

RUMEN METABOLISM AND ECONOMIC ANALYSIS OF RED SOKOTO BUCKS FED VARYING INCLUSION LEVELS OF WYNN CASSIA (*Chamaecrista rotundifolia*) MEAL DIET

A. G. BALA*¹, M. R. HASSAN², R. J. TANKO³, S. B. ABDU², S. S. BELLO², U. B. IBRAHIM², Y.M. ISHIAKU³, S.A. AHMED³, H IBRAHIM³ AND M. A MIJINYAWA⁴

¹Division of Agricultural Colleges, College of Agriculture and Animal Science, Ahmadu Bello University, Mando, Kaduna State, Nigeria.

²Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria.

³National Animal Production Research Institute, Shika, Ahmadu Bello University, Zaria, Nigeria.

⁴Sa'adatu Rimi College of Education, Kano State, Nigeria.

*Corresponding author: agbala@abu.edu.ng ; 08068928548

ABSTRACT

An experiment was carried out to investigate the rumen metabolism and economic analysis of Red Sokoto bucks fed varying inclusion levels of *Chamaecrista rotundifolia* (CR) meal diet. The experiment consisted of 12 Red Sokoto bucks which were balanced for weight and assigned to four dietary treatments containing varying inclusion levels of CR meal (0, 25, 50 and 75%). The bucks were individually pen-fed with the experiment diets at 3% body weight with three bucks per treatment in a Complete Randomize Design for a period of 90 days. Results of this experiment showed that, there was no significant difference ($P>0.05$) in rumen pH across all the treatment groups. There was a significant decrease ($P<0.05$) in the total volatile fatty acids (TVFAs) in bucks fed control diet compared to those fed 75% CR inclusion level (12.68 vs. 14.32 mmol/L). Also, there was a significant increase ($P<0.05$) in ammonia nitrogen ($\text{NH}_3\text{-N}$) with 25% CR inclusion level compared to with 75% CR inclusion level (29.01 vs. 26.76 mg/100ml). However, there is a decrease in the cost of feed/kg gain at 75% inclusion level compared to the control group (N190.60 vs. N942.38). It was hence, revealed from this study that farmers under smallholder production system could include CR meal up to 75% in the diet of Red Sokoto bucks for better performance and reduction in the cost of production without any detrimental effect on rumen metabolites of the animals. Thereby, increasing profit and betters the living standard of farmers in Nigeria.

Keywords: *Chamaecrista*, economic, performance, profit, Red Sokoto bucks.

INTRODUCTION

One of the major constraints to livestock production in Nigeria is lack of feeds, especially during the dry season (Aregawi *et al.*, 2013), which results to the free roaming of livestock in the streets of major towns and cities in Nigeria. Smallholders in sub-Saharan Africa depend mainly on the fermentation of fibrous feeds to provide the protein and energy needs of their livestock because of the limited supply and high cost of conventional protein and energy supplements (Osuji *et al.*, 1993). Sources of cheaper alternative forages of high quality for ruminant livestock production have been a subject of research in the recent years (Alan *et al.*, 2013), especially for small scale livestock producers in tropical areas who still do not realize the advantages of incorporating pastures

into farming due to lack of awareness (Hassan *et al.*, 2015). Their inclusion in the diets could help reduce feed cost and competition between man and the livestock industry for the available conventional feedstuffs.

One of the alternatives that could be considered by smallholder farmers is the incorporation of promising forage legumes such as Wynn cassia. Wynn cassia also known as round-leaf cassia, has been identified as a promising material for 'fodder bank' production with a dry matter production of 2.84t/ha per year and crude protein of 10.7% under rain fed condition (Tarawali, 1994). Despite the availability of information on general feeding management of goats, there is little information on the effective utilization of varying levels of Wynn cassia meal diet in the feeding managements of Red Sokoto bucks. The

main objective of this research was to determine the rumen metabolism and economic analysis of Red Sokoto bucks fed varying inclusion levels of Wynn cassia meal diet.

MATERIALS AND METHODS

Experimental Site

The feeding and rumen metabolism study was conducted at the Animal Science Department, Teaching and Research Farm, Faculty of Agriculture, Ahmadu Bello University, Zaria, Kaduna State. The farm is located at an elevation of 676m and latitude of 11.2° North and longitude of 007.6° East (Ovimaps, 2014).

