Journal of Animal and Veterinary Advances 5 (10): 814-818, 2006

Utilization of Citrus Pulp Based Diets and *Enterolobium cyclocarpum* Foliage (Jacq. Griseb) by West African Dwarf Goats

[1]A.O. Oni, [1]C.F.I. Onwuka, [1]O.O. Oduguwa, [2]O.S. Onifade, [2]O.M. Arigbede and [1]J.E.N. Olatunji
[1]Department of Animal Nutrition, [2]Department of Pasture and Range Mangmt,
College of Animal Science and Livestock Production, University of Agriculture,
P.M.B. 2240, Abeokuta, Ogun State, Nigeria

Abstract: Sixteen West African Dwarf goats weighing 5.0-5.6 kg were used in an experiment that lasted 112 days to investigate the utilization of citrus pulp based diets and *E. cyclocarpum* by West African Dwarf (WAD) goats. A control diet which contained 88.5% Brewers' Dried Grains (BDG) and the three experimental diets in which BDG was replaced by citrus pulp at 25, 50 and 75% levels in the experimental diets, respectively constituted the four treatments. The goats were divided into four treatment groups of four animals each. Each group of animals was then assigned to one of the four different experimental diets formulated. Significant growth rates ($p<0.05$) of 22.14-34.02 gd^{-1} were obtained with the highest growth rate recorded at 50% level of dried citrus pulp inclusion while the growth decreased with increasing levels of dried citrus pulp in the diets. Nitrogen intake (gd^{-1}) decreased significantly ($p<0.05$) with increasing levels of dried citrus pulp in the diets from 45.57-33.28 and was lowest in the control diet. Nitrogen retention also followed similar trend, being highest (42.07 gd^{-1}) at 25% level of dried citrus pulp replacement in the diet. The Packed cell volume, haemoglobin concentration, red blood cells, white blood cells and total blood protein were significantly ($p<0.05$) different across the dietary treatments at the start and end of the trial. The values for PCV, Hb, RBC, MCH, glucose and total protein decreased significantly ($p<0.05$) different in the control diet. Serum Glutamate Pyruvate Transaminase (SGPT) values also increased significantly ($p<0.05$) with increasing levels of dried citrus pulp in the diets at the end of the experiment and were highest (6.50 IU/L) at 75% level of citrus pulp. Therefore, the efficient utilization of citrus pulp and *E. cyclocarpum* by WAD goats was attained at the 50% level of inclusion in the diets.

Key words: Growth rate, nitrogen retention, serum glutamate pyruvate transaminase

INTRODUCTION

Agricultural wastes from crops in the rural, sub-urban and industrial settlements have often constituted health hazards due to inadequate means of disposal. Most agricultural wastes can therefore potentially contribute to pollution. Projected increases in agricultural production in Nigeria suggest that unless adequate plans are made to channel agro-industrial wastes into productive systems, it may become increasingly difficult to dispose of large quantities of these without an unfavourable repercussion on the environment. The systems of small ruminant production in West Africa, especially in Nigeria, are usually characterized by limitation posed by non-availability of year-round feed resources due to usually prolonged dry season Aina[1]. Certain small ruminant production systems are therefore adopted by livestock owners in Nigeria to cope with the problem of feed scarcity. Livestock production especially cattle, sheep and goats, which are capable of converting otherwise waste items into useful products such as meat, milk and skin offers a good method of using these by-products and preventing pollution. However, since citrus pulp is more available in the dry season as waste product when there is scarcity of feed, its use as dry season feed for ruminant animals deserves attention. The animals that offer the best scope for production using citrus pulp are the ruminants. They can cope with the most varied range of by-products and their feed requirements are the least competitive with those of man and monogastric animals.

MATERIALS AND METHODS

This study was conducted in the Small Ruminant Experimental Unit, College of Animal Science and Livestock Production of the University of Agriculture, Abeokuta, Nigeria. Sixteen West African Dwarf (WAD) goats of both sexes, with average live weight of 5.3±kg were used for this study and the animals were housed intensively in well-ventilated individual pens. They were

Corresponding Author: A.O. Oni,, University of Agriculture, College of Animal Science and Livestock Production, PMB 2240, Abeokuta, Ogun State, Nigeria

Table 1: Composition of experimental concentrate diets (%)

