International Journal of Science, Environment and Technology, Vol. 3, No 1, 2014, 67 – 84

ISSN 2278-3687 (O)

MORINGA MULTI-NUTRIENT BLOCKS: FORMULATION, PRODUCTION, AND FEEDING TRIAL UNDER A TROPICAL ENVIRONMENT

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Abstract: The need for improved nutrition and productivity of sheep has led to the development of Moringa Multi-nutrient Blocks (MMNB) as an option to address feed shortages that militate against optimum sheep production. Protocols and conditions for making MMNB considered suitable for on-farm adoption by sheep farmers in the tropics, in terms of desired hardness, compactness and cost, while aiming at nutritional complementarity among the different ingredients were investigated. Three of the formulae resulted in blocks of comparable hardness (+) and compactness (+) up till the 7th day of drying with blocks from formulae 1 maintaining the highest hardness and compactness throughout the drying period. By day 21, however, blocks from formula 1 were apparently the hardest and most compacted (+++). The developed MMNB were tested on twenty five yearling yankasa rams (YYR). The effects of inclusion levels of MMNB on nutrient intake, digestibility, nitrogen balance and haematological parameters of YYR fed Moringa oleifera powder multi-nutrient blocks (MOPMNB) as supplements to Brachiaria decumbens(Signal grass) were investigated in a completely randomized block design experiment using twenty five YYR with average initial weight of 23.10 Kg. There were five treatments:1-5, with 0,5,7,9, and 11% M. oleifera(MOF) inclusion levels respectively. M. oleifera had better nutrient profile with 15.3% CP and 11.84% CF contents than B.decumbens with 7.54% and 33.87% CF respectively. Inclusion of M.oleifera as supplement to B.decumbens in the diets of YYR significantly increased (P < 0.0 5) DM intake especially at higher (7-11%) inclusion rates.EE and NDF intakes were similar but CP increased while CF intake decreased (P < 0.05) as inclusion level increased. The best DM, EE and NDF digestibility were obtained at 11% Moringa inclusion while CP and CF digestibility were highest at 9% inclusion level, which also gave similar DM and CP digestibility with 7% inclusion. N-balance and retention were best under 9% M. oleifera and least under 5% M.oleifera. Packed Cell Volume(PCV), Haemoglobin(Hb), Red Blood Cell(RBC) and White Blood Cell(WBC) counts for the experimental animals were within the normal physiological range for healthy sheep, except for T1 whose RBC were below the range. The blood profile was best for animals on 5% M.oleifera inclusion. It was concluded that inclusion of M. oleifera in MMNB diets significantly improved the blood profile of YYR and invariably enhanced the performance of the animals.

Keywords: Moringa Multi-nutrient blocks, yearling yankasa rams, haematological parameters, Brachiaria *decumbens* , physiological range, Moringa *oleifera*.

*Received Nov 14, 2013 * Published February 2, 2014 * www.ijset.net*

Introduction

It is necessary to supplement the feed of ruminants especially during the critical period of feed inadequacy often experienced during the raining (farming) season of the year. During this period, over 70% of arable farmlands are unavailable for grazing by ruminants because of farming operations which restrict their grazing activities during this period. This invariably leads to feed shortage and poor animal performance. Supplementation with agro-industrial by-products such as groundnut cake, cotton seed cake, palm kernel, maize milling waste (Dusa) to ameliorate the problem are not within the reach of the small-holder farmers. Therefore, with the exception of “Dusa”, the use of other agro-industrial by-products by livestock farmers especially in Nigeria has been restricted to a few individuals who are wealthy because of the high cost (Fayomi, 2001).

The high cost and seasonal availability of protein supplements in Nigeria have prompted renewed interest in the search for alternative proteins sources for ruminants (Lufadeju and Olorunju, 1986). It is recognized that poor quality roughage yields limited nutrients during rumen fermentation, because of their low nutrient content and digestibility. In this case, they fail to satisfy the ruminant need for amino acid, glucose precursors and other nutrients (Preston, 1986). Furthermore, due to the inability of poor quality roughages to provide adequate energy, nitrogen and other essential nutrients through microbial fermentations, inclusion of supplementary energy and protein in diets based on poor quality roughages enhances their utilization (Anderson, 1978; O’Donovan, 1983).

