Nigerian J. Anim. Sci. 2016 (2):492 - 506

Influence of *Moringa* leaf meal (MOLM) supplementation on Growth performance, Haematological parameters and faecal egg count of West African dwarf sheep

[1*]Yusuf, A. O., [1]Iposu, S. O., [1]Sanwo, K. A., [1]Akinde, K. T., [1]Owolabi, A. J., [1]Omotosho, O. O., A, [3]Adedayo, O. A. and [2]Okwelum N.

[1]Department of Animal Production and Health, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria
[2]Institute of Food Security, Environmental Resources and Agricultural Research, Federal University of Agriculture, Abeokuta, Nigeria.
[3]Department of Biological Science, North West University, Mahikeng, South Africa

Corresponding author: zee_mine@yahoo.com

Target Audience: Researchers; Ruminant Nutritionists; and Sheep farmers.

Abstract

Eighteen (18) West African Dwarf (WAD) rams weighing between 9 – 17 kg were used in a feeding trial to determine the effect of Moringa oleifera plant at varying levels of inclusion. The experimental animals were divided into three (3) groups of six (6) animals per group. Each group were randomly allotted to the 3 experimental diet containing 0%, 5% and 10% Moringa oleifera leaves meal respectively in a Completely Randomized Design. Results showed that M. oleifera leaves supplemented had no significant (P> 0.05) effect on performance characteristics of rams. However, weight gain g day[1] and metabolic weight gain (kg) increased with increasing M. oleifera leaves inclusion. At the onset of the experiment, there were no significant (P>0.05) different among all the haematological parameters considered while the mean corpuscular haemoglobin was significantly (P<0.05) influenced by the varying levels of Moringa supplemented in the diets. Oocyst and egg count were reduced by M. oleifera inclusion. Hence, increased inclusion levels M. oleifera leaves supplementation could reduce the worm load of WAD rams and as well increase the feed intake and dry matter intake as well as growth performance characteristics of the WAD rams with no influence on the health status of the rams.

Keywords: Faecal egg count, Growth *Moringa oleifera*

Description of the problem

Sheep is globally accepted animal reared for its meat and other economic importance. As a small ruminant, sheep is a source of meat which provides animal protein that is indispensable to a balanced diet. Rams meat enjoys worldwide acceptability among different socio-cultural groups because there is no taboo against it (1).

Sheep and goats in the humid zone of West Africa especially in Nigeria, roam around and eat natural pastures and kitchen wastes which contain low crude protein, high fibre and lignin contents (2). The low nutritional plane greatly hampers the productivity of these animals especially during the dry season when the crude protein content of the feedstuffs could be as low as 2 % (3). This subsequently leads reduced growth rate, low birth weight, predisposition to diseases as well as maternal and lambs death (4). Adequate balanced diet in terms of protein and energy with other essential nutrients is required to improve the productivity of small ruminants through improvement in the nutritive value of their diet, removal of nutritional limitations to rumen fermentation, and a balanced supply of nutrients to host animals would result in an improvement in animal productivity (5).

Supplementation with concentrate mixtures like cereal grains, maize bran, or oilseed meals has resulted in increased intakes in intensive production systems and has been the subject of several excellent reviews including that of (6). However, due to the competition between man and animals for their available feed resource as well as their relatively high cost, a search for alternatives becomes imperative. The use of forages legumes and other browse plants that are ever green all year round has been suggested as an alternative to the concentrate 8 and 9). However, there use have been hindered due to the presence of secondary plant compounds such as tannins, saponin, cyanogen, mimosine and coumarin, which limit nutrients utilisation (10; 11).

