Performance, Nutrient Utilization and Rumen Fermentation Characteristics of West African Dwarf Goats Fed Concentrate Diet with Corncob in Varying Inclusion Levels.

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ABSTRACT

The feeding value of corncob was evaluated using 12 West African Dwarf goats in a completely randomized design for 84 days. The corncob (CC) was included in compounded ration in varying proportions of 0% (control), 15%, 30% and 45%. *Panicum maximum* was fed in combination with the diets. The crude protein, ash and ether extract decreased as the CC inclusion in the diet increased. The metabolized energy was between 23.69 and 25.72 MJ/Kg DM. Goats on diet 30% CC inclusion level had the highest dry matter intake (559 $g.d^{-1}$), feed conversion ratio (7.89) and weight gain (70.83 $g.d^{-1}$). Dry matter digestibility ranged from 76.8 to 81.3%; crude protein digestibility ranged from 80.2 to 85.2%. Rumen metabolite analysis revealed the pH (5.84 - 6.05) and NH_3-N (8.86 – 11.23 $mmol.mL^{-1}$). The ammonia nitrogen in diets increased with increasing levels of inclusion of CC but there was decrease in the concentration of acetic, lactic, propionic and butyric acid in the rumen. The bacteria population in the rumen decreased with the highest inclusion of CC in the diet. It is concluded that CC can be included in compounded ratio up to 30% inclusion levels for fast growth rate and efficient rumen fermentation which would results to increase animal productivity at least cost.

(Keywords: corncob, nutrient utilization, performance, rumen fermentation characteristics, livestock feed)

INTRODUCTION

Animal production contributes to the economic development and food security of people; therefore there is the need to increase livestock production to enhance family nutrition. Livestock production can be increased when their nutrition is improved. The observed low productivity of ruminant livestock in Nigeria is because they are mostly raised on low quality pastures and crop residues. This problem is aggravated in the dry season leading to serious weight loss and death in areas of acute shortage of feedstuffs. The concern of animal scientists is to address these nutrition problems by providing alternative feedstuffs that can be offered to livestock especially during period of scarcity. These feedstuffs are not suitable for human nutrition is transformed into animal protein.

Goats can utilize forage, crop residue, and agro-industrial by-products and convert them to animal protein thereby reducing the cost of production. However, there is need to supplement their dietary intake with compounded ration in order to increase their productivity because these feedstuffs are fibrous and contain low dietary N. Supplementation using concentrates increases feed intake, improves digestibility and weight gain but the cost is high using conventional protein sources. The crop residue and agro-industrial by-products can best be utilized when used with other conventional feed ingredients to compound ration.

Corncobs are by-products of maize production and may be used as alternative feed resources for ruminants especially during the dry season. It is one of the most available and abundant agricultural wastes (Kategile, 1981). Nutrient intakes from crop residues which are characterized by high lignocellulose and low N are generally insufficient for maintenance

requirements if fed alone. Treatment of such material is advocated for to break the lignocellulose bonds and free some of the cellulose for digestion by the ruminant animal.

The present study was designed to determine the feed intake, weight gain, nutrient utilization and rumen fermentation characteristics of West African Dwarf Goats fed compounded ration consisting of varying levels of corncob as supplement.

MATERIALS AND METHODS

Study Location

The study was carried out in the Sheep and Goat Unit of the Institute of Agricultural Research and Training, Moor Plantation, Ibadan, Nigeria (latitude 7°15'–7°30'N and longitude 3°45'–4°0'E). The area has a tropical humid climate with a mean annual rainfall of 1,415 mm and an average daily temperature between 28 and 35 °C.

Animal Management

The procedures of animal experimentation used were in line with the guidelines of the University's Livestock Ethics Committee. The experimental house and individual pens for the goats were cleaned with disinfectant before being used by the goats. Individual pens were covered with wood shavings up to 5 cm depth. Twelve West African Dwarf (WAD) Goats weighing between 6.5–8.5kg were used for this experiment. The goats were housed intensively in well-ventilated individual pens disinfected with Morigad® solution two weeks prior to the experiment. On arrival, the animals were kept in the pens for proper routine management. All the goats were given antibiotic injection (Oxytetracycline L/A) and Ivomec injection at a dose of 1mL per 10 Kg goat. The goats were vaccinated against Peste de Petit Ruminant (PPR). Fresh feedstuffs and clean water were served daily.