The use of browse plants as supplements is a recent development. Browse plants offer a considerable protein for ruminant nutrition. In his review on browse supplementation experiments involving a Napier diet with Gliricidia, Leucaena spp and Sesbania, Topps (1992) noted that they increased dry matter intake and weight gains. Similarly, Bannulin *et al*., (1986) also noticed an increase in digestibility of CP and OM when sheep were fed tropical pasture supplement with Leuceana. Kimambo *et al*. (1992) reported an increase in total dry matter intake of maize stover by increasing the level of supplemented Leucaena in sheep. Varriko *et al.*, (1992) found that supplementation of a basal natural grass hay with Leuceana, cowpea and tagasaste resulted in increased weight gains. However, some browse plants have been found to have anti-nutritional factors that limit their use as feed supplements. For instance, condensed tannins have been reported to be present in Gliricidia, Leucaena, Acacia spp and Albizia spp (D’ Mello, 1992). Tannins are known to be potent protectors of the proteins from microbial degradation in the rumen thereby increasing the quantity of bypass proteins (Ehoche *et al*, 1983). On the whole, substantial amount of proteins, vitamins and minerals are supplied when ruminants browse on plants or when used as supplements.

Browse plants have great potential as a source of high quality nutrient for ruminants, being high in protein, minerals, and vitamins (Yahaya *et al.*, 2000; Babayemi *et al*; 2003; Amodu and Otaru, 2004). They have the ability to be available all year round because of their draught resistance, persistence, vigorous growth, re-growth and palatability (Crowder and Chheda, 1982).Browse plants which are part of the natural vegetation are accessible to the majority of small-holder farmers and may be a useful feed supplements in small ruminant production (Otsyina and Mckell, 1985). They are found all year round in contrast to grasses which rapidly deteriorate with increasing fiber and decreasing proteins. They also have higher nutrient value than grasses (Agishi, 1984). Among the Browse species, Moringa oleifera, Gmelina arborea, Leuceana leucocephala, and Gliricidia septum have been reported to remain green to a larger part of dry season and have been fed to ruminants with promising results (Lamidi *et al.*, 2009). Present knowledge on the potential value of browse plants indicates that together with their diversity, these feed resources are extremely useful for feeding domestic ruminants. The demonstrable benefits are improved performance of animals and reduced cost of feeding. These advantages justify more intensive and wider utilization of browse plants in appropriate feeding systems and represent an important strategy for increasing the current level of contribution from ruminants. In effect, more information is required on optimum dietary levels of forage supplements either fed alone or in mixtures appropriate to individual ruminants, methods to reduce the incidence of toxicity and development of suitable mixtures of these in economic feeding systems for individual ruminants.

Formulation, development, production and use of multi-nutrient blocks utilizing Moringa oleifera as a basic ingridient will be a long term relieve to feed shortage especially during the dry and wet seasons for the ruminants. Nutrition is a critical factor that could limit ruminant production. Reports (Cheeke and Raharjo, 1988) exist on the formulation of multi-nutrient blocks, crumbs/cakes as partial substitutes for cereal-based concentrates for animals during all phases of production. Pezo (1991) reported that such mini-blocks could be a complete feed for animals by including a source of forage in the formulation. The use of forage legumes as supplement has been suggested as an alternative to use of concentrates (James, 1979; Ndemanisho, 1996; Roothaert and Paterson, 1997). However, many tropical fodder legumes contain secondary plant compounds such as tannins, saponins, cynogens, mimosine and coumarins, which limit nutrient utilization (Leng, 1997; Makkar, 1993). Moringa oleifera Lam, a non- leguminous multipurpose tree with a high crude protein in the leaves (251g/kg DM) and negligible content of tannins and other anti-nutritive compounds (Makka and Becker, 1996) offers an alternative source of protein to ruminants wherever they prosper.