Experimental design and animal's management

Twelve (12) Red Sokoto bucks of average initial weight ranging between 8.56-10.38±0.1 kg were used. The animals were balanced for initial weights before they were allocated to four treatments diets with three bucks per treatment in a Completely Randomize Design (CRD). After arrival from Giwa market, the bucks were dewormed with Albendazole® against internal parasites and were allowed 14 days adaptation period before the actual start of the experiment.

Experimental feeds and treatments

Four dietary treatments containing varying levels of *Chamaecrista rotundifolia* meal (0, 25, 50 and 75% inclusion) in the diets containing 12% crude protein were used for the experiment. The bucks were fed individually once by 8.00am at 3% body weight for the period of 90 days. All bucks were weighed at the beginning of the experiment and fortnightly thereafter to determine the liveweight changes and to adjust the amount of feed offered for the periods of confinement. Fresh drinking water was provided *ad libitum*.

Measurement of rumen metabolites

Rumen fluid samples were collected by aspiration method using stomach tube at the end of the 90 day feeding from the three animals in each treatment at 6hours posts feeding for determination of rumen fluid pH, TVFAs and NH₃-N. The rumen fluid pH was recorded immediately using Philips digital pH. The fluid was then strained through cheese cloth before 20mL of the filtrate was collected and mixed with an equal volume of 0.1M H₂SO₄ into plastic containers to trap ammonia and lower the bacterial activity. The mixture was centrifuged at 3000rpm for 10 minutes. Then about 20 mL of

the supernatant was decanted into plastic bottles and kept in a deep freezer (20°C) until when required for analysis of TVFAs and rumen NH₃-N by steam distillation method following the procedure of Trinh *et al.* (2009).

Economic analysis

The cost – benefit analysis of the experimental diets was done by the addition of the cost of all ingredients in each diet in comparison to the metabolic weight gain in the diets to determine the profitability of replacing *C. rotundifolia* meal in the diet of Red Sokoto bucks. The cost of *C. rotundifolia* forage per kilogram was estimated based on the total expenditure used in production of the legume while the other cost of the various feed ingredients were estimated based on feed cost per kg at prevailing market prices.

Chemical analysis

Samples of *C. rotundifolia* forage which was milled using the feed milling machine and feed samples were analysed for chemical composition using the method described by AOAC (2005) at the Biochemistry Laboratory, Animal Science Department, A.B.U, Zaria. Dry matter, Crude fibre, Crude protein, Nitrogen free extract, Ether extract and Ash contents were analysed. The Acid detergent fibre and Neutral Detergent fibre were determined by the method of Van Soest (1991).

Statistical analyses

Data collected were analyzed using Analysis of Variance (ANOVA) by General Linear Model, procedure of Statistical Analysis System (SAS, 2003). The treatment means were separated using Dunnet's Test. The model used is presented as follows: $X_{ij} = \mu + \alpha_i + e_{ij}$

Where X_{ijk} = Any observation, μ = Population mean, α_i = Treatment effect, e_{ijk} = Random error

RESULTS AND DISCUSSION

Table 3 showed the result of rumen pH, ammonia nitrogen and total volatile fatty acids (TVFAs) of Red Sokoto bucks fed the experimental diets. There was no significant difference ($P>0.05$) in rumen pH across all the treatment groups. The pH values obtained in this study were within the range of 6.0 -7.0 for effective cellulolytic bacterial activity in the rumen (Ndlovu and Hove, 1995). The pH value indicates *C. rotundifolia* (CR) meal to be efficient in maintenance of rumen environment without deleterious effect on rumen pH (Topps, 1995).

