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Evaluation of West African dwarf goats fed graded levels of boiled wild cocoyam (*caladium bicolor*) with guinea grass as basal diet

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Abstract

The unavailability and low quality of forage materials during the dry season faced by ruminant animals directly affects their growth and reproductive performance. Hence, an experiment was conducted with 16 West African dwarf bucks of age between 5 and 9 months using graded levels of boiled wild cocoyam (Caladium bicolor) and supplement with Guinea grass as based diet to check their performance. The inclusion levels of boiled Caladium bicolor meal (BCBM) were A (0% BCBM)), B (10% BCBM), C (20% BCBM) and D (30% BCBM), in a completely randomized design (CRD). The bucks were also randomly divided into four treatment groups. Each treatment group has four goats with a goat being a replicate in their respective group. Feed consumed, total and daily weight gain were obtained while feed conversion ratios were computed for each treatment group. The result showed significant differences (P>0.05) in their total and daily weight gain between treatment groups. Treatment A in their total weight gain of 1.30kg differed significantly from B (1.94), C (2.37) and D (2.62), but the value of 2.37kg obtained for treatment C was similar to value of treatment D (2.62) statistically (P>0.05). The significant differences (P>0.05) in their daily feed intake, followed the same pattern as in their total weight gain. Feed conversion ratio values showed that treatment B, C, and D which contain 10% BCBM, 20% 30% BCBM respectively were statistically similar (P>0.05), but these three treatments (B, C and D) differed significantly (P>0.05) from treatment A (control). Their feed economics Showed no significant difference (P<0.05) among the treatment groups in all the parameters (cost of feed consumed (N), total weight gain, cost/weight gain (N/kg), price/kg meat (N) and total revenue (N)), but cost per kg weight gain was least (₦ 47.73) for diet C (20% BCB) followed by D (₦48.95) and C (₦52.42) and highest in the control diet A (₦125.54). Since 30% boiled C. bicolor inclusion level promoted best growth rate at the lowest cost per kg feed consumed, it is therefore recommended as an ingredient for goat diet.

Keywords: *Caladium bicolor*; digestibility; West African dwarf goat; non-conventional; unutilized

Évaluation des chèvres naines d'Afrique de l'Ouest Niveaux de nivelés du taro sauvage bouilli (Bicolor de Caladium) avec de l'herbe de Guinée en tant que régime basal

Résumé

L'indisponibilité et la faible qualité des matériaux de fourrage au cours de la saison sèche confrontée aux animaux des ruminants affectent directement leurs performances de croissance et de reproduction. Par conséquent, une expérience a été menée avec 16 dollars nains d'Afrique de l'Ouest entre 5 et 9 mois avec des niveaux classés du taro sauvage bouilli (bicolor caladium) et compléter avec l'herbe de guinée comme alimentation basée sur la vérification de leur performance. Les niveaux d'inclusion de la farine de bicolore de caladium bouilli (FBCB) ont été un (0% FBCB)), B (FBCB de 10%), C (20% FBCB) et D

(30% FBCB), dans une conception complètement randomisée (CCR). Les dollars ont également été divisés au hasard en quatre groupes de traitement. Chaque groupe de traitement comporte quatre chèvres avec une chèvre étant une réplique dans leur groupe respectif. On a obtenu de la consommation consommée, totale et quotidienne de gain de poids pendant que des rapports de conversion d'aliment ont été calculés pour chaque groupe de traitement. Le résultat a montré des différences significatives (p> 0,05) dans leur gain de poids total et quotidien entre les groupes de traitement. Le traitement A dans leur gain de poids total de 1,30 kg différait de manière significative de B (1,94), C (2,37) et D (2,62), mais la valeur de 2,37 kg obtenue pour le traitement C'était similaire à la valeur du traitement D (2.62) statistiquement (P> 0.05). Les différences significatives (p> 0,05) dans leur consommation d'alimentation quotidienne, suivaient le même schéma que dans leur gain de poids total. Les valeurs de rapport de conversion d'alimentation montraient que le traitement B, C et D contenant 10% FBCB, 20% 30% FBCB respectivement étaient statistiquement similaires (p> 0,05), mais ces trois traitements (B, C et D) différaient de manière significative (p> 0,05) du traitement A (contrôle). Leur économie d'alimentation n'a montré aucune différence significative (p <0,05) parmi les groupes de traitement de tous les paramètres (coût des aliments consommés (₦), gain de poids total, gain de coût / poids (₦/ kg), prix / kg de viande (₦) et le chiffre d'affaires total (₦), mais le coût de la consommation de poids par kg est le moins (₦ 47.73) pour le régime C (20% BCB) suivi de D (₦48,95) et C (₦52.42) et le plus élevé dans le régime de contrôle A (₦125.54). Depuis 30% de la bouillie C. Niveau d'inclusion Bicolor favorisé le meilleur taux de croissance au plus bas coût par kg d'aliment consommé, il est donc recommandé comme ingrédient pour le régime de chèvre.