In Nigeria, Moringa oleifera is grown in the backyard and as fodders and the leaves are mainly used as food. Evaluation of the blood profile of animals may give some insight as to the potentials of a dietary treatment to meet the metabolic needs of the animals since according to Church *et al* (1984), dietary components have measurable effects on blood constituents such that significant changes in their values can be used to draw inference on the nutritive value of feeds offered to the animals. The assertion of Ikhimoya and Imasuen (2007) that most of the available information on haematological parameters of goats in the humid tropics is based on disease prognosis is also applicable to sheep. Thus, data on blood profile of yankasa (YK) sheep offered multi-nutrient blocks containing varying levels of Moringa oleifera powder is scanty. The objective of this study therefore, was to evaluate the nutrient intake, digestibility, nitrogen balance, and haematological profile of YYR as affected by dietary inclusions of Moringa *oleifera* multi-nutrient blocks as supplement to Signal grass (Brachiaria *decumbens)*

Materials and Methods

Experimental site

The study was conducted at the Experimental Unit (EU) in the Livestock Investigation Department (LID) of the National Veterinary Research Institute (NVRI) Vom, Plateau State, Nigeria, located at latitude 8^0 $45^/$ and longitude 9^0 $43^/$ North. The mean annual temperature is 20.8^0C and mean annual rain fall 1400 mm with a marked dry season (November – May).

Experimental feed

Air-dried leaves of Moringa oleifera were purchased from a recognised plantation in Nasarawa, near Vom. The air-dried leaves were ground through 2 mm mesh harmer mill and stored in polythen airtight bags until required for used. The concentrate was milled at the Farm's Milling Unit (FMU). The basal diet was Signal grass (Brachiaria *documbens*) sourced from the Institute's Farm. Their nutrient compositions are given in Table 1.

Moringa Multi – nutrient Block Ingredients, Formulation and Assessment

Four different formulae were tested using four ingredients: Moringa *oleifera* Leaf Powder (MOLP); Lime Powder (LP); Salt (S), with Cement (C) as a possible binder. The MOLP was prepared from Moringa leaves. The other ingredients were purchased from a reputable livestock feed ingredients Store in Bukuru, Jos, Nigeria. The blocks were prepared manually from 10kg of the ingredient for each formulation. The S and C in each formulation were mixed together, and these mixtures were separately mixed with water at the ratio of 1:2 (w/v; Aye and Adegun, 2010) before being incorporated into the second mix, comprising of MOLP and LP. Cylindrical plastic moulds (13cm x13cm with a height of 10cm) were used in casting the blocks to give 1 kg per block. During casting, the insides of the moulds were lined with thin nylon sheets to prevent the blocks from sticking to the wall of the moulds, and to allow for easy removal of the blocks from the moulds. Each mix was pressed separately into moulds and the blocks were made on the floor. The floor was sprinkled with wheat offals, so that the blocks were removed sequentially from the blocks immediately after moulding. The blocks were left to air-dry in the well-ventilated shed. The blocks were monitored and assessed for hardness and compactness over 7, 14 and 21 days respectively by 4 persons independently using a subjective scale: Soft (+) Medium (++) and Good (+++). Hardness was determined by pressing with the thumb in the middle of the block while compactness was measured by the ease to break the block by hand (Mohammed *et al*. 2007).

About 50g sample from each of the four investigated formulation were separately pulverized, pooled together and sampled for their respective proximate contents (AOAC, 1995). Mineral analysis was by wet digestion of sample. Ca, Zn, Mg and Cu contents were determined with the aid of an AAS. MOLP was similarly analyzed for proximate and mineral contents.

The second phase of the experimental work was the testing of the moulded blocks on yearling yankasa rams at the LID, NVRI, Vom. Yearling Yankasa rams (n= 25) averagely weighing 23.10kg were used in a Completely Randomnized Design (CRD) experiment. The animals were housed in five demarkated pens of five animals per pen. They were divided into five groups of five animals each after balancing for weight and each group randomly assigned to five treatments namely:

Treatment 1:B. decumbens + concentrate (Control)

Treatment 2: B. decumbens + concentrate + 5% Moringa Block

Treatment 3: B. decumbens + concentrate + 7% Moringa Block

Treatment 4: B. decumbens + concentrate + 9% Moringa Block

Treatment 5: B. decumbens + concentrate + 11% Moringa Block

The experiment was conducted during the raining season of 2012(June-September) and lasted for 70 days.

Digestibility Trial

In the last week of the experiment, total faecal and urinary outputs were collected from each animal daily and weighed. 10% of daily faecal outputs were dried, bulked together and stored until needed for proximate analysis, while 10% of the daily urine output preserved with 50% Sulphuric acid was frozen till it was required for nitrogen analysis.