Feeding Trial

Concentrate feed and Guinea grass was fed to the goats during the 14 d adaptation period. The goats were allotted to four experimental diets of concentrate consisting corncob at 0%, 15%, 30% and 45% in a Completely Randomized Design of three goats per treatment. The corncob was milled using 2mm sieve tube before mixing with other ingredients. Each goat served as a replicate. Guinea grass (*P. maximum*) was chopped to 5 cm and fed as basal diet to the goats. Feed and grass were offered initially to the animals at 2% and 3% of the bodyweight of the goats respectively. The quantity offered was increased weekly as intake of the goats increased. Feed intake was monitored daily while weight changes of the goats were recorded weekly during the 84 d feeding trial.

Digestibility and Nitrogen Balance Study

Each goat was kept in metabolic cage designed for separate collection of urine and feces for 14 d. The study was carried out for 28 d period during which the quantity of feed offered, feed residues, feces and urine from each goat were determined. Loss of nitrogen was prevented by adding 10ml of 10% H_2SO_4 into each container for collection of urine (Chen and Gomez, 1992). Daily collections of feces and urine were bulked and 10% sub sample of each was taken. Urine samples were frozen for nitrogen determination while the fecal samples were oven dried at 105^0C.

Collection of Rumen Fluid

Sixty mls of rumen fluids was collected at the end of the experiment from goats in each treatment for determination of rumen pH, ammonia nitrogen, volatile fatty acids and microbial viable count with suction tube inserted directly to the rumen through the oesophagus according to the procedure (Babayemi and Bamikole, 2006). After collection, the rumen fluids were kept in ice-packed containers for laboratory analysis.

Chemical Analysis

Samples of diets and *P. maximum* and fecal samples were oven dried at 105°C until constant weight. Sub-samples were milled using 2mm sieve to determine the parameters of proximate composition according to AOAC, (1990). The acid detergent fiber (ADF), neutral detergent fiber (NDF) and acid detergent lignin (ADL) were analyzed according to the procedures of Van Soest *et. al.* (1991). The pH was determined by using a pH meter E520 using glass reference electrodes. The concentration of ammonia

nitrogen in the rumen fluid (NH_3-N) was determined by distillation and absorption in boric acid followed by titration with H_2SO_4 0.1N (Preston 1995). Volatile fatty acids concentration was done as described by Gilchrist (1969); and microbial count using pour-plate technique. Rumen microbial count was done using Kumar et al. (2012) method.

Statistical Analysis

Data were subjected to statistical analysis using SAS (1998), means were compared using Duncan Multiple Range F- test of the same package.

RESULTS AND DISCUSSION

Table 1 shows the gross composition of the diets, calculated analysis revealed crude protein (CP) range of 11.83% in diet 4 to 18.35% in the control (diet 1). The chemical composition of the diet (Table 2) shows that CP, ether extract and ash concentration decreased as the proportion of CC increased in the diet compounded whereas the NDF, ADF and ADL increased. The CP content obtained in the diets fell within the recommended (NRC, 1981) for weaned and growing goats. The CP of grass was 8.4% with the lowest value of ether extract. Corncob has the lowest crude protein (2.8%) and the highest EE and NDF which were 4.2% and 63.3% respectively. The performance characteristics of the goats fed the experimental diets differed significantly ($P < 0.05$) among the treatments (Table 3). The highest dry matter intake was observed in goats fed diet 3 with value of 559 $g.d^{-1}$ and was followed by that of goats on diet 1 (540 $g.d^{-1}$); values observed for goats diet 2 and 4 were similar ($P > 0.05$).

Goats on diet 3 had the highest crude protein intake (16 g per kilogram $W^{0.75}$ per day while goats on diet 4 had the least crude protein intake (11.2 g per kilogram $W^{0.75}$ per day. The best feed conversion ratio (7.89) was also observed in goats fed diet 3 and this culminated to the highest weight gain (70.83 $g.d^{-1}$) observed when compared to goats on diet 1, 2, and 4.

Table 1: Gross Composition of Experimental Diet Containing Varying Levels of Corncobs.

