offered and refused per animal was recorded as voluntary feed intake on dry matter basis. At the end of the digestibility trial, daily samples of feed offered, feed refused 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.

Chemical analysis

The samples of oven-dried feed offered and feed refused

Table 1. Proximate composition of crop by-products (peels) used for the growth and digestibility trials.

Constituents (%)	Crop by-products (peels)			
	Yam	**Cassava**	**Sweet potato**	**Ripe plantain**
DM	84.84	93.77	87.29	84.64
Ash	3.95	11.77	3.95	14.85
CP	6.90	6.23	6.07	7.37
EE	4.95	5.10	4.05	8.90
CF	2.10	14.90	3.05	10.85
NFE	80.25	61.24	82.44	56.78
NDF	39.0	42.90	45.50	35.70
ADF	5.63	32.85	7.64	13.70
ADL	1.95	10.20	1.95	5.90
*Metabolizable energy (MJ/kgDM)	13.04	7.67	12.61	10.24

*ME (MJ/kgDM) = 13.5 – 0.15*ADF% + 0.14 *CP% - 0.15*Ash% (MAFF, 1984). DM – Dry Matter, CF – Crude Fibre, EE – Ether Extract, CF – Crude Fibre, NFE – Nitrogen Free Extract, NDF – Neutral Detergent Fibre, ADF – Acid Detergent Fibre, ADL – Acid Detergent Lignin.

were further dried at 105^0C for about 6 hours to climatic residual moisture before being ground through 1mm screen for chemical analysis. About 1g samples were weighed into crucibles and placed in a muffle furnace at 500^0C for 24 hours to determine ash content, while organic matter concentration was computed by difference (AOAC, 1990). The crude protein (CP) concentration (total nitrogen × 6.25) was determined according to the Micro-kjeldahl method, while crude fat (CF) was determined by extraction (AOAC, 1990). Similarly, neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined according to prescribed standard procedures (Van Soest and Robertson, 1985). Metabolizable energy (ME) was estimated according to the model suggested by MAFF (1984) as

ME (MJ/kg DM) = 135 – 0.15*ADF%+ 0.14*CP% - 0.15*Ash%.

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 growth and digestibility trials. Treatment means were separated using Duncan Multiple Range Test (Steel and Torrie, 1980).

RESULTS AND DISCUSION

Proximate composition of crop by-products

Table 1 shows results of the proximate composition (on % DM basis) of yam tuber peels, ripe plantain peels, sweet potato tuber peels and cassava peels used for the experiment. The yam tuber peel possess 84.84 DM, 3.95 Ash, 6.90 CP, 4.95 EE, 2.10 CF, 80.25 NFE, 39.00 NDF, 5.63 ADF, 1.95 ADL and the calculated metabolizable energy (ME) (MJ/kg DM) of 13.04. The EE content was higher than the EE content (1.20) and lower than the CP (11.33), CF (9.50) and Ash (9.80) of sweet potato tuber peel reported by Akinmutimi et al. (2006). Similarly, the NFE was higher than the NFE content (43.46), but lower than the CP (11.14), CF (12.78), EE (5.87), Ash (6.75), NDF (70.17), ADF (56.63) and ADL (15.89) contents reported by Akinfemi et al. (2009). Furthermore, Akinfemi et al. (2009) reported gross energy value of 2.988 (kcal/g) for yam tuber peels in their study.

The ripe plantain peel possess 84.64 DM, 14.85 Ash, 7.37 CP, 8.90 EE, 10.85 CF, 56.78 NFE, 35.70 NDF, 13.70 ADF, 5.90 ADL and the calculated metabolizable energy (ME) (MJ/kg DM) of 10.24. The CF and EE contents are higher than the CF (6.43) and EE (5.67), but lower than the DM (90.90), CP (9.19) and Ash (17.23) contents reported by Akinmutimi et al. (2006) in their study. These workers reported gross energy values of 2.993(kcal/g) for ripe plantain peel.

The sweet potato tuber peel possess 87.29 DM, 3.95 Ash, 6.07 CP, 4.05 EE, 3.05 CF, 82.44 NFE, 45.50 NDF, 7.64 ADF, 1.95 ADL and the calculated metabolizable energy (ME) (MJ/kg DM) of 12.61. The DM, EE and CF contents was higher than the DM, EE and CF contents (11.73, 1.34 and 0.34, respectively) and lower than the CP (6.33), NFE (87.44) and Ash contents reported by Oyenuga (1978).

The cassava peels possess 94.04 DM, 12.00 Ash, 6.13 CP, 5.00 EE, 15.00 CF, 61.87 NFE, 43.00 NDF, 33.00 ADF, 10.00 ADL and the calculated metabolizable energy (ME) (MJ/kg DM) of 7.61. The DM, CP, CF and Ash content of the cassava peel used were higher than the DM, CP, CF and Ash contents (89.62, 6.01, 10.10 and

Table 2. Performance and economics of production of the West African Dwarf (WAD) bucks fed the crop by-products for the growth and digestibility trials.