Chemical Analysis

Feed and faeccal samples were oven-dried, ground to pass through 1mm screen and analysed for proximate compositions (AOAC, 1995). Nitrogen in urine was determined by Microkjedahl methods. Results obtained were used to calculate the nutrients intake, digestibility, N balance and retention.

Haematological Studies

Blood was collected from the jugular vein of the experimental animals at the termination of the experiment in a vial containing ethylene diamine tetra-acetic acid (EDTA). The bottles were immediately capped and the content mixed gently for about a minute by repeated inversion or rocking. Blood samples were analysed immediately after collection for packed cell volume (PCV) and haemoglobin (Hb) concentration as described by Jain (1993). Red blood cells (RBC), white blood cell (WBC), as well as the differential WBC counts were determined using the Neubauer Haemocytometer after appropriate dilution (Lamb, 1981). Values for the constants: mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) and mean corpuscular volume (MCV) were calculated from RBC, Hb and PCV values as described by Jain (1993).

Statistical Analysis

The data collected were subjected to analysis of variance (ANOVA) using the general linear model(GLM) procedure of MINITAB(2000) and where significant F-values for treatment effect were found, means were compared by Least Significant Difference (LSD). Linear correlation and regression analyses were carried out according to SAS (1999).

Results and Discussion

Nutrients composition

The proximate compositions of Moringa and Brachiaria indicated in Table 1 show that both plants had differing dry matter (DM) contents (90.06% and 69.36% respectively) with Moringa higher in DM than Brachiaria. The crude protein (CP) content of Moringa at 15.93% is higher than that for Brachiaria (7.54%) and it exceeds the minimum protein requirements for ruminant recommended by ARC (1985). The CP of Moringa (15.93%) obtained in this study fell within the range (7.8-20.5%) obtained by Aganga and Tshwenyane (2004). However, the CP value obtained in this study differs from values reported by other authors. For instance, Makkas and Becker (1996) and Manh *et al*. (2005) obtained CP values of 25.1 and 26.4% for Moringa respectively. Variability in the nutrient content of browses has been attributed to within species differences, plant parts, season, harvesting regime, location, soil type and age (Norton, 1994).

Table 1: Proximate composition (%) of Moringa *oleifera*, Brachiaria *decumbens* and Concentrate

Composition	M. *oleifera*	B. *decumbens*	Concentrate	SEM
DM	90.06	69.36	92.87	3.51
CP	15.93	7.54	12.28	6.43
CF	11.84	33.87	9.27	7.12
EE	1.06	1.05	4.87	0.59
Ash	4.89	12.15	6.39	4.31
NFE	66.28	54.62	32.81	1.50

Crude fiber (CF) content in Brachiaria was similar to 33.4% reported by Aganga and Tswenyane (2004) and was higher than the value obtained for Moringa in this study. This is consistent with the observation of Okoli *et al*. (2003) that CF content of tropical grasses is usually higher than that of browse shrubs and trees.

Nutrient Intake and Digestibility

Table 2 shows the nutrient intake and feed utilization by Yankasa rams fed dietary inclusion of Moringa *oleifera* powder multinutrient blocks and Brachiaria decumbens as basal diet. DM intake was highest ($P < 0.05$) in treatment 1 but it is comparable with values for treatments 2 to 5. The higher DM intake for treatment 1 could be due to the fact that small ruminants have affinity for Signal grass and since it was offered as sole feed, animals have no choice than to eat what was served (Babayemi and Bamikole, 2006).

Table 3 shows the DM and nutrient digestibility in Yankasa rams fed dietary inclusions of Moringa. With the exception of CF, nutrient digestibility were significantly higher ($P<0.05$) in supplemented diets than in the control. Among the Moringa- supplemented diets, DM and

ADF digestibility were highest in treatment 5 while CF and EE digestibility were best in treatment 3.

CP digestibility in treatments with dietary levels of Moringa were statistically similar and were all significantly higher ($P < 0.05$) than in the control. This is probably because Moringa fodder consists of more degradable components especially crude protein than Brachiaria *decumbens* and this could serve as supplement to the latter in ruminant diets. The higher CF digestibility in treatments 3 and 4 equally suggests an increase in the rumen activities of fibrolytic bacteria in the rumen probably as a result of the availability of essential nutrients especially protein, energy and minerals in balanced proportions to enhance microbial growth and multiplication.