	Treatments			
	Diet 1	Diet 2	Diet 3	Diet 4
		25% DCP	50% DCP	75% DCP
Ingredients	Control	75% BDG	50% BDG	25% BDG
Brewers' Dried Grains (BDG)	88.5	66.37	44.25	22.13
Dried Citrus Pulp (DCP)	0	22.13	44.25	66.37
Non-dehydrated molasses	5.0	5.0	5.0	5.0
Urea	5.0	5.0	5.0	5.0
Salt	1.0	1.0	1.0	1.0
Premix	0.5	0.5	0.5	0.5
Total	100	100	100	100
Calculated analysis				
Dry matter	83.06	84.37	83.01	8 2 . 6 4
Crude protein	23.88	21.68	18.05	19.44
Crude fibre	15.57	12.44	15.52	14.61
Ether extract	1.35	1.47	2.41	2.35
Ash	14.45	16.17	11.17	10.82
NFE	32.10	39.88	46.56	41.23

dewormed with albendazole and treated against ectoparasites with Ivomec. The animals were maintained on forage grass (*Panicum maximum*) and concentrate supplement with a gradual replacement of the grass with *E. cyclocarpum* leaves during equilibration. The control diet contained 88.5% Brewers' Dried Grains (BDG) and in the experimental diets, Dried Citrus Pulp (DCP) replaced 25, 50 and 75% of the BDG.

Other ingredients in the diets included non-dehydrated molasses, urea, salts and vitamin/mineral premix (Table 1). After the equilibration period, the animals were divided into four treatment groups of four animals each. Each group of animals was then assigned to one of the four different experimental diets formulated. The basal feed of *E. cyclocarpum* was harvested every evening and allowed to wilt before feeding to the animals the following day. Each animal was kept and fed in a separate cage during the entire experimental period of 112 days.

DATA COLLECTION

Growth and digestibility parameters: To monitor the growth of the animals in response to the experimental treatments, pre-experimental body weights of the animals were taken after which the animals were weighed prior to feeding on a weekly basis to determine the weight changes. Feeds offered daily per animal were recorded and refusals every following morning were weighed and recorded to compute feed intake on daily basis. Faeces and urine were collected separately during the last seven days in metabolic cages with provision for separate collection of urine and faeces for digestibility and nitrogen balance studies. Urine samples were collected each morning just before feeding at 08.00 h in sample bottles rinsed with H_2SO_4. These were stored in the refrigerator at-5°C for analyses of nitrogen content.

Blood parameters: Blood samples were collected from each animal at the commencement and end of the experiment, via jugular vein puncture using hypodermic syringe and needle in the morning before feeding the animals. The blood samples collected were drawn into sample bottles containing Ethylene Diamine Tetra-Acetic Acid (EDTA) anti-coagulant. Sample bottles were labelled daily and taken to the laboratory for analysis of haematological parameters such as Packed Cell Volume (PCV), Haemoglobin Concentration (Hb), White Blood Cells (WBC), Red Blood Cells (RBC), serum protein, serum glucose, Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC), Serum Glutamate Oxalate Transaminase (SGOT) and Serum Glutamate Pyruvate Transaminase (SGPT). The packed cell volume was measured for each animal in fresh Ethylene Diamine Tetra Acetic Acid (EDTA) anti-coagulant samples within 24 h of collection using the micro haematocrit method. Haemoglobin concentration was also measured in fresh EDTA anti-coagulant samples using the Sahl's (acid haematin) method Benjamin[2]. WBC and RBC were measured in fresh EDTA with the aid of Neubaur counting chamber (Haemocytometer). Plasma glucose was measured in fluoride oxalate anti-coagulant blood samples using the enzymatic glucose oxidase method Bauer [3]. MCH and MCHC values were calculated from PCV, Hb and RBC values Jain[4]. Total serum protein was measured in serum for individual animal using the biuret method. Serum Glutamate Pyruvate Transaminase and Serum Glutamate Oxalate Transaminase were analysed spectrophotometrically by using commercially available diagnostic kits (Randox® Test Kits).

Statistical analysis: All data were laid out as Completely Randomized Design and analyzed with one-way Analysis of Variance using SPSS[5].

RESULTS AND DISCUSSION

Table 2 shows the growth performance of WAD goats fed graded levels of citrus- pulp based diets. The total weight gain was between 2.48 and 3.83 Kg while the values for total weight gain were significantly different

Table 2: Performance characteristics of wad goats fed graded levels of citrus pulp- based diets