Moringa oleifera leaves have been documented to contain essential nutrients which makes it a potential replacement for the common conventional and costlier ruminant diets. Moringa can easily be established in the field, has good coppicing ability, as well as good potential for forage production. Furthermore, there is the possibility of obtaining large amounts of high quality forage from *Moringa* without expensive inputs due to favourable soil and climatic conditions for its growth. Sarwatt *et al*., (3) reported that *Moringa* foliage are potential inexpensive protein source for livestock feeding. *Moringa oleifera* is an edible plant. Its roots, bark, leaves, flowers, fruits, and seeds have been reported to have wide variety of nutritional and medicinal attributes (12, 13; 14). Results of phytochemical analyses have shown that its leaves are particularly rich in minerals like potassium, calcium, phosphorous, iron, vitamins A and D, essential amino acids, as well as antioxidants such as β-carotene, vitamin C, and flavonoids (15, 16, 17, 18, 19). Hence, this study therefore evaluates the effect of *Moringa oleifera* supplementation on growth performance, haematological parameters and faecal egg count of West African Dwarf (WAD) rams.

Materials and Method

Experimental site

The experiment was conducted at the sheep unit, Directorate of University Farms (DUFARMS), of the Federal University of Agriculture, Abeokuta, Ogun state, Nigeria. The farm is located in the humid tropical zone of South-Western Nigeria with minimum and maximum temperature of 20.66°C and 35.48°C respectively. It is located within 7°13'49.46"N and longitude 3°26'11.98"E. The altitude is 76 meters above sea level (55).

Experimental Animals and Management

Eighteen (18) growing WAD rams of average weight (13.75 kg ± 0.62) were used for this study. The animals were housed individually in a pen, quarantined and acclimatized for a period of four (4) weeks in which they were assessed and treated for various conditions. The animals were administered Oxytetracycline L.A. (1ml Kg^{-1}BW) and Multivitamins (1ml Kg^{-1}BW) against any bacterial infection and to increase the animals' appetite during this quarantine period. During the period, the animals were introduced to the control diet in order to adjust their rumen bacteria to the feed. The pens were cleaned every morning and clean water provided in the morning and evening. All animal husbandry practices were carefully observed to ensure proper hygiene.

Preparation of experimental diets

Fresh *Moringa* leaves were collected from existing trees, defoliated and dried under shade until they are crispy to touch while retaining their greenish colouration. The leaves were then milled to obtain a product herein referred to as *Moringa oleifera* leaf meal (MOLM) which was stored in sacks until needed for inclusion in the concentrate diet. Three experimental concentrated diets were formulated using 0%, 5% and 10% inclusion levels of MOLM. The MOLM were mixed with palm kernel cake (*PKC), Wheat offal, Rice bran, Oat meal, Premix and salt* to formulate a concentrate diet milled at a commercial feed mill (Table 1). The animals were fed on forages (wilted *Panicum maximum*) as a basal diet in the morning and the experimental diets was served as supplement in the evening. Forages were offered *ad-libitum* to the individual animals and concentrate diet was also served at 4% of their body weight.

Table 1: Ingredient composition and calculated analysis of experimental concentrate

Ingredients	DIET I MOLM (0%)	DIET II (5% MLOM)	DIET III (10% MOLM)
PKC	19.24	18.26	16.79
Wheat offal	20	20	20
Rice bran	40	37	35
Oat meal	20	18.99	17.46
Premix (GBF)	0.25	0.25	0.25
Salt	0.5	0.5	0.5
MOLM	0	5	10
Total	100	100	100

PKC: Palm kernel cake MOLM: *Moringa* leaf meal

Experimental design

The eighteen (18) WAD yearling rams were randomly divided into three (3) treatment groups of six (6) animals per group. Each group was randomly allotted to the three (3) experimental diets in a completely randomized design (CRD).

Data Collection

Body weight

Individual animals were initially weighed with a digital hanging scale at the commencement of the experiment and at 7 days interval throughout the period of the experiment. Weighing was done in the morning before feeding.

Feed intake

The feed offered and leftover feed were measured manually on daily basis. It was calculated as thus; Feed offered – Leftover.

Feed conversion ratio

Body weights were used to calculate the daily weight gain and feed conversion ratio (FCR). It was obtained using the formula; Feed conversion ratio (FCR) =

$$\frac{\text{Feed intake (kg)}}{\text{Weight gain (kg)}}$$

Chemical Analysis

The proximate composition of Moringa oleifera Leaf Meal and the experimental diets was carried out according to the methods of (20).