The significant ($P < 0.05$) positive relationship between Moringa inclusion and both CP and NFE intakes is probably a reflection of the increasing quality of the diets with increasing level of Moringa supplementation since according to Ventura *et al* (1975), forage quality increases as nutrient intake increases.

Nitrogen Balance

Table 4 depicts the N-balance when varying levels of Moringa Multi-nutrient Blocks were fed to YYR. N-intake increased progressively from treatments 1 to 4 and only dropped slightly in treatment 5, hence it has significant ($P < 0.05$) direct relationship with dietary level of Moringa. This is probably due to increased CP intake with increasing level of Moringa inclusion in the experimental diets as reported above. However, this is at variance with the 9.2g day^{-1} obtained by Alli- Balogun *et al* (2003) for Yankasa/WAD sheep crosses fed grasses supplemented with cassava foliaga or groundnut hay. The difference may not be unconnected with the method of feeding, materials fed and genotypic difference.

Both faecal and urinary-N did not differ ($P > 0.05$) among the diets in agreement with Black *et al.,* (1978) that faecal and urinary-N were not significantly affected by N intake. According to Brooker *et al.,* (1995), when feed is high in soluble plant protein, then, N metabolism occurs mainly in the rumen rather than in the lower digestive tracts leading to the production of large quantities of ammonia-N in excess of the requirement of rumen micro-organisms. The ammonia-N not utilized by the bacteria is converted to urea by the animal and excreted in urine. This means that more rumen ammonia would be produced with the Moringa supplemented diets which would have increased as N intake increased from treatments 2 to 5.

All the treatments gave positive N-balance and N-retention values, except treatment 1 which gave negative N-retention value, an indication that protein requirement for maintenance in the experimental animals was adequate by the dietary treatment, except treatment 1 which did not enjoy Moringa benefits. Treatment 4 had the highest (P<0.05) N-balance and N-retention. The implications of treatment 4 having the best N-balance and N-retention in this study is that, optimum level of supplementation of Brachiaria *decumbens* with M.*oleifera* is probably at 9% and that at higher inclusion levels, efficiency of protein utilization decreases. Nitrogen balance has been described as a good indicator of the protein value of a diet when the amino acid supply is balanced with the energy supply (Babayemi and Bamikole, 2006).

Haematological Studies

The data presented in table 5 show that except for mean corpuscular haemoglobin (MCH), mean corpuscular value(MCV) and neutrophils (N) which were apparently significantly different (P<0.05), other erythrocytic indices were apparently similar across the treatments. Even though, the red blood cell (RBC) counts did not differ significantly (P>0.05), only value obtained for treatment 1 did not fall within the normal physiological range of 9.0 – $15.0 \times 10^{12/L}$ for healthy sheep (Jain, 1993). RBC counts aid in the characterization of anaemia (Ikhimioya and Imasuen, 2007). Thus the abnormally low values recorded for treatment 1 is an indication of a likely high susceptibility to anaemia-related disease conditions by these animals. This is corroborated by the fact that animals in this treatment also recorded MCV that was comparatively at the high end of the normal physiological range of 28.0 – 40.0 FL (Jain, 1993) which according to Merck (1979) increases the probability of the release of immature red blood cells into the circulatory system.

Mean PCV was highest in treatment 3 and lowest in the control diet, that is, treatment 1, but all fell within the physiological range of 27.0 – 45.0% given by Jain, (1993). Similarly, haemoglobin (Hb) concentration was least in numerical value in the control but all fell within the physiological range (9.0–15.0g/dl) as given by Jain (1993), indicating the stable physiological status of the experimental animals.

