Effect of mixed *Gmelina* and *Moringa* leaf meal inclusion on growing Red Sokoto does fed *Digitaria smutsii* hay based complete diets

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Abstract— *Gmelina arborea and Moringa oleifera (GMMO) leaf meal were combined at the ratio of 3:1 and included in the diets of Red Sokoto does at 0, 10, 20 and 30% to investigate the effect on dry matter intake, live weight and cost of feed in Digitaria smutsii hay based diets. Twenty-eight (28) growing Red Sokoto does aged between 6 and 7 months with average weight of 14.71±0.09 kg were randomly assigned to four treatments balanced for weight with seven does per treatment in a completely randomized design. The experimental diets were offered at 4% of body weight. Cost of feeding was studied to determine the cost effectiveness of GMMO leaf meal inclusion in the diets. Results indicated that inclusion of GMMO leaf meal significantly (P<0.05) improved weight gain of Red Sokoto does. Animals fed dietary treatments containing 10% and 20% of GMMO leaf meal had significantly (P<0.05) higher weight gain (3.30kg and 3.38kg) than animals on 30% inclusion level. The feed cost/kg gain ranged from ₦ 326.75 in 20% followed by ₦354.59, ₦ 441.74 and ₦518.30 in 10%, 30% and 0%, respectively. The cost-benefit analysis showed that at 20% GMMO leaf meal inclusion, cost of feed/kg gain was reduced by 36.96% and gave more profit. The GMMO leaf meal inclusion did not have any adverse effect on Red Sokoto does. It can be concluded that mixed Gmelina and Moringa leaf meal can be included at 20% in diets of Red Sokoto does for improved dry matter intake, average daily weight gain and profitability*.

Keywords— Leaf meal, weight gain, Red Sokoto goats, Gmelina arborea and Moringa oleifera.

I. INTRODUCTION

Small ruminants form an integral part of the livestock economy in Nigeria. The arid and semi-arid areas are home to over 80% of small ruminants and their sustenance is reducing due to dependence on natural pastures (Kosgey *et al.,* 2008). They support 46-58% of pastoral households and play a significant role in the food chain and overall livelihoods of rural households, where they are largely the property of women and their children (Lebbie, 2004).

Dry season feeding of ruminants in most tropical areas has always been a problem for farmers since little good pasture exists during this period. At this time, the performances of these animals are seriously impaired. One possible way to alleviate this problem and maintain production in the tropics is to feed them with crop residues and browse plants. These feed resources are not consumed by man but can be converted by ruminants into animal products desirable as human food. This therefore reduces total cost of animal production without a decrease in productivity and also maintains efficient feed utilization.

Browse plants have great potential as source of high quality nutrient for ruminants, being high in protein, minerals and vitamins (Amodu and Otaru, 2004). They are available all year round because of their drought resistance, persistence, vigorous growth, re-growth and palatability (Crowder and Chheda, 1982). The use of browse plants as supplement has been shown to enhance intake, improve growth rate and increase reproduction in ruminants (Lamidi *et al.,* 2009; Okafor *et al*., 2012; Abdu *et al.* 2012).

Moringa is one of the most promising plants which could contribute to increased intake of some essential nutrients and health-promoting phytochemicals. It has a high crude protein content ranging from 20-26% CP in leaves (Ben Salem *et al.,* 2004 and Asaolu *et al.,* 2011) with negligible contents of anti-nutrients (Makkar and Becker, 1996).

Gmelina arborea Roxb. (Family verbenanceae) is a fast growing deciduous tree that can grow up to 40 m tall and 140 cm in diameter (Jensen, 1995). Even though *Gmelina arborea* can shed some of its leaves when the dry season is approaching, the regrowth of new leaves could serve as animal feed during the dry season (Osakwe and Udeogu 2007). The objective of this study was to investigate the effect of mixed Gmelina and Moringa (GMMO) leaf meal inclusion levels on growing Red Sokoto does fed *Digitaria smutsii* hay based diets.