	Levels of replacement of BDG with DCP				
Nutrients intake	0%	25%	50%	75%	SEM
Number of animals /treatment	4	4	4	4	
Average initial live weight (kg)	5.00^{c}	5.60^{a}	5.30^{b}	5.10^{bc}	0.06
Average final live weight (kg)	8.19^{b}	9.06^{a}	9.13^{a}	7.58^{c}	0.20
Average metabolic weight ($LWkg^{0.75}$)	3.34^{b}	3.64^{a}	3.49^{b}	3.39^{b}	0.05
Total weight gain (kg)	3.19^{a}	3.46^{a}	3.83^{a}	2.48^{b}	0.19
Growth rate ($g.d^{-1}$)	28.48^{a}	30.89^{a}	34.20^{a}	22.14^{b}	1.73
Average total intake (Kg)	57.01	59.99	66.44	55.34	0.03
Average daily intake ($g.d^{-1}$)	509.03	535.71	593.19	494.14	31.45
Feed conversion ratio	17.87^{b}	17.34^{b}	17.34^{b}	22.32^{a}	0.86

a,b,c -Means on the same row having different superscripts are significantly ($p<0.05$) different

Table 3: Nitrogen utilization by WAD goats fed citrus pulp-based diets ($g.d^{-1}$)

	Levels of replacement of BDG with DCP				
Parameters	0%	25%	50%	75%	SEM
Nitrogen intake	33.12^{b}	45.57^{a}	43.89^{a}	33.28^{b}	0.61
Faecal N-output	2.85^{b}	3.27^{b}	4.21^{a}	3.39^{b}	0.20
Urinary N-output	0.21	0.24	0.31	0.23	0.03
Total N-output	3.05^{b}	3.50^{b}	4.51^{a}	3.62^{b}	0.22
Nitrogen retention	30.07^{c}	42.07^{a}	39.38^{b}	29.66^{c}	0.41
Nitrogen retention (%)	90.83^{ab}	92.32^{a}	89.73^{b}	89.18^{b}	0.47

a,b,c -Means on the same row having different superscripts are significantly ($p<0.05$) different

($p<0.05$) between treatment 4 and other treatments. The growth rate followed similar trend with treatment 3 having the highest value of 34.20 $g.d^{-1}$. The weight gains reported in this study fell far below those reported for goats on different diets. For instance, Adeloye[6] has reported gains of between 70.46-134.76 $g.d^{-1}$ for young male WAD goats fed on concentrate diets. It, however, fell within figures reported by Adejumo[7] who reported daily gains of between 24.36-33.13 $g.d^{-1}$ for WAD goats fed graded levels of *L. leucocephala* as supplements to Guinea grass. Ifut[8] reported between 25.7-66.3 $g.d^{-1}$ for WAD goats fed *G. sepium*, *P. maximum* and cassava peels mixture. Similarly, Mba[9] reported daily live weight change of between 27-49 $g.d^{-1}$ for Fouta Djallon WAD kids fed concentrate supplementation with *Gliricidia sepium*. The result obtained in this study may be attributed to increased crude protein intake. Kay and MacDearmid[10] indicated that a dietary crude protein content of 11% was ideal for normal weight gain by sheep and goats. The lower growth rate recorded in treatment 4 may be attributed to lowered DM intake of the animals.

The N-intake values were similar between 25 and 50% dried citrus pulp replacements but the reduction became significant at 75% DCP replacement treatment (Table 3). Nitrogen retention ($g.d^{-1}$) decreased with increasing levels of citrus pulp replacement in the diets. All the animals were in a positive nitrogen balance. There were significant ($p<0.05$) differences between the nitrogen intake of the control and the 25 and 50% levels of DCP in the rations while the values between the control and 75% were similar. The highest nitrogen intake and retention values were recorded with the 25% level of DCP in the diets. The mean faecal nitrogen increased significantly ($p<0.05$) from the control to the 25 and 50% levels of citrus pulp inclusion and subsequently decreased at the 75% level though not significantly different ($p>0.05$) from the control and 25% levels of citrus pulp inclusion. The value of 4.21 g kg^{-1} at 50% level was similar to the values of 4.10 g kg^{-1} DM and 4.3 g kg^{-1} DM reported by Majumdar[11] and Akinsoyinu[12], respectively. The high nitrogen retention was because of high digestibility of the nutrients in the dietary treatments. Arigbede[13] reported that low dry matter intake of animals resulted in maximal utilization of nutrients which are present in the foliage within the body system of animals. Nitrogen could not be stored within the body system of animals; high levels of N-intakes via high DM intake will result in wastage of N-consumed through belching or rumination while low intakes will ensure maximal utilization of the nitrogen in the feed. The result obtained in this trial was in contrast with the report of Adu[14] who observed that rams on the 25% BDG diet retained more nitrogen and utilized the nitrogen better than those on the control.