Table 5 also presents the total and differential leucocytes counts of Yankasa sheep when offered M. *oleifera* as supplement to Brachiaria *decumbens*. All treatments fell within the physiological range of $4.0\text{-}10.0^{9}$ /L given by Jain, (1993) for normal sheep. Out of all the differential leucocyte parameters, only neutrophil counts showed significant difference (P<0.05). Aikuomobhogbe and Orheruata (2006) pointed out that varying lymphocyte values indicated different levels of immune status of farm animals and Lazzaro (2001) further explained that depressed levels of lymphocytes might indicate a depleted immune system or elevated neutrophil in an active infection. However, lymphocyte and neutrophil counts obtained in this study fell within the physiological range of 40.0-75.0% and 20.0-70.0% respectively for healthy sheep (Jain, 1993). Further statistical analysis in Table 6 revealed that neutrophil and lymphocyte counts had non-significant (P>0.05) negative correlation (r = -0.22). In Table 6 also, all other haematological parameters had variable, significant and non-significant correlations (P<0.05) with Moringa inclusions, suggesting that, the probability of predicting haematological profile of Yankasa sheep from levels of dietary inclusion of M. *oleifera* is high. This is in contrast with the report of Akinyemi *et al* (2010) who discovered that all the haematological parameters had variable but non-significant correlations (P>0.05) with Moringa suggesting that the probability of predicting haematological profile of WAD sheep from levels of dietary inclusion of M.*oleifera* was low. The contrast in the two positions may be due to differences in animal species, location, period of the experiment and type/nature/method of feed and feeding.

Conclusion

This study revealed that Moringa leaf powder multi-nutrient Blocks had significantly high crude protein and lower crude fiber contents than Brachiaria *decumbens* and its inclusion in the diets of Yankasa rams as supplement to grass resulted in significantly higher crude protein intake, higher dry matter and nutrient digestibility, higher nitrogen retention and better haematological profile in the supplemented than non-supplemented. It was also found out that the optimum inclusion level of Moringa at which the best nitrogen balance, nitrogen retention and haematological profile was recorded was at 9% Moringa inclusion.

Acknowledgements

The authors are grateful to the Management of the National Veterinary Research Institute (NVRI), Vom, under the abled leadership of Dr. M.S. Ahmed (Executive Director), for sponsoring this research work. We are equally grateful to the staff of Livestock Investigation Department (LID) for providing the technical logistics of this work. We also thank the staff of the Central Diagnostic Laboratory (NVRI), Vom and the Laboratory staff of the Animal Science Department, Faculty of Agriculture, Ahmadu Bello University, Zaria, for the analyses of the samples.

TABLE 2: FEED INTAKE, LIVE WEIGHT CHANGES AND FEED UTILIZATION OF YEARLING YANKASA RAMS FED VARYING LEVELS OF MLP

	Levels of Inclusion of MLP (%)					
Parameters	**T1 (0%)**	**T2 (5%)**	**T3(7%)**	**T4(9%)**	**T5 (11%)**	**±SEM**
Intake (g/day)						
Concentrate	1340[a]	3310[ab]	3270[b]	3220[b]	3380[a]	0.004
Signal grass hay (Brachiaria decumbens)	3220[b]	3310[ab]	3270[b]	3220[b]	3380[a]	0.003
Total DMI (g)	4660[a]	4560[a]	4520[a]	4470[a]	4630[a]	0.002
Live Weight Changes(g)						
Initial body weight (g)	25100[b]	24000[b]	22000[a]	22600[a]	21400[a]	0.031
Final body weight (g)	23600[a]	24800[a]	26000[b]	24000[a]	23200[a]	0.006
Average weight gain (g)	-1.500[a]	800[b]	4000[d]	1400[c]	1800[c]	4.35
ADWG (g)	-21.4	11.4	57.1	20.0	25.7	
Body temperature (T^{O})	37.7[a]	37.6[a]	37.5[a]	37.7[a]	37.8[a]	0.77
Body condition scorings	3.3[a]	3.5[b]	4.0[c]	3.5[b]	3.6[b]	0.09

DMI= Dry Matter Intake, ; ADWG= Average Daily Weight Gain;

a,b,c,d means along the same row with different superscripts are significantly different ($P<0.05$); SEM= standard error of means.

TABLE 3: MLP NUTRIENT DIGESTIBILITY

Parameters	% Levels of MLP					
%	T1(0%)	T2(5%)	T3(7%)	T4(9%)	T5(11%)	±SEM
DM	80.51^{a}	84.76^{b}	87.67^{b}	86.08^{b}	89.01^{b}	1.42
CP	15.21^{a}	20.11^{b}	20.21^{b}	21.12^{b}	20.18^{b}	2.03
ASH	25.01^{a}	27.96^{b}	28.88^{b}	27.84^{b}	27.69^{b}	2.66
EE	1.22^{a}	1.98^{b}	2.13^{b}	1.88^{b}	1.99^{b}	1.34
CF	4.21^{a}	4.87^{a}	4.93^{a}	5.03^{a}	4.79^{a}	1.48
NDF	20.03^{a}	21.30^{b}	21.21^{b}	22.15^{b}	23.12^{b}	1.52
ADF	10.61^{a}	11.36^{b}	10.59^{b}	11.12^{b}	11.39^{b}	1.05
Lignin	3.44^{a}	2.64^{b}	1.98^{b}	2.02^{b}	2.34^{b}	0.81

a, b Means along the same row with different superscripts are significantly different ($P< 0.05$); SEM= Standard error of the mean