The highest pH value (7.10) was observed at 75% CR inclusion level. This could be due to high buffering capacity and rate of degradation of N in this treatment, which might facilitated the growth of cellulolytic bacteria and overall performance of the bucks (Anbarasu *et al.*, 2002). The level of TVFAs increased with increasing level of CR inclusion ($P < 0.05$). There was a significantly lower ($P < 0.05$) TVFAs in bucks fed control diet (0% CR inclusion level) compared to those with 75% CR inclusion level (12.68 vs. 14.32). The results agree with the report of Topps (1995) that addition of forage legumes in the diet of ruminant livestock help to increase the production of volatile fatty acids due to increased fermentation in the rumen. However, there was a significant increase in ammonia N with 25% CR inclusion level compared to with 75% CR inclusion level (29.01 vs. 26.76 mg/100ml). However, the rumen ammonia N observed in the study was higher than the value (2-8 mg/100ml) reported for high producing ruminant livestock (Ndlovu and Hove, 1995), indicating that there was high degradation of the experimental diet in the rumen.

Table 4 shows the economic analysis of varying inclusion levels of (CR) meal diet fed to Red Sokoto bucks. The results indicate that feed cost/kg was higher at 0% CR inclusion level compared to 75% CR inclusion level (N44.30 vs. N39.22). The cost of feeding per buck was higher at the control group compared to at 75% CR inclusion level (N310.98 vs. N181.07). The result further indicated that there was significant increase ($P < 0.05$) in weight gain in bucks fed at 75% CR inclusion level diet compared to those fed the control diet (2.85 vs. 0.99kg) which resulted to a decrease in the cost of feed/kg gain at 75% inclusion level compared to the control group (N190.60 vs. N942.38). The Higher cost of feed/kg gain in the bucks fed the control group might be explained by the fact that it contained 100% cotton seed cake which is more expensive (Olomola *et al.*, 2008) when compared to CR meal.

CONCLUSION

From the result obtained in this study, it is concluded that farmers could include *Chamaecrista rotundifolia* meal up to 75% in the diet of Red Sokoto bucks for better performance and reduction in the cost of production without

any detrimental effect on rumen metabolites of the animals.

REFERENCES

- Alan, J. L., Gavin, D. K., Robert, G. D., Gavin, J. P. and Hayley, C. N. (2013). The potential of a salt-tolerant plant (*Distichlis spicata* cv. NyPa Forage) to treat effluent from inland saline aquaculture and provide livestock feed on salt-affected farmland. *Science of the Total Environment*, 445-446:192-201
- Anbarasu, C., Dutta, N., Sharma, K. and Naulia, U. (2002). Blood- biochemical profile and rumen fermentation pattern of goats fed leaf meal mixture or conventional cakes as dietary protein supplements. *Asian- Australian journal of Animal Science* 15:665-670.
- AOAC, (2005). Official Methods of Analysis of Association of Official Analytical Chemist, 17th Edition, Washington D. C., U. S. A.
- Aregawi, T., Animut, G. and Kassa, H. (2013). Utilization and nutritive value of sesame (*Sesamum indicum* L.) straw as feed for livestock in the North western lowlands of Ethiopia. *Livestock Research for Rural Development*. (25), 124.
- Hassan, M. R., Muhammad, I. R., Amodu, J. T., Jokthan, G. E., Abdu, S. B., Adamu, H. Y., Musa, A., Braimah, Y., Abubakar, M. Y. and Abubakar, S. A. (2015). Small Holder Irrigated Forage Production: A neglected option for improved livestock productivity in the northzone of Nigeria. *Nigerian journal of Animal Science*, Vol. 17 (2): 233-250.
- Ndlovu, L. R. and Hove, L. (1995). Intake, digestion and rumen parameters of goats fed mature veld hay ground with deep poultry manure and supplemented with graded levels of poorly managed groundnut hay. *Livestock Research for rural Development*. 6(3) Retrieved, from <http://www.Irrd.org/irrd19/9/ngon19129.htm> on 1st january, 2013.
- Olomola, O.O., Babayemi, O.J and Akinsoyinu, A.O. (2008) Performance characteristics and nitrogen utilization of pregnant West African Dwarf Goats fed Groundnut cake, urea and rumen epithelial wastes in cassava flour and citrus pulp-based diets. *Tropical and subtropical Agroecosystems*, 8: 61 – 67.
- Osuji, P. U., Nsahli, I. V. and Khalil, H. (1993). *Feed evaluation*. ILCA manual 5 : ILCA, Addis Ababa Ethiopia. 40.