Ingredient (Kg)	Diet 1 (Control)	Diet 2	Diet 3	Diet 4
Brewers' dried grain	60	45	30	15
Corncob	-	15	30	45
Wheat offal	10	10	10	10
Palm kernel cake	20	20	20	20
Groundnut cake	5	5	5	5
Limestone	4.5	4.5	4.5	4.5
Salt	0.25	0.25	0.25	0.25
Grower premix	0.25	0.25	0.25	0.25

Table 2: Chemical Composition (%) of the Diets Containing Varying Levels of Corncobs.

Parameters (%)	Diet 1 control	Diet 2 (15%)	Diet 3 (30%)	Diet 4 (45%)	Guinea Grass	Corn cob
Dry matter	90.1	90.2	90.3	90.1	36.1	88.4
Crude protein	17.2	16.7	16.3	15.8	8.4	2.8
Ether extract	3.66	3.62	3.58	3.54	2.44	4.2
Ash	9.9	8.8	9.6	9.0	9.9	3.8
NDF	51.4	53.7	52.8	55.2	61.4	63.3
ADF	42.4	44.2	43.2	46.3	46.8	30.2
ADL	6.8	7.8	6.9	7.0	9.7	9.5

NDF= Neutral detergent fibre; ADF= Acid detergent fibre; ADL= Acid detergent lignin

Table 3: Performance Characteristics of Goats Fed Diet Containing Corncob in Varying Proportions.

Parameters	Diet 1 (0%)	Diet 2 (15%)	Diet 3 (30%)	Diet 4 (45%)	SEM
Dry Matter ($g.d^{-1}$)					
Grass	350	351	362	349	
Concentrate	190	182	197	180	
Total	540^{b}	533^{c}	559^{a}	529^{c}	5.44
Nutrient intake ($g/KgW^{0.75}.d^{-1}$)					
Dry matter	99.1	96.0	97.4	97.1	
Crude protein	15.1	15.7	16.4	11.2	
NDF intake	61.5	57.7	55.5	56.0	
ADF intake	43.4	45.2	44.4	47.4	
ADL intake	6.6	8.7	8.4	9.2	
Feed conversion ratio	10.19^{a}	9.18^{a}	7.89^{b}	10.79^{a}	1.24
Initial weight (Kg)	7.43	7.40	7.37	7.53	
Final weight (Kg)	11.88	12.28	13.32	11.65	
Live weight ($g/Kg\ W^{0.75}.d^{-1}$)	5.45	5.56	5.77	5.45	0.25
Weight gain ($g.d^{-1}$)	52.98^{b}	58.09^{b}	70.83^{a}	49.04^{b}	5.12

abc= Mean in the in the row with similar superscript are not significantly different (P>0.05)
NDF= Neutral detergent fiber; ADF= Acid detergent fiber; ADL= Acid detergent lignin

The grinding of the corn cob to reduce the particle size increased the surface area for rumen microbial action. Factors affecting feed intake include dietary crude protein, palatability, gut fill, rumen outflow rate/retention time in the rumen (Ahamefule and Elendu (2010). Highest weight gain of 70.83 $g.d^{-1}$ was higher than reported value for goats fed cassava leaf meal in corn bran based diet (Yousuf *et al*., (2007). Apparent digestibility of the goats was significantly ($P > 0.05$) different among the treatments (Table 4).

Crude protein digestibility was highest in goats fed diet 1 (85.2%) and lowest in goats fed diet 4 (80.2%), the digestibility values for goats on diet 2 and 3 was similar ($P > 0.05$) in CP, NDF, ADF and EE. Ash digestibility was highest in goats fed diet 1 and was followed by goats fed diet 3. The high digestibility values observed in this study is in agreement with FAO report (1983) that concentrates contain high digestible nutrients. The values obtained were comparable to reported values (Ososanya *et.al*. 2013) for WAD sheep fed diet mixtures comprising dried cassava peel, wheat offal and palm kernel oil. Metabolizable energy values decreased in the diet with increasing inclusion level of corncob. The nitrogen utilization of the goats differed ($P > 0.05$) significantly among the treatments (Table 5).

Nitrogen intake values of goats on diets 1-3 were not significantly ($P > 0.05$) different, however, the intake of goats on diet 4 was the least (2.15 $g.d^{-1}$). The highest nitrogen loss was observed in goats fed diet 4 and this was responsible for the least value of apparent digestibility percent (41.9%). Goats fed diet 3 had the highest percent of nitrogen retained, absorbed and apparent digestibility.

