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

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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 (NH_3-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 11.2^0 North and longitude of 007.6^0 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 de-wormed 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 NH_3-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 H_2SO_4 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^{0}C) until when required for analysis of TVFAs and rumen NH_3-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.

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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.

	Inclusion of *Chamaecrista rotundifolia* (%)			
Feed components (kg)	0	25	50	75
C. rotundifolia	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.

	Inclusion of *Chamaecrista rotundifolia* (%)					
Parameters	0	25	50	75	SEM	LOS
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 NH_3-N= Ammonia nitrogen

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

Parameters	Inclusion of *Chamaecrista rotundifolia* (%)					
	0	25	50	75	SEM	LOS
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

EVALUATION OF NUTRIENT COMPOSITIONS OF IRRIGATED GAMBA (*ANDROPOGON GAYANUS*) FORAGE IN ZARIA, NIGERIA

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ABSTRACT

A field experiment was conducted to evaluate the effect of varying levels of irrigation volume, irrigation frequency and compost on chemical compositions of gamba (*Andropogon gayanus)* forage. The experiment was laid out in a complete randomized block design with Split-Plot arrangement. The factors were arranged in a 3×2×2 factorial arrangement, with three replications. There were three (3) levels of irrigation volumes (25, 50 and 100 L), two irrigation frequencies (3 and 6-day intervals) and two levels of compost manure application (25 and 50 kg/ha), respectively. Irrigation volumes were assigned as the main plots, while irrigation frequencies and compost were sub-plot factors. The result showed there were no treatment effects ($P > 0.05$) on all variables measured of the proximate composition (%) of gamba froage at 8 and 12 weeks. However, there were significant on interactions variables ($P < 0.05$) detected but the trend was inconsistent at all the age intervals considered. The mineral composition at all ages remained similar ($P > 0.05$) in all the irrigation volume, intervals and compost treatments. However, interactions showed inconsistent trend ($P < 0.05$) in some mineral composition variables throughout the plant age. In conlusion, it is revealed that the combination of treatments imposed, have a significant effect on the chemical composition of Gamba. It is therefore, economically feasible for famers to irrigate the forage based on the minimum irrigation volume (25L) that supplies adequate soil moisture in combination with cheap nutrient source (25kg/ha Compost manure) at 6 days irrigation interval for better nutritional quality and to save the extra cost of labour and waste of resources in Zaria, Nigeria.

Keywords: Gamba, chemical composition, irrigation, compost.

INTRODUCTION

The supply of nutrients to animals can be improved by cultivation of promising tropical forage species (Bayble *et al.*, 2007). Irrigation gives a powerful impetus to forage production and use by providing high quality feed in the dry season as trials by Akinola (1975) and Kallah (1988) in the Savannah zone of Nigeria have shown that various grass and legume forages can be grown during the dry season with varying degrees of success as farmers have a lot of control over how much water to supply and when to apply it. Gamba is grass forage that has soft leaves and grows well on infertile, acid soils in hot climates and in a wide range of climates, but is particularly useful in areas with a long dry season. Gamba stays green long into the dry season when most other grasses are already dry, it is easy to cut and can tolerate grazing. The quality of any forage material depends to some extent on the presence or absence of mineral content of the forage. Mineral content of these forage plant is low with about (0.08 P and 0.27 Ca in DM) (Ajiji *et al.*, 2013). The problem with *Andropogon gayanus*, like other tropical grasses, is the rapid decline in crude protein and soluble carbohydrate with age. This is coupled with a progressive increase in crude fibre and lignin (Lambert and Litherland, 2000). Chemical analysis has become an initial step in assessing the potential nutritional value of forage feedstuff to animals. The chemical composition of a forage feedstuff may vary from locality to locality due to variation in Soil, climate and rainfall. However, much work has been done on but at the moment, it appears that there is scanty information on the chemical composition of Gamba forage indigenous to Zaria area in Nigeria. This study will therefore attempt to assess the chemical composition of Gamba forages indigenous to Zaria area in Nigeria. The main objective of this reseach is to deterine the chemical composition of Gamba forage indigenous to Zaria Nigeria under flood c irrigation.