At the commencement of the trial, there were significant differences ($p<0.05$) in the Packed Cell Volume (PCV), Haemoglobin Concentration (Hb), Red Blood Cell (RBC), Total protein and the Serum Glutamate Oxalate Transferase (SGOT) across the treatments (Table 3). At the end of the experiment, PCV, Hb, RBC, Total Protein and SGPT increased significantly ($p<0.05$) with increasing levels of citrus pulp replacement in the diets compared with the control diet. The packed cell volume, Haemoglobin concentration, Red blood cells and blood total protein were significantly ($p<0.05$) different across the dietary treatments at the commencement and end of the experiment. However, the result showed that there were significant ($p<0.05$) increases in the blood PCV between the citrus-based diets and the control. PCV in this study was higher than 25.7±3.1 (%) obtained for Red Sokoto goats Tambuwal[15]. Earlier report in Baladi goats Azab and Abdel-Maksoud[16] showed a PCV value of 27.25±0.59. The negative value recorded in the control showed that the animals in this treatment did not utilize the dietary protein maximally and this further affects the

Table 4: Blood parameters of WAD goats fed citrus pulp based diets

	Levels of replacement of BDG with DCP												
	0%			25%			50%			75%			
Parameters	Start	End	Difference	Start	End	Difference	Start	End	Difference	Start	End	Difference	SEM
PCV %	30.00^{a}	29.00^{b}	-1.00	29.75^{ab}	30.00^{b}	0.25	27.59^{ab}	31.25^{ab}	3.75	31.50^{a}	35.50^{a}	s4.00	0.95
Hb (g/dl)	10.03^{a}	9.40^{b}	-0.63	9.93^{ab}	10.13^{b}	0.20	9.13^{b}	10.13^{b}	1.00	10.60^{a}	12.35^{a}	1.75	0.32
RBC x 10^{12}/l	3.33^{ab}	3.33^{b}	0.00	3.33^{ab}	3.35^{b}	0.02	3.10^{b}	3.55^{b}	0.45	3.55^{a}	4.10^{a}	0.55	0.11
MCH (µµg)	30.50	29.25	-1.25	29.50	30.50	1.00	30.00	29.75	-0.25	29.50	29.50	0.00	0.35
MCHC (%)	33.50	33.50	0.00	29.50	34.00	4.50	33.50	33.50	0.00	33.50	33.50	0.00	0.22
WBC x 10^{9}/l	6.20	5.40	-0.80	6.20	5.40	-0.8	6.1	6.6	0.5	5.9	5.2	-0.7	1.48
Glucose (mg/dl)	57.50	56.50^{b}	-1.00	55.50	56.50^{b}	1.00	52.50	60.50^{b}	8.00	60.00	70.00^{a}	10.00	2.19
Total Protein (mg/dl)	47.75^{a}	45.50^{b}	-2.25	47.50^{a}	47.50^{b}	0.00	43.25^{b}	50.25^{b}	7.00	50.50^{a}	57.25^{a}	6.75	1.45
SGOT (IU/L)	6.00^{a}	6.50	0.50	5.50^{a}	6.00	0.50	4.50^{b}	6.25	1.75	6.00^{a}	7.00	1.00	0.33
SGPT (IU/L)	4.50	4.50^{b}	0.00	4.50	4.50^{b}	0.00	4.50	5.25^{b}	0.75	5.50	6.50^{a}	1.00	0.32

a, b = means on the same row having different superscripts are significantly ($p<0.05$) different

build up of red blood cells. Hb values in this study fell within the range of high values of 7-15, 9.8±0.3 and 11.4±1.6 g dL^{-1} reported by Daramola[17], Tambuwal[15] and Oduye and Adadevoh[18], respectively. West African Dwarf goats seem to possess relatively high Hb values and this is an advantage in terms of the oxygen carrying capacity of the blood. Haemoglobin concentration, which was reduced in the control diet, showed that the animals in this treatment were in short supply of oxygen. However, significant differences ($p<0.05$) occurred at the end of the experiment for blood glucose with the 75% citrus pulp replacement having the highest level of significance with the exception of treatments 2 and 3. This result did not agree with that of Bhattacharya and Harb[19] who reported that there was no significant ($p>0.05$) difference in the blood glucose among treatments fed at 0, 20, 40 and 60% levels of citrus pulp inclusion in the rations.

The SGOT was within the range of 2-22 IU/litre reported by Daramola[17] but lower than the value of 8.9±0.9 reported by Tambuwal[15]. The SGPT was, however, different from the values of 12-38 and 20.9±1.2 reported by Daramola[17] and Tambuwal[15], respectively. These differences might be the effect of the *E.cyclocarpum*, which contained the anti-nutritional factor, saponin. The concentration of SGPT in the blood was highest (6.50 U/L) at 75% levels of citrus pulp and this may partly account for the low performance characteristics demonstrated by animals in this treatment as liver enzymes are known to be high in the blood when the nutrient intake is low.