II. MATERIALS AND METHODS

2.1 Experimental animals and diets

The experiments were conducted in the Experimental Unit of the Small Ruminant Research Programme of the National Animal Production Research Institute (NAPRI), Shika, Zaria, Kaduna State, Nigeria.

Twenty-eight (28) Red Sokoto does aged between 6 and 7 months with average weight of 14.71±0.09 kg were used with 7 animals per treatment. The animals were obtained from Small Ruminant Research flock, NAPRI. They were individually penned and given prophylactic treatment, consisting of Ivermectin® at 200µg/kg body weight (BWT) against endo- and ectoparasites and Terramycin long acting (LA)® at 20mg/kg BWT against bacterial diseases 7 days before the commencement of the experiment.

Fresh *Gmelina arborea* (GM) leaves were harvested within Ahmadu Bello University Main Campus and the leaves were allowed to air-dry for three days. Dried *Moringa oleifera* leaves were sourced from Sabon-Gari market, Zaria. *Digitaria smutsii* (Wooly finger grass) hay was sourced from the Feeds and Nutrition Research Programme of NAPRI. The dried leaves of the two browses and *D. smutsii* hay were ground with a hammer mill fitted with 2cm screen for easy mixing with other feed ingredients. The ground ingredients were packed in sacks and stored in a well-ventilated store.

Four isonitrogenous complete diets were formulated, with 40% *D. smutsii* hay base. The complete diets were compounded to contain 13% CP. *Gmelina arborea and Moringa oleifera* leaf meals were combined at 75 and 25% respectively. The mixed Gmelina and Moringa leaf meal was included at 0, 10, 20 and 30%. Each level of inclusion served as a treatment. Other ingredients in the complete diet include maize offal, cotton seed cake, salt and bone meal (Table 1).

TABLE 1
INGREDIENT COMPOSITION OF EXPERIMENTAL DIETS (%) FED TO RED SOKOTO DOE

Ingredients	Level of GMMO leaf meal inclusion (%)			
	T_1	T_2	T_3	T_4
75GM:25MO	0	10	20	30
Cottonseed Cake	23.40	20.00	16.00	12.30
Maize offal	34.60	28.00	22.20	15.80
Bone meal	1.5	1.5	1.5	1.5
Salt	0.5	0.5	0.5	0.5
D.smutsii hay	40	40	40	40
Total	100	100	100	100
Calculated analysis				
% Crude Protein	13.01	13.06	13.02	13.00
ME (Kcal/kg)	2437	2407	2375	2357
Cost/kg feed (₦)	44.14	40.63	37.12	33.52
75 GM: 25 MO= 75:25% combination of Gmelina and Moringa leaf meal; ME=Metabolizable energy.				

The diets were mixed fortnightly to maintain freshness and samples were taken to determine the chemical composition. Seven animals were randomly allocated to four treatments with each animal serving as a replicate in a completely randomized design.

At 8.00 hours, the animals were offered their daily ration of 4% body weight of the experimental diets. The does were weighed weekly. Weight changes were recorded as the difference between weight of the previous week and the current. Weekly weights of the does were used to adjust the quantities of feeds offered in order to maintain the pre-determined level. The animals had free access to clean drinking water. The growth trial was carried out for a period of 60 days after 14 days'

adjustment period. Daily feed intake and weekly body weight of the animals were recorded before feeding in the morning throughout the experiment.

2.2 Feed cost analysis

Market prices in Zaria and its environs were used for determining the cost of does and feeds as at the time of research. The costs of harvesting and transportation of *Gmelina* leaves were estimated. Feed consumed by the animals was multiplied by the cost of feed per kilogram to obtain the cost of feed consumed. The information from the market cost was used to work out total cost of feed consumed per treatment, value of gain, and net benefit.

2.3 Chemical analysis

The feeds samples were analyzed for proximate analysis using the procedures outlined by the Association of Official Analytical Chemists (A.O.A.C., 2005). Acid Detergent Fibre (ADF) and Neutral Detergent Fibre (NDF) were determined according to Van Soest *et al.,* (1991) procedures.