MATERIALS AND METHODS

ExperimentalSite

The experiment was conducted at the Irrigation Site of the Institute for Agricultural Research (I.A.R), Samaru-Zaria, Kaduna State. Samaru is located on latitudes 11° and 11'N and on longitudes 7° and 11'E with an altitude of 686 m above sea level in the Northern Guinea savanna of Nigeria (Ovimaps, 2014). The maximum temperature for the period (February to April) recorded at Samaru, in Sabon Gari Local Government Area of Kaduna state showed the maximum temperature of about 30°C. The relative humidity in the months of February and April is about 70 – 80%, during dry season (I.A.R, Samaru Weather Station, 2015).

Sources of Experiental Material

Gamba seeds for the experiment were obtained from the Feeds and Nutrition Research Programme of the National Animal Production Research Institute (NAPRI), Shika-Zaria. 50 kg of compost manure was sourced from Samaru, Sabon Gari Local Government Area of Kaduna state, and was analyzed for the chemical properties at the Department of Soil Science, Faculty of Agriculture, Ahmadu Bello University, Zaria.

Experimental Design and Treatments

The experiment was laid out in a complete randomized block design with Split-Plot arrangement. The factors were arranged in a 3×2×2 factorial arrangement, with three replications. There were three levels of irrigation volumes (25, 50 and 100 L), two irrigation frequencies (3 and 6-day intervals) and two levels of compost manure application (25 and 50 t/ha), respectively. Irrigation volumes were assigned as the main plots, while irrigation frequencies and compost were sub-plot factors. Soil moisture content was measured with a Tensiometer in each of the plots to determine the Volumetric Water Content. All the experimental plots received a uniform dose of 18 kgha^{-1} NPK fertilizer by broadcasting prior to sowing. A total of 36 plots measuring 2 m^2 with 1m inter-row path and watering channels, were used while the total area used for the experiment was 288 m^2. Prior to the forage establishment the field was cleared, ploughed and harrowed using hand hoes. Seeds of Gamba were broadcasted in each plot.

chemical composition of Gamba forages,

Chemical composition determination

Forage samples were harvested at the 8th and 12th weeks after planting were analysed for chemical composition which was carried out at the Biochemistry Laboratory of the Animal Science Department, Ahmadu Bello University, Zaria. The contents of dry matter, crude protein, ether extract and ash were determined according to AOAC (1995). Fibre fraction analysis: Neutral detergent fibre (NDF); acid detergent fibre (ADF); acid detergent lignin (ADL) (Van Soest *et al.*, 1991); cellulose was taken as the difference between ADF and ADL while hemicellulose was calculated as the difference between NDF and ADF. The samples of the grasses were dried in a forced draught oven at 105°C for 24 hours and were analysed for some macro minerals (Ca, P, K, Na and Mg). The concentration of potassium (K) was estimated with a flame photometer after wet digestion in nitric acid and per chloric acid. Concentration of calcium and phosphorus were determined with atomic absorption spectrophotometry (Fritz and Schenk, 1979).

Statistical analysis

Data collected on chemical compositions were analyzed using Analysis of Variance of the General Linear Model (GLM) Procedure of Statistical Analysis System (SAS, 2002) while the treatment means were separated by Dunnet's Test.

RESULTS AND DISCUSSION

Table 1 shows the effects of varying levels of irrigation volume, frequency, levels of compost age of maturity and their interaction on the proximate composition of Gamba grass at 8 and 12 weeks after sowing. There were no treatment effects ($P > 0.05$) on all variables measured at a ages. However, significant interactions (P 0.05) were detected in most of the variables b the trend was inconsistent in all the age intervals considered. The observed, variation might be due to higher levels of water stress which could have decreased the amount of fiber content of the forage and increased ash content, crude fiber content and ether extract. Sasani *et al.* (2009) reported that water stress condition could lead to decreased cellulose and structural ligin that, decreased fiber content.

Table 2 shows the effect of varying levels of irrigation volume, frequency, compost and their interactions on mineral composition of Gamba forage at 8 and 12 weeks after sowing. The mineral composition at all ages remained similar (P >0.05) in all the irrigation volume, intervals and compost treatments. However, the interactions also showed inconsistent trend (P< 0.05) in some mineral composition variables throughout the plant age. The significant interactions observed in this study could be related to variation in soil moisture content (Zafar *et al.*, 2007). George *et al.* (2005) reported that mineral content of forage species are influenced by climatic and soil factors.

