Effect of mixed *Gmelina* and *Moringa* leaf meal inclusion and sampling periods on haematology and serum biochemistry of growing Red Sokoto does

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Abstract— *A study was carried out to investigate the effect of mixed Gmelina arborea and Moringa oleifera (GMMO) leaf meal inclusion and sampling periods on the haematology and serum biochemistry of Red Sokoto does fed Digiteria 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. Experimental diets were offered at 4% of body weight. Haematological values shows that all parameters measured are significantly different. Significant (P<0.05) differences were observed cholesterol levels of the animals across the treatments. Cholesterol level was significantly higher (P<0.05) in 0% (107.90) and 10% (107.57) compared to other treatments. Effect of sampling periods on haematological parameters of growing does shows significant differences (P<0.05) in all the parameters measured except white blood cells count. There were significant differences (P<0.05) on total protein and globulin. Total protein ranged from 65.58 to 69.75 g/L at the end and middle of the experiment, respectively. It was significantly higher (P<0.05) at the mid than other periods. Values of globulin were statistically higher (P<0.05) at mid and end of the experiment than at the beginning. Values for all the parameters measured in this study were within the normal ranges for healthy goats. GMMO leaf meal inclusion and sampling periods did not have any adverse effect on blood profile of Red Sokoto does. It can be concluded that GMMO leaf meal can be included in the diets of Red Sokoto does up to 30% without detrimental effects.*

Keywords— Haematology, Serum biochemistry, Red Sokoto goats, Gmelina arborea and Moringa oleifera.

I. INTRODUCTION

Small ruminants are the principal domesticated animals in terms of total numbers and production of food and fibre products. This attribute may partly be due to their lower feed requirements compared to cattle, because of their body size (Okunlola *et al*., 2010). Lower feed and of course the lower capital requirement allows for easy integration into different farming systems (Hirpa and Abebe, 2008; Pollot and Wilson, 2009). Small ruminants have served as means of ready cash and reserve against economic and agricultural production hardship (Hamito, 2008). Goats are considered superior to other ruminant species in their utilization of poor quality and high fibre feeds (Oyeyemi and Akusu, 2005). Goats are by far the most important domesticated small ruminants in Nigeria (FAOSTAT, 2009).

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). It produces leaves during the dry season and during times of drought, and is an excellent source of green vegetable when little other food is available (FAO, 2014). Moringa leaves can serve as feed for animals. They are valuable source of protein for ruminants but used in poultry, pigs, and fish diets in limited amount because of fibre and anti-nutrients.

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). According to Little (1983), the leaves are harvested for fodder for animals and silkworm; the bitter-sweet fruits used to be consumed by humans. Gmelina fruit pulps, seeds and flowers have also been very useful in the feeding of livestock (Amata and Iwelu, 2012). 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 anti-nutritional content of the leaves is low, implying that the overall nutritional value of the leaves will not be affected (Amata and Lebari, 2012).

Haematological studies represent a useful tool in the investigation of the extent of damage to the blood (Ogunbanjo *et al*., 2009). Etim *et al.* (2014) reported that it provides the opportunity to clinically investigate the physiological, nutritional and pathological status of an animal. Nutrition, age, sex, breeds, reproductive status, housing stress and environmental factors are known to affect the haematological and biochemical parameters in farm animals (Addass *et al.*, 2010, Daramola *et al.*, 2005). Iriadam (2007) reported that nutritional status and management practices can influence the physiological attributes and ability of animals to cope with stress.

The objective of this study was to investigate the effect of mixed Gmelina and Moringa (GMMO) leaf meal inclusion levels and sampling periods on haematology and serum biochemistry of 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 DOES

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 animals had free access to clean drinking water. The experiment was carried out for a period of 60 days after 14 days' adjustment period.

2.2 Haematological Analysis

Blood samples of about 5ml were collected from the does at the beginning, middle and end of the experiment, through the jugular vein using a 5 ml syringe. Two (2ml) of the blood sample collected was transferred into a sampling bottle containing ethylene diamine tetra acetic acid (EDTA) as anticoagulant. The blood samples collected were taken to the Veterinary Teaching Hospital, Ahmadu Bello University, Zaria for determination of haematological parameters (Packed cell volume, haemoglobin, red blood cells and white blood cells).

2.3 Evaluation of serum Biochemical Constituents

The remaining blood sample of about 3ml was poured into plain bottle and allowed to clot at room temperature within 3 hours of collection. Plasma was separated by centrifugation at 3500 r.p.m. for 15 min and serum was thereafter frozen at -20ºC for the determination of total protein, albumin, total cholesterol, glucose, creatinine and urea nitrogen with the use of Elisa Multiplex Commercial Kits (Pfizer Animal Health, New York, NY) following the methods of the Manufacturers. The globulin values were obtained by subtracting the values of albumin from the corresponding values of total protein (Coles, 1974).