2.4 Statistical Analysis

All data generated were analyzed statistically using the General Linear Model (GLM) procedure of SAS, (2005). Significant differences between treatment means were determined according to Duncan's Multiple Range Test of SAS, (2005).

III. RESULTS AND DISCUSSION

3.1 Chemical composition (%) of experimental diets fed to growing Red Sokoto does

The chemical composition (%) of experimental diets fed to growing Red Sokoto does is shown on Table 2. The dry matter content varied from 93.90 to 94.44% across the treatments. The crude protein content of 13.09%, 13.00%, 13.15% and 13.25% were recorded for 0%, 10%, 20% and 30% levels of GMMO leaf meal inclusion in the diets, respectively. Ash content ranged from 6.47 to 6.85%, while NDF and ADF varied from 41.59 to 46.22 and 22.56 to 26.94 %, respectively.

TABLE 2
CHEMICAL COMPOSITION (%) OF EXPERIMENTAL DIETS FED TO GROWING RED SOKOTO DOES

Parameters	Level of GMMO leaf meal inclusion			
	0%	10%	20%	30%
Dry matter	94.44	94.10	93.90	94.08
OM	87.59	87.63	87.19	87.23
Crude protein	13.09	13.00	13.15	13.25
Crude fibre	27.43	25.26	23.27	28.23
Ash	6.85	6.47	6.71	6.85
Ether Extract	7.91	5.66	5.08	5.88
NDF	41.59	46.22	45.71	43.51
ADF	22.56	26.94	26.41	24.51
OM= Organic Matter; NDF=neutral detergent fibre; ADF=acid detergent fibre.				

The CP contents of all the diets were above the level suggested as adequate to meet the nutritional requirements for moderate weight gain in goats (NRC 2007). Norton (1994) recommended a diet with 8 % CP for moderate live-weight gains in goats and according to this criterion all the diets had sufficient CP content. The chemical composition of experimental diets showed that the diets contained adequate dry matter and crude protein to support normal rumen functions (Ahamefule et al., 2002). Also the CP contents of all the diets fed to pregnant does were within the level 8.9–16.0% recommended for growth and production in goats (NRC, 2007). The chemical composition of experimental diets showed that the diets contained adequate dry matter and crude protein to support normal rumen functions (Ahamefule et al., 2002) and to meet the CP requirement of pregnant Red Sokoto does. There was no adverse effect on the pregnant does during the study.

3.2 Effect of Gmelina and Moringa leaf meal inclusion on intake and growth performance of Red Sokoto does fed *Digitaria smutsii* hay based diets

The results of the effect of Gmelina and Moringa leaf meal inclusion on growth performance of Red Sokoto does fed *D. smutsii* hay based diets are presented in Table 3. The result showed no significant (P>0.05) difference in feed intake across

the treatments. The feed intake varied from 421.50 to 455.95g/d in animals fed 30% and 20% respectively. Final weight of does was also not significant (P>0.05) but increased with GMMO leaf meal inclusion. Animals on 10% and 20% leaf meal inclusion had significantly higher (P<0.05) weight gain than the other treatment groups. Average daily weight gain (ADG) in this study showed no significant (P>0.05) difference across the treatments. ADG varied from 38.81 to 55.48 g/d. There was no significant (P>0.05) difference in feed conversion ratio. It varied from 8.73 to 13.18 in animals fed 20% and 30% leaf meal inclusion respectively.

TABLE 3
EFFECT OF *GMELINA* AND *MORINGA* LEAF MEAL INCLUSION ON INTAKE AND GROWTH PERFORMANCE OF RED SOKOTO DOES FED *DIGITARIA SMUTSII* HAY BASED DIETS

Parameters	Levels GMMO leaf meal inclusion				SEM
	0%	10%	20%	30%	
Feed intake (g/d)	455.31	447.08	455.95	421.50	35.23
DMI (g/kgW $^{0.75}$)	52.80	50.97	51.94	50.07	1.77
Initial weight (kg)	14.79	14.71	14.71	14.71	1.22
Final weight (kg)	17.59	18.01	18.04	17.07	1.16
Metabolic Wt $^{(0.75)}$	8.58	8.73	8.74	8.39	0.42
Weight Gain (kg)	2.80^{ab}	3.30^{a}	3.38^{a}	2.33^{b}	0.52
ADG (g/d)	46.67	55.00	55.48	38.81	8.60
FCR	11.74	8.73	8.80	13.18	2.41

a,b, Mean values with different superscripts within a row differ significantly (P<0.05) SEM standard error of mean; DMI=Dry matter intake; ADG=average daily gain; FCR= feed conversion ratio.