Parameters	Crop by-products (peels)					
	T1	T2	T3	T4	Mean	±SEM
Average Initial weight (g)	7290^{ns}	7300^{ns}	7330^{ns}	7300^{ns}	7305	1475.1
Average final weight (g)	10025^{a}	10500^{a}	9550^{a}	8050^{b}	9531.3	1011.7
Average Total weight gain (g)	2735^{a}	3200^{a}	2220^{b}	750^{c}	2226.3	500.01
Average weight gain (g/day)	30.39^{b}	35.56^{a}	24.64^{c}	8.33^{d}	24.73	3.84
Feed DM intake (g/day)	178.50^{b}	234.20^{a}	145.77^{b}	107.14^{c}	166.40	33.04
FCR (intake/Gain)	5.87^{b}	6.59^{b}	5.92^{b}	12.86^{a}	4.81	2.18
Cost of feed /kg (₦)	36.00^{a}	26.00^{b}	36.00^{a}	16.00^{c}	28.50	0.82
Cost of feed consumed/ Animal (₦)	6.43^{a}	6.09^{b}	5.25^{c}	1.71^{d}	4.87	0.08
Cost of feed/ kg weight gain (₦)	214.30^{a}	169.17^{c}	210.00^{b}	213.00^{a}	201.81	1.78
Dry matter digestibility (%)	53.98^{ab}	57.98^{a}	42.88^{b}	27.39^{c}	45.56	13.75

[a,b,c,d]Means bearing different superscripts along the same row are significantly different (P < 0.05); T_1 = Yam peels; T_2 = Cassava peels; T_3 = Sweet potato peels; T_4 = Ripe plantain peels.

10.01 respectively) reported by Idowu et al. (2006) but lower than the EE (6.88) and NFE (67.00) of sun-dried cassava peel reported by the same author. Similarly, the DM was higher than the DM (90.20), CP (3.25), EE (0.07) and Ash (5.50), but lower in CF (30.30) and NFE (66.47) reported for sun-dried cassava peel by Ukanwoko and Ibeawuchi (2009). However, the ME energy recorded in this study was higher than the ME (1.82 MJ/kg DM), reported by Ukanwoko and Ibeawuchi (2009), but lower than the ME (2044.80 kcal/kg DM or 8.56 MJ/kg DM) by Ademosun (1981). The difference in energy values may be due to the amount of flesh retained during the peeling process (Smith, 1988). Generally, the variations in nutrient composition of these feed stuffs may be due to genetic or varietal differences, differences in sampling and analytical procedures (Gizzi and Givens, 2004), among other factors.

Performance of WAD bucks fed crop by-products

The results of the performance of the WAD bucks fed different crop by-products in terms of weight gain are presented in Table 2. The initial weights of the WAD bucks allotted to the different feed treatment groups: T_1 (yam peels), T_2 (cassava peels), T_3 (sweet potato peels) and T_4 (ripe plantain peels) were not significantly (P > 0.05) different. However, the final total weight and the weight gains were significantly (P < 0.05) different. The final weight in order of superiority for the WAD bucks were 10500, 10025, 9550 and 8050 g for T_2 (cassava peels), T_1 (yam peels), T_3 (sweet potato peels) and T_4 (ripe plantain peels), respectively. The average total weight gains of the WAD bucks was also significantly (P < 0.05) different. Their average total weight gain values varied from as high as 3200 g to as low as 750 g for T_2 (cassava peels) and T_4 (ripe plantain peels), respectively.

The average daily weight gain values in the WAD bucks varied from as high as 35.35 g/day to as low as 8.33 g/day for T_2 (cassava peels) and T_4 (ripe plantain peels), respectively. The values of daily weight gains recorded for the WAD bucks is within the range of values (6.55 - 31.90 g/day) reported by Fasae et al. (2007) in their study while improving the utilization of cassava peels. The marked variation in weight gain by WAD goats fed the different crop by-products may be attributed to the various levels of metabolizable energy in the crop by-products (Mahgoub et al., 2000). Although the metabolizable energy of T_2 (cassava peels) was lower than that of T_4 (ripe plantain peels) they were within the range 6 - 13 MJ/kg DM necessary for optimal productivity (Steele, 2006). The superior weight gains exhibited by WAD bucks fed T_2 (cassava peels) may also be attributed to the level of voluntary intake of the crop by-products. Forbes, (1995) observed that if voluntary intake of feed by the animals is too low, rate of production will be depressed. This factor has thus, been described as one of the factors for productivity in small ruminants (Do Thi Thanh, 2006). The WAD bucks fed T_2 (cassava peels) possessed the highest weight gains.

Similarly, the results in Table 2 revealed that there were significant (P < 0.05) differences in the FCR among the WAD bucks fed the different crop by-products. However, the FCRs for T_2 (cassava peels - 6.59), T_3 (sweet potato peels - 5.92) and T_1 (yam peels - 5.87) were not statistically different. The WAD bucks on treatment T_4 (ripe plantain peels) utilized the crop by-product for body weight gain poorly when compared with other dietary groups. The poor intake may be due to some intrinsic factors such as the presence of heavy metals (lead and cadmium) and some anti-nutritional factors - saponins, tannins oxalates, phytate, cyanogenic glucosides and phenolic compounds (Adeniji et al., 2008) which may have caused poor intake and a resultant reduction in weight which brought about the condition. This is in support of the observation of Yousuf and Adeloye (2011) who explained that efficiency of feed utilization for production is a function of the nutrients profile of feeds as well as level of production.