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

The effects of Gmelina and Moringa leaf meal inclusion on hematological parameters of growing Red Sokoto does fed *D. smutsii* hay based diets are presented in Table 2. Significant differences were observed in all the parameters measured. The PCV, Hb and RBC were significantly ($P<0.05$) higher in animals fed 10% GMMO leaf meal compared to other treatments. White blood cell count was statistically ($P<0.05$) higher in animals fed 30% than those on 20% but comparable to values recorded in control and 10% respectively.

TABLE 2
EFFECTS OF GMELINA AND MORINGA LEAF MEAL INCLUSION ON HEMATOLOGICAL PARAMETERS OF GROWING RED SOKOTO DOES FED *DIGITARIA SMUTSII* HAY BASED DIETS

Parameters	Levels of Gmelina and Moringa leaf meal inclusion				SEM
	0%	10%	20%	30%	
PCV (HCT) (%)	35.89^{b}	41.11^{a}	33.78^{b}	34.44^{b}	2.46
Hgb(×10g/L)	11.93^{b}	13.69^{a}	11.22^{b}	11.46^{b}	0.82
RBC ($\times10^{12}$/L)	16.03^{ab}	16.96^{a}	15.72^{b}	15.71^{b}	1.16
WBC ($\times10^{12}$/L)	9.51^{ab}	9.93^{ab}	8.10^{b}	12.22^{a}	1.91

a,b, Mean values with different superscripts within a row differ significantly (P<0.05), SEM= Standard Error of Means. WBC = White blood cells; RBC = Red blood cells; Hb = Haemoglobin; PCV (HCT) = Packed cell volume (Haematocrit).

Etim *et al.* (2014) reported that haematological parameters are indicator of the physiological, nutritional and pathological status of an animal. The result showed that packed cell volume, haemoglobin, red blood cell and white blood cell were all within normal range for healthy goats (Latimer *et al.*, 2010). This may be due to the quality and adequacy of the treatment diets. Reports of Roberts *et al*. (2000) and Bello and Tsado (2013) indicated that diets containing poor protein affect the haematology and health of animals.

Table 3 shows the results of the effect of feeding of GMMO leaf meal on serum biochemistry of growing Red Sokoto does fed *D. smutsii* hay based diets. Significant (P<0.05) differences were observed cholesterol levels of the animals across the treatments. The cholesterol level decreased with increasing level of GMMO leaf meal inclusion. The cholesterol level was significantly higher (P<0.05) in 0% (107.90) and 10% (107.57) compared to other treatments. There were no significant differences (P>0.05) in other parameters measured.

TABLE 3
EFFECT OF MIXED GMELINA AND MORINGA LEAF MEAL ON SERUM BIOCHEMISTRY OF GROWING RED SOKOTO DOES FED *D. SMUTSII* HAY BASED DIETS

Parameters	Levels of Gmelina and Moringa leaf meal inclusion				SEM
	0%	10%	20%	30%	
Total protein (g/L)	66.67	66.44	68.22	67.33	5.09
Albumin (g/L)	38.00	32.56	35.11	34.44	9.46
Globulin (g/L)	28.67	33.89	33.11	32.89	9.94
Glucose (mg/dL)	61.67	70.11	59.56	61.78	9.42
Creatinine (µmol/L)	108.44	102.44	107.78	116.00	21.66
BUN (mmol/L)	5.97	5.32	5.28	5.49	1.69
Cholesterol (mg/dL)	107.90^{a}	107.57^{a}	86.28^{b}	81.07^{b}	10.53

a,b, Mean values with different superscripts within a row differ significantly (P<0.05), BUN= Blood Urea Nitrogen; SEM= standard error of mean.

The values of the parameters measured were within the normal ranges for healthy goats reported by Kaneko *et al.* (2008). This is in contrast with the work of Ologhobo *et al.* (2014) who reported no significant effect on most parameters measured for birds fed graded levels of *Moringa oleifera* leaf meal. The lower cholesterol level obtained in animals fed 20% and 30% GMMO leaf meal agreed with the work of Aderinola *et al.* (2013). This can be as a result of the hypocholesterolemic properties of Moringa leaf meal included in the diets (Olugbemi *et al*., 2010).