CONCLUSION

Results of the study revealed that the combination of treatments imposed, have a significant effect on the chemical composition of Gamba *(Andropogon gayanus)*. It is therefore, economically feasible for farmers to irrigate the forage based on the minimum irrigation volume (25L) that supplies adequate soil moisture in combination with cheap nutrient source (25kg/ha Compost manure) at 6 days irrigation interval for better nutritional quality and to save the extra cost of labour and waste of resources in Zaria, Nigeria.

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Table 1: Effects of varying levels of irrigation volume, frequency and compost manure and their interactions on proximate composition of Gamba grass at 8 and 12 weeks after sowing.

	DM		NFE		CP		CF		EE		ASH	
Treatments	8	12	8	12	8	12	8	12	8	12	8	12
I.V (L)												
100	22.22	32.81	52.04	52.88	9.62	10.01	26.83	27.18	0.99	1.17	10.62	8.69
50	25.46	28.12	52.63	51.85	9.23	10.28	26.73	27.76	0.97	1.33	10.34	8.78
25	24.21	30.11	51.13	53.02	9.44	10.51	26.69	26.69	1.01	1.01	11.73	8.76
I.F (days)												
3	24.09	29.35	51.95	52.87	9.63	10.17	26.66	27.00	1.00	1.24	10.77	8.74
6	23.81	31.28	52.04	52.26	9.25	10.32	26.85	27.48	0.98	1.13	10.88	8.75
C (Kg/ha)												
25	24.39	30.89	52.35	52.74	9.23	10.12	26.69	27.09	0.99	1.21	10.72	8.79
50	23.43	29.79	51.60	52.33	9.35	10.39	26.82	27.44	0.98	1.15	10.95	8.69
SEM	1.91	2.31	1.41	1.22	0.87	0.80	1.2	1.03	0.23	0.56	1.1	0.75
Interaction												
V×A	*	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS
C×A	NS	NS	NS	*	NS	NS	*	*	NS	NS	NS	*
F×A	*	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
V×F C×A	NS	NS	NS	*	NS	NS	NS	*	*	*	NS	*

SEM= Standard Error of Means. NS= Not significantce, * = Significant VA= Volume × Age CA,= Compost manure × Age, FA= freq × Age, VFCA= Volume × frequency × compost manure × Age

Table 2: Effects of varying levels of irrigation volume, frequency and compost manure, and their interactions on mineral composition (%) of Gamba grass at 8 and 12 weeks after sowing.

	N		Ca		Na		P		Mg		K	
Treatments	8	12	8	12	8	12	8	12	8	12	8	12
I.V (L)												
100	1.27	1.32	1.27	0.88	0.06	0.71	0.69	0.71	0.20	0.23	0.59	0.52
50	1.21	1.15	1.22	0.85	0.14	0.69	0.68	0.69	0.24	0.22	0.59	0.56
25	1.29	1.15	1.28	0.84	0.07	0.72	0.78	0.72	0.23	0.22	0.61	0.57
I.F (days)												
3	1.24	1.23	1.24	0.86	0.09	0.72	0.70	0.72	0.23	0.23	0.60	0.56
6	1.27	1.19	1.27	0.85	0.08	0.69	0.72	0.69	0.22	0.22	0.59	0.54
C (Kg/ha)												
25	1.27	1.18	1.25	0.86	0.08	0.71	0.71	0.71	0.23	0.21	0.59	0.53
50	1.24	1.24	1.27	0.85	0.09	0.70	0.72	0.70	0.22	0.23	0.61	0.57
SEM	0.40	0.42	0.38	0.26	0.36	0.30	0.33	0.30	0.20	0.20	0.24	0.22
Interaction												
V×A	NS	*	*	NS	*	*	*	*	NS	NS	NS	NS
C×A	NS	*	*	*	NS	*	*	*	NS	NS	NS	NS
F×A	NS	NS	*	*	NS	*	*	*	*	*	NS	NS
V×F×C×A	*	NS	NS	NS	NS	*	NS	*	NS	*	*	NS

[a] means with different superscripts along the column differed significantly (P <0.05), SEM= Standard Error of Means
VA= Volume × Age CA,= Compost manure × Age, FA= frequency × Age