The pH, volatile fatty acids and microbial population in the rumen of the goats were influenced by the diets (Table 6). The values obtained for the goats differed ($P < 0.05$) significantly among the treatments. The ammonia nitrogen in diets 1-3 increased with increasing levels of inclusion of corncob in the diet. The increase in NH_3-N resulted into high microbial growth leading to efficient utilization of N in the diets. Goats fed diets 1, 2, and 4 had ruminal pH within 6 and 7 which are normal except for goats on diet 3 with less alkaline medium (5.84). Volatile fatty acids (VFA) produced over 70% of the energy for ruminants. Concentrate diets results to increase VFA and higher rate of microbial protein synthesis through microbial proliferation. The acetic acid and butyric acid values obtained were highest in goats fed diet 3 while the propionic acid values increased in rumen of goats fed diet 1 and 2 because the diets are less fibrous and more digestible. The protozoa population in the rumen of goats on diet 3 was the lowest because of acid intolerance. However, it was not too low to affect the cellulolytic activities of bacteria in the rumen and metabolic activities.

Table 4: Apparent Digestibility of WAD Goats Fed Diet Containing Corncob in Varying Proportions.

Parameters	Diet 1 (0%)	Diet 2 (15%)	Diet 3 (30%)	Diet 4 (45%)	SEM
Dry matter	81.3[a]	80.8[a]	80.7[a]	76.8[b]	1.10
Crude protein	85.2[a]	83.3[b]	83.6[b]	80.2[c]	1.04
Neutral detergent fiber	85.7[a]	80.4[b]	81.2[b]	77.5[c]	1.31
Acid detergent fiber	84.2[a]	82.7[b]	82.3[b]	71.1[c]	1.22
Acid detergent lignin	81.0[a]	78.4[b]	74.5[c]	68.6[d]	1.30
Ether extract	93.8[a]	91.4[b]	92.1[b]	75.7[c]	1.27
Ash	88.7[a]	83.5[c]	86.2[b]	81.8[c]	2.06
Metabolizable energy (MJ/Kg DM)	25.72	25.14	25.09	23.69	0.86

Table 5: Nitrogen Utilization of WAD Goats Fed Diet Containing Corncob in Varying Proportions.

Parameters	Diet 1 (0%)	Diet 2 (15%)	Diet 3 (30%)	Diet 4 (45%)	SEM
Nitrogen intake ($g.d^{-1}$)	2.41[a]	2.48[a]	2.57[a]	2.15[b]	0.11
Nitrogen excretion (g.d-1)					
Faecal	1.10	1.14	1.15	1.25	0.77
Urinary	0.09	0.10	0.08	0.12	0.14
Total	1.19[b]	1.24[b]	1.23[b]	1.37[a]	0.09
Nitrogen balance ($g/Kg\ W^{0.75}.d^{-1}$)	1.16[b]	1.18[b]	1.25[a]	0.83[c]	0.05
Nitrogen retained (%)	50.6[b]	50.0[b]	52.1[a]	36.3[c]	1.32
Nitrogen absorbed (%)	93.1[b]	92.5[b]	94.4[a]	86.7[c]	1.07
Apparent digestibility (%)	54.4[b]	54.0[b]	56.4[a]	41.9[c]	1.14

Table 6: Rumen Fermentation Parameters of West African Dwarf Goats Fed Diets Containing Varying Levels of Corncobs after 6 Hours.

Parameters	T_1 (0%)	T_2 (15%)	T_3 (30%)	T_4 (45%)	SEM
Rumen pH	6.03	6.03	5.84	6.05	0.04
Ammonia nitrogen ($mmol.mL^{-1}$)	886[c]	1019[b]	1036[b]	1123[a]	27.8
Total VFA ($mmol.mL^{-1}$)	214[a]	201[a]	180[a]	131[b]	24.3
Acetic acid ($mmol.mL^{-1}$)	120[b]	137[b]	189[a]	107[b]	18.7
Propionic acid ($mmol.mL^{-1}$)	118[a]	112[a]	105[a]	77[b]	8.4
Butyric acid ($mmol.mL^{-1}$)	136[b]	122[b]	177[a]	105[c]	16.4
Bacteria $x10^6$ $cfu.mL^{-1}$	4.13[a]	4.40[a]	2.95[b]	2.18[b]	0.42
Fungi $x10^6$ $cfu.mL^{-1}$	0.53	0.60	0.45	0.45	0.05
Protozoa ($mL.100mL^{-1}$)	4.50	4.25	3.25	4.00	0.33

abc: Means on the same row with different superscripts differ significantly ($P< 0.05$)