Economics of production of WAD bucks fed different crop by-products

The results (Table 2) of the economics of production of WAD bucks fed the different crop by-products revealed that there was significant ($P < 0.05$) difference in the cost of the different feed materials, the feed consumed per animal and the cost of feed consumed per kg weight gain. The cost of the feed materials for T_1 (yam peels), T_2 (cassava peels), T_3 (sweet potato peels) and T_4 (ripe plantain peels) were ₦ 36.00, ₦ 26.00, ₦ 36.00 and ₦ 16.00 per kg respectively. T_2 (cassava peels) and T_4 (ripe plantain peels) were observed to be cheaper than T_1 (yam peels) and T_3 (sweet potato peels). The cheaper price of T_2 (cassava peels) may be attributed to the predominance and the steady increase in the production of cassava tubers seen as a major staple food for humans as well as serving as a primary, secondary or supplementary staple for over 200 million people in Africa (Smith, 1988). Similarly, the cassava peels are of no food value to humans as compared to T_1 (yam peels) that are seen as a delicacy among the Yorubas" in Nigeria for the production of "amala" (Coursey, 1983). Furthermore, earlier reports by Kalio and Ayuk, (2011) confirmed large quantities of cassava tubers produced in the rural villages of Cross River State which brought about increased availability of its peels. These authors have also reported cassava peels as ranking amongst the topmost crop by-product produced in the area. However, contrary to T_2 (cassava peels), T_4 (ripe plantain peels) is reported to be the cheapest in this study. This may be attributed to the lack of awareness by small-holder livestock producers to use the material as a major feed resource as compared to the use of T_2 (cassava peels) by small-holder sheep and goat farmers in southwest Nigeria where cassava products and by-products are regularly fed to animals as supplementary feed to grass and hay (Smith, 1988).

The cost of feed per kilogramme (kg) live weight gain for the WAD bucks was ₦ 214.30, ₦ 169.17, ₦ 210.00 and ₦ 213.00 for T_1 (yam peels), T_2 (cassava peels) T_3 (sweet potato peels) and T_4 (ripe plantain peels) respectively. Judging from the cost of utilizing the various crop by-products to achieve an equivalent kilogramme (kg) weight gain in the WAD bucks it was revealed that the WAD bucks fed T_2 (cassava peels) with an affordable price of the feed materials portrayed higher live weight gain irrespective of the higher amounts of feed consumed when compared to the T_1 (yam peels), T_3 (sweet potato peels) and T_4 (ripe plantain peels) treatment groups. This showed that it is cheaper to produce 1 kilogramme (kg) of WAD goat by using T_2 (cassava peels).

Dry matter digestibility

The results in Table 2 revealed significant ($P < 0.05$) differences in the dry matter digestibility among the WAD bucks fed the different crop by-products. The dry matter digestibility of the crop by-products varied from as high as 57.98% to as low as 27.39% for the WAD bucks fed T_2 (cassava peels) and T_4 (ripe plantain peels), respectively. Although animals fed T_2 (cassava peels) possessed the highest digestibility value (57.98%), they were not statistically different from those of T_1 (yam peels - 53.98%). It was observed that the particle sizes of the various crop by-products varied as a result of the various processing methods the root and stem tubers as well as the fruits were exposed to during the separation of the by-products from their primary products (yam, cassava and sweet potato tubers and ripe plantain fruits) during peeling. The order in reduction of the sizes was T_4 (ripe plantain peels) > T_1 (yam peels) > T_3 (sweet potato peels) > T_2 (cassava peels). The variation in the particle sizes may have affected the intake and subsequently the digestibility of the crop by-products. Reed and Brown, (1987) explained that making the particles of food to smaller sizes has two effects on digestion. Firstly it increases the amount of rumen degradation needed to make individual particles small enough to pass through the reticulo - omasal orifice as well as increases the overall surface area of the food so that more microbes can attack the food at the same time. This results in the stimulation of the rate of fermentation and hence better digestibility (Chesworth, 2006). Furthermore, the high digestibility value recorded by the WAD bucks fed T_2 (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.

CONCLUSION AND RECOMMENDATION

The energy content of the entire crop by-products used in this study were within the values recommended for an average diet (6 - 13 MJ/kg/DM) hence can enable the WAD bucks to fulfill their daily energy intake and requirements for optimal productivity. The crude protein levels in all the crop by-products were slightly above the level (6%) and within the minimum range (6 - 8%) that can encourage feed intake. However, the increase in the intake and digestibility of the cassava peels by the WAD bucks was as a result of the marked personal preference and the adaptation to the feed stuff to meet the maintenance requirement and optimal productivity of the bucks. Hence, cassava peel as a basal feedstuff could be recommended as a better dry season feed for small ruminants in humid tropical Cross River State.

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