The highest pH value (7.10) was observed at 75% CR inclusion level. This could be due to high buffering capacity and rate of degradation of N in this treatment, which might facilitated the growth of cellulolytic bacteria and overall performance of the bucks (Anbarasu *et al.*, 2002). The level of TVFAs increased with increasing level of CR inclusion ($P < 0.05$). There was a significantly lower ($P < 0.05$) TVFAs in bucks fed control diet (0% CR inclusion level) compared to those with 75% CR inclusion level (12.68 vs. 14.32). The results agree with the report of Topps (1995) that addition of forage legumes in the diet of ruminant livestock help to increase the production of volatile fatty acids due to increased fermentation in the rumen. However, there was a significant increase in ammonia N with 25% CR inclusion level compared to with 75% CR inclusion level (29.01 vs. 26.76 mg/100ml). However, the rumen ammonia N observed in the study was higher than the value (2-8 mg/100ml) reported for high producing ruminant livestock (Ndlovu and Hove, 1995), indicating that there was high degradation of the experimental diet in the rumen.

Table 4 shows the economic analysis of varying inclusion levels of (CR) meal diet fed to Red Sokoto bucks. The results indicate that feed cost/kg was higher at 0% CR inclusion level compared to 75% CR inclusion level (N44.30 vs. N39.22). The cost of feeding per buck was higher at the control group compared to at 75% CR inclusion level (N310.98 vs. N181.07). The result further indicated that there was significant increase ($P < 0.05$) in weight gain in bucks fed at 75% CR inclusion level diet compared to those fed the control diet (2.85 vs. 0.99kg) which resulted to a decrease in the cost of feed/kg gain at 75% inclusion level compared to the control group (N190.60 vs. N942.38). The Higher cost of feed/kg gain in the bucks fed the control group might be explained by the fact that it contained 100% cotton seed cake which is more expensive (Olomola *et al.*, 2008) when compared to CR meal.

CONCLUSION

From the result obtained in this study, it is concluded that farmers could include *Chamaecrista rotundifolia* meal up to 75% in the diet of Red Sokoto bucks for better performance and reduction in the cost of production without

any detrimental effect on rumen metabolites of the animals.

REFERENCES

- Alan, J. L., Gavin, D. K., Robert, G. D., Gavin, J. P. and Hayley, C. N. (2013). The potential of a salt-tolerant plant (*Distichlis spicata* cv. NyPa Forage) to treat effluent from inland saline aquaculture and provide livestock feed on salt-affected farmland. *Science of the Total Environment*, 445-446:192-201
- Anbarasu, C., Dutta, N., Sharma, K. and Naulia, U. (2002). Blood- biochemical profile and rumen fermentation pattern of goats fed leaf meal mixture or conventional cakes as dietary protein supplements. *Asian- Australian journal of Animal Science* 15:665-670.
- AOAC, (2005). Official Methods of Analysis of Association of Official Analytical Chemist, 17th Edition, Washington D. C., U. S. A.
- Aregawi, T., Animut, G. and Kassa, H. (2013). Utilization and nutritive value of sesame (*Sesamum indicum* L.) straw as feed for livestock in the North western lowlands of Ethiopia. *Livestock Research for Rural Development*. (25), 124.
- Hassan, M. R., Muhammad, I. R., Amodu, J. T., Jokthan, G. E., Abdu, S. B., Adamu, H. Y., Musa, A., Braimah, Y., Abubakar, M. Y. and Abubakar, S. A. (2015). Small Holder Irrigated Forage Production: A neglected option for improved livestock productivity in the northzone of Nigeria. *Nigerian journal of Animal Science*, Vol. 17 (2): 233-250.
- Ndlovu, L. R. and Hove, L. (1995). Intake, digestion and rumen parameters of goats fed mature veld hay ground with deep poultry manure and supplemented with graded levels of poorly managed groundnut hay. *Livestock Research for rural Development*. 6(3) Retrieved, from <http://www.lrrd.org/lrrd19/9/ngon19129.htm> on 1st January, 2013.
- Olomola, O.O., Babayemi, O.J and Akinsoyinu, A.O. (2008) Performance characteristics and nitrogen utilization of pregnant West African Dwarf Goats fed Groundnut cake, urea and rumen epithelial wastes in cassava flour and citrus pulp-based diets. *Tropical and subtropical Agroecosystems*, 8: 61 – 67.
- Osuji, P. U., Nsahli, I. V. and Khalil, H. (1993). *Feed evaluation*. ILCA manual 5 : ILCA, Addis Ababa Ethiopia. 40.