Blood Sample Collection

Five (5 ml) of blood was collected via jugular vein-puncture using hypodermic needle and syringe at the beginning and at the end of the experiment. The blood was collected into ethylene-diamine-tetra acetic-acid (EDTA) tubes for blood haematology analysis as described (21).

***Faecal Egg Count* (FEC)**

Faecal samples of about 5 grams were collected directly from the rectum of each animal on the first and the last three days of the growth experiment and taken to the laboratory to determine the faecal egg count using the McMaster salt floatation technique.

Statistical analysis

Data collected was subjected to one-way Analysis of variance (ANOVA) in a Completely Randomized Design (CRD). Significant different means were separated using the new Duncan's Multiple Range Test (22).

Result and Discussion

Table 2 shows the proximate composition of *Moringa oleifera* and the experimental diets. *Moringa oleifera* contained 4.0 % moisture, 96.00 % Dry matter (DM), 31.47. % Crude protein, 43.33 % Crude fibre, 4.00 % ether extract and total ash of 9.67 %. In the diets, the DM ranges between 89.44-% - 97.40 %, the crude protein ranged from 22.90 % in diet I to 27.66% in diet III, crude fibre ranged between 3.85 % in diet II to 4.96 % in diet III, and total ash ranged from 5.82 % - 6.98 %. It was (23) stated that multipurpose tree species contain 20 % crude protein (CP) or above in their leaves. This corroborate with the result of this study, where 31.47 % crude protein was observed for *Moringa* leaves. It is however higher than 17.016g kg^{-1} (1.701 %) reported (24) for *M. oleifera* harvested in northern Nigeria. Odee (53) reported a crude protein content of 29% for *M. oleifera*, which is lower to what was obtained in this study (31.47 %). Also, the crude protein value obtained in this experiment was higher compared to those reported by other authors (25; 26) and it exceeded the crude protein requirement for growing rams. Hence, it is valuable in feed of growing and reproducing sheep.

Table 2: Proximate composition of *Moringa oleifera* and experimental diets

Proximate Composition	DIET I (0% MOLM)	DIET II (5% MOLM)	DIET III (10% MOLM)	*M. oleifera*
Moisture (%)	4.03	10.56	2.60	4.00
Dry matter (%)	95.97	89.44	97.40	96.00
Crude protein (%)	22.92	25.58	27.66	31.47
Crude fat (%)	4.56	3.85	4.96	4.00
Crude fibre (%)	9.26	8.61	10.11	43.33
Total ash (%)	6.21	5.82	6.98	9.67

Ether extract is the lipid fraction, which is a major form of energy storage in the plant. The energy derivable from the plant is what the animal uses for its body maintenance and production (56). The ash content represents the inorganic (mineral matter) content in a feed. The values obtained in this study for Ether extract and Ash (4.00 % and 9.67 % respectively) were higher than values obtained by (27) who obtained 2.63% and 5.13%, respectively. Also, the values obtained for ash content was higher compared to 7.5 % reported by (24) for *M. oleifera* harvested in northern Nigeria. It was also higher compared with a range of 15.27 – 20.55g kg^{-1} (1.527 - 2.055 %) reported by some authors (28) who worked with Red Sokoto goats (weaners).

The Crude fibre obtained in this study (43.33%) for *M. oleifera* was higher than the value obtained by (27) who obtained a crude fibre value of 19.20% for *M. oleifera*.

Dry matter of this study falls within the 91.05g kg^{-1} range reported by (29). The Ether extract of the study is in accordance with that recommended by (30) for growth as crude fat above 5% will limit consumption and result in gastro intestinal disturbances. Variability in the nutrient content of browse plants has been attributed to within species differences, plant parts, season, harvesting regime, location, soil type and age (31).