Mots-clés: Caladium Bicolor; digestibilité; Chèvre naine de l'Afrique de l'Ouest; non-conventionnel; inutilisé

Introduction

High cost of conventional feedstuff hampered an increase in animal production and small ruminants (sheep and goat) in particular (Udo *et al*., 2019) which amount to well over 70% of the total cost of production (Agbakoba, 1995). Livestock, especially those in Nigeria and neighboring countries are faced with the problems of continual inadequate feedstuffs (Udo *et al.,* 2018). Obviously, there is high demand for meat as protein source due to corresponding geometrical increase in human population. Udo *et al*, (2018) asserted that it has become important to supply adequate feed in quantity and quality for optimal livestock performance. Nutritional constraint that is severe mostly during dry season can be copped with the provision of concentrate diet formulated with locally available feed ingredient in other to reduce the cost of feed. The utilization of local and readily available feedstuff will not only reduce the cost of animal feed, but also eliminate the competition between man and animal for conventional feedstuff. Goats and West African Dwarf (WAD) in particular form an integral part of an average household in the Southern Nigeria. West African Dwarf goat is classified as small ruminant and efficient feed converters into meat and milk irrespective of the environment where they are raised (Lebbie, 2004). They are stunted with a typical height of 30-50cm, and the capability to breeding at 12-18 months with multiple births of twins and triplets. Nigerian West African Dwarf goats are trypanotolerant and haemon-chotolent (Ohizu, 2019). Goat provides food security, animal protein, fibre and skin and household income to rural livestock farmers (Udo, 2015). One of readily available non-conventional and unutilized feedstuff is caladium bicolor (C. bicolar). Wild cocoyam has not been utilized as feed ingredient in animal feed formulation and

uncompetitive and non-conventional feedstuff but it is mostly used for aesthetic purposes. C. bicolor is a perennial plant grown mainly for its decorative colored leaves and ornamental. The nutritive value of *C. bicolor* according to Udo *et al*. (2021), Onu and Madubuike (2006) stands as: dry matter 90.70, crude protein 7.15, crude fibre 1.49, ether extract 4.22, ash 5.21, nitrogen free extract 82.02, and gross energy 5.21; therefore being a veritable good energy source. However, there is paucity of information on the utilization of *C. bicolor*. This research was designed to assess the performance of West African Dwarf goats fed boiled wild Cocoyam (*C. bicolor*) with guinea grass as a basal diet.

Materials and methods

Experimental location

The research was carried out in Obio Akpa village, Oruk Anam L.G.A. Akwa Ibom State. Obio Akpa lies between latitudes $5^{o}17^{1}$ and $7^{o}27^{1}$N and longitude $7^{o}27^{1}$ and $7^{o}58^{1}$E of the Greenwich Meridian. It is in the humid tropics, characterized with two seasons of dry that spanned from November to March and rainy from March to November. The average annual rainfall of Obio Akpa is 4205.3-5381.2mm with mean annual temperature of 24°C-30°C. (SLUS-AK, 2019).

Experimental animals and management

Sixteen West African Dwarf (WAD) goats of 6-9 months of age with a mean weight of 6.33kg were purchased from goat farmers within Akwa Ibom State and used for the experiment. The animals were vaccinated against Pestes des petite ruminants (PPR) using Rinder pest Tissue Culture Vaccine. The animals were randomly allotted to four treatment groups of four goats per treatment and housed singly in well ventilated pens equipped with feeders and drinkers. Each of the goats received 0.5kg of the formulated diet and 2kg of Guinea grass (*Panicum maximum*) daily and the trial lasted for 56 days. Daily feed intake was determined by subtracting daily feed leftover from the amount given the previous day. Weekly body weight was taken weekly and used to determine the average weight gain and feed conversion ratio of the animals. Clean fresh water was also offered daily *ad libitum* to each animal. The experiment was designed as a Completely Randomized Experiment, which the sixteen WAD goats were randomly divided into four treatments groups and each group comprised of four animals with an animal being a replicate in its group. Four experimental diets were formulated and assigned to the four treatment group of animals.

Processing of wild Cocoyam (Caladium bicolor)

Wild Cocoyam were harvested from the bushes around the University vicinity and then washed to remove dirt and sand before being boiled in a pot whose water has attained boiling temperature (100°C), and then allowed to boil for 30 minutes before the water was decanted. The boiled wild Cocoyam was peeled and chopped into tiny chips for easy drying before being milled and used to formulate the boiled *C. bicolor* diets.