TABLE 4: NITROGEN BALANCE (g day^{-}1)

Parameter	% Level of MLP					
(%)	T1(0%)	T2(5%)	T3(7%)	T4(9%)	T5(11%)	±SEM
N- intake	2.72^{a}	3.22^{b}	3.23^{b}	3.38^{b}	3.23^{b}	1.41
Feacal- N	2.17^{a}	2.38^{a}	1.85^{a}	1.78^{a}	1.50^{a}	1.62
Urinary- N	0.60^{a}	0.64^{a}	0.59^{a}	0.71^{a}	0.85^{a}	2.10
N – retention	-0.05^{a}	0.20^{b}	0.79^{b}	0.89^{b}	0.85^{b}	0.81

TABLE 5: EFFECT OF DIFFERENT LEVELS OF MORINGA OLEIFERA LEAF POWDER SUPPLIMENTATION ON HEAMATOLOGICAL INDICES OF YEARLING YANKASA RAMS USING BRACHIARIA DECUMBENS AS BASAL DIET

PARAMETER	TREATMENTS					
	T1	T2	T3	T4	T5	±SEM
RBC Count ($\times 10^{6}$ mm^{-3})	8.1^{a}	9.7^{a}	9.5^{a}	9.3^{a}	9.4^{a}	0.88
Haemoglobin (g $100ml^{-1}$)	9.7^{a}	10.1^{a}	10.2^{a}	9.8^{a}	9.9^{a}	1.01
PCV (%)	29.8^{a}	30.2^{a}	34.8^{a}	29.9^{a}	30.4^{a}	3.02
MCHC (%)	32.6^{a}	33.8^{a}	26.2^{a}	33.6^{a}	32.2^{a}	2.94
MCH (pg)	12.0^{ab}	13.8^{ab}	9.4^{b}	17.8^{a}	14.7^{ab}	2.08
MCV (um^{3})	37.0^{ab}	40.6^{ab}	28.8^{b}	52.6^{a}	45.7^{ab}	5.80
WBC Count ($\times 10^{3}$ mm^{-3})	8.1^{a}	8.7^{a}	5.5^{a}	6.5^{a}	8.0^{a}	1.22
Monocytes (%)	0.2^{a}	0.0^{a}	0.0^{a}	0.4^{a}	0.5^{a}	0.23
Lymphocytes (%)	51.2^{a}	59.8^{a}	51.5^{a}	51.2^{a}	48.4^{a}	8.34
Neutrophils (%)	46.0^{ab}	39.2^{ab}	32.7^{b}	54.4^{a}	50.6^{a}	7.33
Eosinophils (%)	0.6^{a}	1.0^{a}	0.4^{a}	0.8^{a}	0.8^{a}	0.65
Basophils (%)	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	0.00

a,b means along the same row with different superscripts are significantly different ($P< 0.05$); S.E = Standard error of the means

TABLE 6: MATRIX OF CORRELATION COEFFICIENTS AMONG HEAMATOLOGICAL PARAMETERS OF SHEEP

	PCV	WBC	HB	RBC	HCHC	MCH	MVC	N	L
PCV	1.000	0.554**	0.997**	0.882**	0.870*	0.390	0.434	0.390	0.632
WBC		1.000	0.573**	0.597**	0.631**	0.371	0.381	0.375	0.234
HB			1.000	0.901**	0.878**	0.392*	0.431	0.379	0.650
RBC				1.000	0.928**	0.499**	0.526**	0.415	0.666**
HCHC					1.000	0.617**	0.643**	0.512**	0.641**
MCH						1.000	0.993*	0.607**	0.144
MVC							1.000	0.629**	0.167
N								1.000	-0.215
L									1.000

**,*=Significant at 0.01 and 0.05% level of probability respectively

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