CONCLUSION

The problem associated with scarcity of forages that are available for ruminants during the dry season can be solved by adopting the use of crop residues that are cereal based in compounded ration. This would results to production of feed at least cost and high nutrient profile for livestock productivity. The voluntary dry matter intake, weight gain and rumen fermentation characteristics obtained for the West African Dwarf goats in this study confirmed that corncob can be utilized up to 30 % inclusion level in compounded ration.

REFERENCES

1. Ahamefule, F.O. and C. Elendu. 2010. "Intake and Digestibility of West African Dwarf Bucks Fed Cassava Leaf Maize Offal Based Diets". *J. Anim, Vet*. 9:535-539.

2. Anderson, J.M. and J.S. Ingram. 1979. *Tropical Soil Biology and Fertility: A Handbook of Methods*. 2nd edition. 73 – 74.

3. AOAC. 1990. *Official Method of Analysis. 15th Edition.* Association of Official Analytical Chemists: Washington, DC.

4. Babayemi, O.J. and M.A. Bamikole. 2006. "Effects of *Tephrosia candida* DC Leaf and its Mixtures with Guinea Grass on *in vitro* Fermentation changes as Feed for Ruminants in Nigeria". *Pakistan J. Nutr*. 5(1):14 – 18.

5. Chen, X.B. and M.J. Gomex. 1992. "Estimation of Microbial Protein Supply to Sheep and Cattle Based on Urinary Excretion of Prime Derivative: An Overview of the Technical Details". International Feed Res. Unit, Ronett Res. Inst. Occasional public. Aberdeen, UK. 2 – 20

6. FAO. 1983. *Production Year Book*. Food and Agriculture Organization: Rome, Italy.

7. Gilchrist, S.D.W. 1969. *A Practical Course in Agricultural Chemistry. 1st Edition*. Pergamon Press: New York, NY.

8. Kategile, J.A. 1981. "Digestibility of Low Quality Roughages Supplemented with Concentrate". In: *Utilization of Low Quality Roughages in Africa*. Proceedings of a Workshop held in Arusha, Tanzania. 181-184.

9. Kumar, A., A. Kumar, S. Devi, S. Patil, C. Payal, and S. Negi. 2012. "Isolation, Screening and Characterization of Bacteria from Rhizospheric Soils for Different Plant Growth Promotion (PGP) Activities: An *in vitro* Study". *Recent Res. in Sci. and Tech.* 4(1):1-5.

10. NRC. 1981. *Nutrient Requirement of Goats: Angora, Dairy and Meat Goats in Temperate and Tropical Countries*. No 15..National Academy of Sciences: Washington, D.C. 93 pp.

11. Ososanya, T.O., O.T. Odubola, and A. Shuaib-Rahim. 2013. "Intake, Nutrient Digestibility and Rumen Ecology of West African Dwarf Sheep Fed Palm Kernel Oil and Wheat Offal Supplemented Diet". *Inter. J. of Agri. Sci*. 3(5):380-386.

12. Preston, T.R. 1995. "Tropical Animal Feeding: A Manual for Research Workers". Animal Production and Health Paper 126. FAO: Rome, Italy. http://www.fao.org/DOCREP/003/V9327E/V9327E00.HTM

13. Statistical Analytical Systems (SAS). 1998. *SAS/STAT User's Guide Statistical Analysis Institute Inc. Version 6, 3rd ed.* SAS: Cary, NC. 943 pp.

14. Van Soest, P.J., J.B. Robertson, and B.A. Lewis.1991. "Methods for Dietary Fiber, Neutral Detergent Fiber, and Non-starch Polysaccharides in Relation to Animal Nutrition". *J. Dairy Sci*. 74: 3583–3597.

15. Yousuf, M.B., M.A. Belewu, J.O. Daramola, and N.I. Ogundun. 2007. "Replacing Cotton Seed Cake with Cassava Leaf Meal in Corn Bran Based Diet Fed to the Goat". *Bulgarian J. of Agric. Sci.* 13:231 – 236.

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