Experimental diet

Four experimental diets A, B, C and D were formulated with diet A as control and contained no *Caladium bicolor,* while treatment B, C and D had 10%, 20% and 30% *C. bicolor* respectively. Other ingredients used were: Cassava peel, Palm kernel cake, Bone meal, Common salt and Brewers dried grain. Treatment A being the control contained 0% of the tested ingredient (*Caladium bicolor*), 40% cassava peels, 17% palm kernel cake, 2% bone meal, 0.5% common salt and 40.5% brewer's dried grain. Diets B, C and D contained 10%, 20% and 30% of *C. bicolor* meal respectively together with the same inclusion level of cassava peels, palm kernel cake, bone meal and common salt but varied in the inclusion level of brewer's dried grain. The four diets were randomly allotted to the four experimental animal

groups.

Table 1: Composition of the experimental diets

Ingredients (%)	A(0%BC)	B(10%CB)	C(20%CB)	D(30%CB)
Caladium bicolor	0.00	10.00	20.00	30.00
Palm Kernel Cake	17.00	17.00	17.00	17.00
Cassava Peels	40.00	40.00	40.00	40.00
Bone meal	2.00	2.00	2.00	2.00
Common Salt	0.50	0.50	0.50	0.50
Brewers Dried Grain	40.50	30.50	20.50	10.50
Total	**100.00**	**100.00**	**100.00**	**100.00**

CB= Caladium bicolor

Data collection

Data on the initial weight of the animals were collected at the beginning of the experiment before the experimental diets were given. Weekly body weights of each animal were also taken and used to derive the average daily weight gain of each animal. Data on daily feed intake was recorded for each animal by subtracting the leftover feed from the amount offered the previous day. This was used to derive the feed conversion ratio for each animal. The economics of production for each treatment group was also computed.

Chemical analysis

The four experimental diets were analyzed for proximate constituents (moisture, crude fibre, crude protein, ash, nitrogen-free extracts and ether extract) using the AOAC (2000) procedures.

Statistical analysis

All the data obtained from the experiment were analyzed using the Analysis of Variance (ANOVA) while significant means were separated using Duncan's Multiple Range Test (Duncan, 1955).

Result and discussion

The nutrient composition of the experimental diet formulated to contain 0-30% level of boiled wild Cocoyam (*Caladium bicolor*) is presented in Table 1. Table 2 shows the determined proximate composition of the experimental diet. The dry matter (DM %) content of diet A, B, C and D were fairly comparable; 89.85, 89.96, 90.06 and 90.10 respectively. The crude protein (CP) ranged of 10.35% – 13.41%, indicates a CP level that ruminant animal and goats in particular can utilize for ultimate production. The crude protein decreased from A – D due to the low content of crude protein in *C. bicolor* meal which was used to replace brewer's dried grain that contains 18% CP. The crude fibre content followed the same pattern as CP which the values were; 9.51, 9.44, 9.41 and 9.37 for diet A, B, C and D respectively. These values prove a high level of fibre which enhances good rumen functioning.

Table 2: Chemical constituents of experimental diet

Parameters	A(0%CB)	B(10%CB)	C(20%CB)	D(30%CB)
Dry matter	89.85	89.96	90.06	90.10
Crude protein	13.41	12.36	11.34	10.35
Crude fibre	9.51	9.44	9.41	9.37
Ether extract	5.58	5.32	5.17	4.78
Ash	5.27	5.28	5.22	5.20
NFE	56.07	57.55	58.91	60.20
GE(Kcal/g)	4.02	4.01	4.01	4.00

NFE= Nitrogen free extract GE= Gross Energy CB= *Caladium bicolor*

The ether extract composition (%) decreased also from diet A – D as a result of low content of ether extract in *Caladium bicolor* meal (0.6 %) (Udo *et al*., 2021). The ash concentration increased from treatment A (5.27 %) to B (5.28 %) and decreased from treatment C (5.22 %) to D (5.20 %).

Nitrogen free extract (NFE) increased from treatment A to D; 56.07, 57.55, 58.91 and 60.20 respectively due to high composition of NFE in *Caladium bicolor* meal. These values increased as the inclusion levels increases.