CONCLUSION

Citrus pulp inclusion at 50% therefore produced better growth performance, nitrogen retention and blood profile, indication that citrus pulp inclusion should not exceed 50 while 75% inclusion level of citrus pulp retards growth and interferes with proper nutrient utilization. However, further studies should be carried out on the feeding quality of *E. cyclocarpum* as indigenous multipurpose tree specie suitable for the sustenance of small ruminants in the dry season.

REFERENCES

1. Aina, A.B.J., O.A. Oladotun and E.B. Oguntona, 2003. Evaluation of formulated agro-industrial wastes as dry season feed for sheep. Nig. J. Anim. Prod., 30: 71-80.
2. Benjamin, M.M., 1978. Outline of veterinary clinical pathology. 2nd Edn. Iowa State. University Press, Iowa, U.S.A., pp: 35-105.
3. Bauer, T.D., P.G. Ackermann and G. Toro, 1974. Methods in clinical chemistry. Clinical laboratory methods. The C.V. Mosley Company, Saint Louis, pp: 946.
4. Jain, N.C., 1986. Schalman's Veterinary Haematology. 4th edition Lea and Babings, Philadelphia. P.A., U.S.A., pp: 208-224.
5. SPSS, 1999. Statistical Package for Social Sciences. Procedures and facilities for release. McGraw-Hill Book Co. NY.
6. Adeloye, A.A., 1983. Calcium and phosphorus utilization by WAD goats in Nigeria. Ph.D Thesis. University of Ibadan, pp: 180.
7. Adejumo, J.O., 1987. Effect of graded levels of *Leucaena leucocephala* cv. Cunningham on feed intake and growth of WAD goats. J. Anim. Prod. Res., 7: 65-73.
8. Ifut, O.J., 1992. Body weight response of West African Dwarf goats fed *Gliricidia sepium*, *Panicum maximum* and cassava (*Manihot*) peels. In: The complementarity of feed resources for animal production in Africa. Proceedings of the joint feed resources networks workshop held in Gaborone, Botswana. Edited by Stares, J.E., Said, A.N. and Kategile, J.A.

9. Mba, A.U., S.A. Manigni and A.A. Awah, 1982. Influence of concentrate supplementation with browse plant (*Gliricidia sepium*) on nutrient utilization and growth of West African Dwarf (Fouta Djallon) kids. Nigerian J. Anim. Prod., 9: 63-73.
10. Kay, M. and E. MacDearmid, 1973. A note on the effects of changing the concentration of protein in the diet of fattening beef cattle. Anim. Prod., 10: 205-207.
11. Majumdar, B.N., 1960. Studies on goats' nutrition. Part 1. Minimum protein requirements of goats for maintenance-endogenous urinary nitrogen and metabolic faecal nitrogen studies. J. Agric. Sci. Camb., 54: 329-334.
12. Akinsoyinu, A.O., 1974. Studies on protein and energy utilization by the West African Dwarf goats. Ph.D Thesis. University of Ibadan, Nigeria.
13. Arigbede, O.M., 1998. Potentials of some indigenous multi-purpose tree species for livestock feeding in south western Nigeria. Ph.D. thesis, University of Ibadan, Ibadan, Nigeria.
14. Adu, I.F., 1985. Utilization of graded levels of Brewers' dried grains by growing -finishing sheep. J. Anim. Prod. Res., 5: 59-66.
15. Tambuwal, F.M., B.M. Agale and A. Bangana, 2002. Haematological and biochemical values of apparently healthy Red Sokoto goats. Proceedings of 27th Annual Conference Nigerian Soc. Anim. Prod. (NSAP), FUTA, Akure, Nigeria, pp: 50-53.
16. Azab, M.E. and H.A. Abdel-Maksoud, 1999. Changes in some haematological and biochemical parameters during pre-partum and post-partum periods in female Baladi goats. Small Ruminant Res., 34: 77-85.
17. Daramola, J.O., A.A. Adeloye, T.A. Fatoba and A.O. Soladoye, 2005. Haematological parameters of West African Dwarf goats. Livestock Research for Rural Development, pp: 17. Retrieved from http://www.cipav.org.co/lrrd17/8/dara 17095/htw.
18. Oduye, O.O. and B.K. Adadevoh, 1976. Biochemical values of apparently normal Nigerian sheep. Nigerian Vet. J., 5: 43-50.
19. Bhattacharya, A.N. and M. Harb, 1973. Dried Citrus pulp as a grain replacement for Awassi Lambs. J. Anim. Sci., 36: 1175-1180.