3.2 Effect of sampling periods on haematological parameters of growing Red Sokoto does fed levels of GMMO leaf meal in *D. smutsii* hay based diets

Table 4 shows the result of the effect of sampling periods on haematological parameters of growing Red Sokoto Does fed *D.smutsii* hay based diets supplemented with GMMO leaf meal inclusions. There were significant differences (P<0.05) in all the parameters measured except white blood cells count. Pack cell volume and haemoglobin were statistically similar at the beginning and middle of the experiment than at the end of experiment. Red blood cell was significantly (P<0.05) higher at the beginning of experiment than other periods.

TABLE 4
EFFECT OF SAMPLING PERIOD ON HAEMATOLOGICAL PARAMETERS OF GROWING RED SOKOTO DOES FED LEVELS OF GMMO LEAF MEAL INCLUSION IN *D. SMUTSII* HAY BASED DIETS

Parameters	Sampling Periods			SEM
	Beginning	Mid	End	
PCV (HCT) (%)	38.08[a]	35.33[ab]	33.17[b]	1.59
Hgb(×10g/L)	12.67[a]	11.36[ab]	10.91[b]	0.47
RBC ($\times10^{12}$/L)	12.10[a]	8.18[b]	9.55[b]	1.12
WBC ($\times10^{12}$/L)	16.28	16.29	15.75	0.36

a,b, Mean values with different superscripts within a row differed significantly (P<0.05), SEM= Standard Error of Means. WBC = White blood cells; RBC = Red blood cells; Hb = Haemoglobin; PCV (HCT) = Packed cell volume (Haematocrit).

All the values of parameters measured in this study fell within the normal range for healthy goats (Latimer, 2010). Reduction in the haemoglobin may be accompanied by a fall in the red blood cells count (RBC) and packed cell volume (haematocrit). Red blood cells are responsible for the transportation of oxygen and carbon dioxide in the blood and also involved in the manufacture of haemoglobin (Ologun and Ikeobi, 2006). Haemoglobin is an iron- containing compound found in the red blood cells, which transports oxygen around the body (Soetan *et al.,* 2006; Isaac *et al.,* 2013). Reduction in packed cell volume and red blood cell values are indicative of low protein intake or mild anemia but values are within the normal ranges for healthy goats.

3.3 Effect of sampling periods on serum biochemical parameters of growing Red Sokoto does fed levels of GMMO leaf meal inclusion in *D. smutsii* hay based diets

The results of effect of sampling periods on serum biochemical parameters of growing Red Sokoto does fed levels of GMMO leaf meal inclusion *in D. smutsii* hay based diets are presented in Table 5. There were significant differences (P<0.05) on total protein and globulin. The other parameters measured were not significant across the sampling periods. Total protein ranged from 65.58 to 69.75 g/L at the end and middle of the experiment, respectively. It was significantly higher (P<0.05) at the mid than other periods. The values of globulin were statistically higher (P<0.05) at mid and end of the experiment than at the beginning. The reduced total protein observed in this study may be as a result of the quality of protein fed. The parameters measured were within the ranges reported for clinically healthy goats (Kaneko *et al.,* 2008). This implied that the animals were in good health condition and were not stressed by the nutrition or environment. Reports of Olafedehan *et al*. (2010) found that blood acts as a pathological reflector of the status of exposed animals to diseases and other conditions.

TABLE 5
EFFECT OF SAMPLING PERIODS ON SERUM BIOCHEMICAL PARAMETERS OF GROWING RED SOKOTO DOES FED LEVELS OF GMMO LEAF MEAL INCLUSION IN *D. SMUTSII* HAY BASED DIETS

Parameters	Sampling Periods			SEM
	Beginning	Mid	End	
Total Protein	66.17[b]	69.75[a]	65.58[b]	1.35
Albumin	37.58	35.08	32.42	2.68
Globulin	28.58[b]	34.67[a]	33.17[a]	2.79
Glucose	62.83	62.17	64.83	2.92
Creatinine	95.92	118.08	112.00	11.53
BUN	5.66	5.61	5.28	0.49
Cholesterol	92.54	97.31	97.26	4.69

a,b, Mean values with different superscripts within a row differed significantly (P<0.05), SEM= Standard Error of Means; BUN= Blood Urea Nitrogen

IV. CONCLUSION

The study showed that mixed Gmelina and Moringa leaf meal inclusion and the sampling periods have no detrimental effects on in Red Sokoto does fed *D.smutsii* based diets. The animals were not stressed and were in healthy condition throughout the

period of the study. It was therefore concluded that mixed Gmelina and Moringa leaf meal can be included in the diets of Red Sokoto does up to 30% without adverse effects on them.

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