Feed consumption and growth rate of West African dwarf goats fed graded levels of boiled *Caladium bicolor* meal

The performance characteristics of West African dwarf (WAD) goats fed the experimental diet are presented in Table 3. Total feed intake (Kg) of goats fed diet B (5.56) was statistically similar (P>0.05). Goat placed on treatment B (5.65) had a lower value of total feed intake that differed significantly (P<0.05) from treatment D (9.16). The result obtained is similar to the report of Onu and Madubuike (2006), showing improvement in feed intake as levels of inclusion increased with a no significant (P>0.05) difference in the performance of birds fed graded levels of boiled wild Cocoyam up to 20%. This can be as a result of palatability or eating to meet up nutrient requirement (Obioha, 1985). There was no significant difference (P>0.05) in the total feed intake of treatment C and D. This result is in line with the report of Udo (2016) who reported a no significant difference (P>0.05) in the feed intake of goats fed 20% and 30% levels of boiled rubber seed meals. The average total weight gain of goats fed in B (1.94) was statistically similar (P>0.05) with the treatment group C (2.37) but differed significantly (P<0.05) from the treatment group A (1.30) and B (2.62). This result agrees with the report of Onu and Madubuike (2006), where there was no significant difference (P>0.05) in the weight of broiler birds fed 10% and 20% of cooked *Caladium bicolor* meal.

The control diet (A) was second to the highest in feed consumption and this was probably so as animal eats to meet up with their nutritional requirement in terms of energy and protein (Obioha, 1985). The weight of the animals increased as the inclusion level increases; thus, agreeing with the report of Onu and Madubuike (2006) that cooked *Caladium bicolor* can be increased above 20% in the diet of animals to obtain maximum result. Goats fed 10% *C. bicolor* meal (diet B) had the best feed conversion ratio though it was statistically similar (P>0.05) to the values obtained for animals in treatment C (20% *C. bicolor* meal) and D (30% *C. bicolor* meal) but differed significantly (P<0.05) from treatment A, the control.

The feed economics of West African Dwarf goats fed diets containing different inclusion level of boiled *C. bicolor* meal is shown in Table 4. The cost/kg weight gain indicated that treatment D had the least amount of – 14.00 and the values for treatment A, B and C were – 20.00, – 18.00 and – 16.00 respectively. This result followed the trend reported by Onu and Madubuike (2006) of which as the levels of inclusion level increased, the cost of production reduces.

Table 3: Growth performance of West African dwarf goat s fed graded levels of boiled *Caladium bicolor* meal

Parameters	A(0%CB)	B(10%CB)	C(20%CB)	D(30%CB)	SEM
Initial Body Weight (kg)	6.50	6.38	6.50	6.38	0.39
Final Body Weight (kg)	7.80	8.32	8.87	8.99	0.38
Average Total Weight gain (kg)	1.30^{c}	1.94^{b}	2.37^{ab}	2.62^{a}	0.14
Average Daily weight gain (g)	23.22^{c}	34.69^{b}	42.28^{ab}	46.74^{a}	2.53
Total feed intake (kg)	8.16^{ab}	5.65^{b}	7.07^{ab}	9.16^{a}	0.93
Daily feed intake (g)	145.67^{ab}	100.85^{b}	126.25^{ab}	163.62^{a}	16.56
Feed conversion ratio	7.01^{a}	2.94^{b}	2.98^{b}	3.49^{b}	0.82

a,b,c means within the same row with different superscripts differed significantly ($P<0.05$)
CB= *Caladium bicolor*

Table 4: Feed economics of WAD goats fed graded levels of boiled *C. bicolor* meal

Parameters	A(0%CB)	B(10%CB)	C(20%CB)	D(30%CB)
Cost of 100kg feed (₦)	2000	1800	1600	1400
Cost/ kg (₦)	20	18	16	14
Total feed consumed(kg)	8.16	5.65	7.07	9.16
Cost of feed consumed (₦)	163.20	101.70	113.12	128.24
Total weight gain (kg)	1.30	1.94	2.37	2.62
Cost/weight gain(₦/kg)	125.54	52.42	47.73	48.95
Price/kg meat (₦)	500	500	500	500
Total Revenue (₦)	650	970	1185	1310

CB=*Caladium bicolor*

This therefore reinforces the supremacy of diet D over diets A, B and C since it supported least cost/kg weight gain and would likely yield more profits on investment. Diet D is therefore the diet of choice in this trial. This confirms that boiled *C. bicolor* meal mixed with other ingredients could be well tolerated and better utilized by West African Dwarf (WAD) goats even above 30% inclusion levels.

Conclusion

This research revealed that treatment D containing 30% boiled *C. bicolor* meal has the best daily weight gain, cost/kg weight gain and a least feed conversion ratio, and therefore stands out as the best inclusion levels (10%, 20% and 30% Caladium bicolor) and thus could be recommended for use as an ingredient in goat's ration formulation. Based on the above observations, recommendation is made for research to be conducted using unpeeled *C. bicolor* to evaluate goat performance. Also, research should be conducted on the feeding of goats with a higher inclusion level (above 30%) of *Caladium bicolor.*

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