- Ovimaps, (2014). Ovilocation map;ovi earth imaginary date, February, 2014.
- SAS, (2003) .SAS/STAT. Guide for personal computer version, 6th Edition. Statistical Analysis System Institute, Inc. Cary, North Carolina, USA.
- Tarawali, S.A. (1994). The yield and persistence of selected forage legumes in subhumid and semi-arid West Africa. *Tropical Grasslands* 28:80-89.
- Topps, J. H. (1995). Forage legumes as protein supplements to poor quality diets in the Semi-Arid tropics. In : Wallace, R. J. and Lahlou- Kassi, A. (1995). Rumen Ecology Research Planning. *Proceedings of a workshop held at ILRI, Addis Ababa, Ethiopia*, 259pp.
- Trinh, P. H., Ho, Q. D., Preston, T. R. and Leng, R. A. (2009). Nitrate as fermentable nitrogen supplement for goats fed forage based diets low in true protein. *Livestock Research for Rural Development*. 21 (10)
- Van Soest, J. P. (1991). The Use of Detergents in the Analysis of Fibrous Feeds. Determination of Plant Constituents. *Journal Association of Agricultural Chemistry*. 50: 50-55.

Table 1: Proximate composition of *C. rotundifolia* forage meal

Parameters	DM	CP	CF	EE	NFE	Ash
Percentage	72.20	11.05	20.73	00.57	63.16	04.49

DM = Dry matter CP = Crude protein CF = Crude fibre EE= Ether extract NFE= Nitrogen Free Extract

Table 2: Ingredient composition of the experimental diets.

Feed components (kg)	Inclusion of <i>Chamaecrista rotundifolia</i> (%)			
	0	25	50	75
<i>C. rotundifolia</i>	0.0	5.5	9.6	12.7
Cotton seed cake	22.0	16.5	12.4	9.3
Maize offal	40.0	40.0	40.0	40.0
Rice offal	36.0	36.0	36.0	36.0
Bone meal	1.5	1.5	1.5	1.5
Common salt	0.5	0.5	0.5	0.5
Total	100.0	100.0	100.0	100.0
ME(Kcal/kg)	3344	3314	3289	3301
Crude Protein (%)	12.86	12.51	11.95	12.79

M.E = Metabolisable Energy N = Naira

Table 3: Effect of varying inclusion levels of *C. rotundifolia* meal diet on rumen metabolites in Red Sokoto bucks.

Parameters	Inclusion of <i>Chamaecrista rotundifolia</i> (%)				SEM	LOS
	0	25	50	75		
pH	6.25	6.75	6.50	7.10	0.55	NS
TVFA (mm/l)	12.68 ^b	14.41 ^a	13.84 ^a	14.32 ^a	0.60	*
NH ₃ -N (mg/l)	28.46 ^a	29.01 ^a	27.81 ^a	26.76 ^b	0.82	*

^{abc} Means with different superscripts along the row differed significantly (P < 0.05) SEM = Standard error of mean

LOS = Level of significance TVFA = Total volatile fatty acids NH₃-N= Ammonia nitrogen

Table 4: Economic analysis of inclusion levels of *C. rotundifolia* meal diet fed to Red Sokoto bucks.

Parameters	Inclusion of <i>Chamaecrista rotundifolia</i> (%)				SEM	LOS
	0	25	50	75		
Initial weight (kg)	9.79	10.00	8.11	8.10	1.59	
Final weight (kg)	10.78 ^b	11.74 ^a	10.61 ^b	10.95 ^b	0.14	*
Weight gain (kg)	0.99 ^c	1.74 ^b	2.51 ^a	2.85 ^a	0.58	*
Cost of feeding (N/buck)	310.98	278.70	193.53	181.07	—	—
Cost/kg feed (Nkg ⁻¹)	44.30	42.10	40.46	39.22	—	—
Cost of feed/kg gain (Nkg ⁻¹)	942.38	480.52	231.31	190.60	—	—

^{abc} Means with different superscripts along the row differed significantly (P < 0.05) SEM = Standard error of mean N =Naira