No significant effect of GMMO inclusion on feed intake, average daily gain and feed conversion ratio recorded in this study was similar to reports of several researchers (Okafor *et al*., 2012; Aye and Tawose, 2015). Higher live weight gain recorded in does fed 20% GMMO leaf meal agreed with findings of (Torres-Acosta *et al.,* 2006; Ogunbosoye and Babayemi, 2012; Fasea *et al*., 2010) who fed browse leaves. This may be as a result of an improved ruminal environment and digestibility of diets. The finding is in agreement with the reports of Kabir *et al*. (2004) and Torres-Acosta *et al.* (2006). The higher live weight gain may be as a result of adequate crude protein content, increased intake of the diet, improved digestibility and nitrogen retained by the animal on 20% GMMO leaf meal inclusion.

3.3 Effect of Gmelina and Moringa leaf meal inclusion on cost of feeding of Red Sokoto does fed *Digitaria smutsii* hay based diets

Table 4 showed the result of the feed cost-benefit analysis of experimental diets fed to growing Red Sokoto does. The total feed cost ranged from ₦847.74 in 30% to ₦1205.84 in the control. The feed cost/kg gain ranged from ₦ 326.75 in 20% followed by ₦354.59, ₦ 441.74 and ₦518.30 in 10%, 30% and 0% respectively. Net profit was higher on treatment diets with GMMO leaf meal than the control. Reduction percent in feed cost/ kg gain was highest in 20% (36.96%) and least in 30% (14.77%) leaf meal inclusion.

TABLE 4
COST BENEFIT OF FEEDING RED SOKOTO DOES GMELINA AND MORINGA LEAF MEAL IN *DIGITARIA SMUTSII* HAY BASED DIETS

Parameters (₦)*	Levels of GMMO leaf meal inclusion			
	0%	10%	20%	30%
Total feed intake (kg)	27.32	26.83	27.36	25.29
Weight Gain (kg)	2.80	3.30	3.38	2.33
Cost/kg	44.14	40.63	37.12	33.52
Total cost of feed consumed	1205.84	1089.89	1015.49	847.71
Cost/kg Gain	518.30	354.58	326.75	441.74
Value of gain	1400.00	1650.00	1664.30	1164.30
Net Profit	194.20	560.10	648.80	316.60
% Reduction in feed cost/kg gain	-	31.59	36.96	14.77

**** Naira = Nigerian currency (100 kobo make 1 naira)***

The result demonstrated that the best feed cost benefit was recorded in bucks fed 20% GMMO leaf meal. The results indicated that treatment diets with leaf meal were more cost effective than the control diet and it can be due to cheaper cost of feed and improvement in feed utilization and weight gain. The result of this study is similar to the work of Njidda and Ikhimioya (2010) reported that diet supplemented with *Ziziphus mauritiana* reduced the cost of production. Incorporation of unconventional feed stuff has been reported to reduce the cost of feeding (Okafor *et al*., 2012 and Okpara *et al*., 2014).

IV. CONCLUSION

The study showed that mixed Gmelina and Moringa leaf meal inclusion in diets of Red Sokoto does improved dry matter intake, weight gain and profitability. The cost-benefit analysis showed that fed 20% GMMO leaf meal gave more profit and reduced cost of feed/kg gain by 36.96% in the diets of Red Sokoto does. It was therefore concluded that GMMO leaf meal be included at 20% in diets of Red Sokoto does for improved feed intake, weight gain and profitability.

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