The results of the performance characteristics of WAD rams fed *M. oleifera* at varying inclusion levels are presented in Table 3. The dietary treatment had no significant (P>0.05) effect on the weight gain, feed intake, dry matter intake and protein intake. The non-significant feed intake and dry matter intake had the highest values (511.05 and 497.76), respectively, in sheep fed 10 % Moringa leaf meal supplementation compared to others treatments. This agrees with the findings of (32) and (33) who reported increasing dry matter intake with increasing level of browse supplementation. The higher dry matter intake (DMI) obtained in Diet III may be due to greater palatability and higher protein content of the diet. Richter *et al*., (34) opined that low quality livestock fodders or rations can be improved by adding Moringa as supplement which increases the dry matter intake (DMI) of the ration by livestock. It was also reported that diet with higher protein content increase feed intake (35).

Despite the fact that the inclusion level of Moringa did not significantly influence the weight gain, animals fed Diet III had numerically higher values for weight gain (kg), weight gain (g), weight gain (gday^{-1}) and metabolic weight gain followed by ram fed Diets II while those fed Diet I had the least values. The numerically higher values for weight gain (kg), weight gain (g), weight gain (gday^{-1}) and metabolic weight gain obtained in rams with 5 and 10 % *Moringa* inclusion might probably be reflection of increasing quality of the diets with increasing level of Moringa which will be probably enhance the utilization and the availability of essential nutrients especially protein, energy and mineral of the dietary organic matter (36).

Table 3: Performance characteristics of West African Dwarf sheep fed *M. oleifera* leaf meal at varying levels of inclusion.

Parameters	Levels of supplementation			SEM
	DIET I (0% MOLM)	DIET II (5% MOLM)	DIET III (10% MOLM)	
Initial weight (kg)	13.75	13.75	13.75	0.62
Final weight (kg)	15.75	16.00	17.00	0.92
Weight gain (kg)	2.00	2.25	3.25	0.42
Weight gain (g)	2000.00	2250.00	3250.00	417.42
Weight gain gday^{-1}	54.05	60.81	87.84	11.28
Met wt. gain (kg)	1.64	1.83	2.34	0.63
Feed intake	396.79	495.20	511.05	26.90
Protein intake	114.75	126.67	141.36	6.96
DMI	378.97	418.15	497.76	25.38
FCR	8.69	8.38	8.56	1.05

SEM: Standard Error of Mean, DMI: Dry Matter Intake, FCR: Feed Conversion Ratio, Met wt.: Metabolic weight

Feed efficiency is the amount of dry matter intake (DMI) required producing one kg of live body weight gain. The better feed efficiency obtained by feeding Diet 2 and Diet 3 may be attributed to the beneficial effects of *M. oleifera* leaf meal, which provided stimulator factors and essential nutrients especially protein, energy, minerals and vitamins that better utilized by the rams. These factors and essential nutrients resulted in some change in the digestive function that led to increasing the availability and utilization of nutrients in the rumen and could have a significant impact on the feed utilization and growth rate (36).

The non-significance higher feed conversion ratio (FCR) recorded for Diet II is in line with the report of (37) who stated that feed to gain decreased linearly with increasing protein intake, indicating that animals on Diet II were more efficient in converting feed to weight gain than others. Earlier similar observations by (36) between growth and feed conversion efficiencies of growing lambs fed varying levels of tree leaves and concentrates were attributed to the influence of better nutrient density and quality of nutrients available for utilization.

Haematological parameters of the experimental rams at the beginning of the experiment are presented in Table 4. This serves as a reference and basis to ascertain the health status of the experimental animals. There were no significant (P>0.05) different among all the haematological parameters considered.

The non-significant packed cell volume values were however, within the range of 24-45% reported by (38) and 27-45% reported by (40). with rams on 10 % level of inclusion having the highest (37.00), followed by those on 0 % (35.00) with those on 5 % level of inclusion having the least value (29.67). Haemoglobin concentration, red blood cell, mean corpuscular haemoglobin, mean corpuscular volume and white blood cell followed the same trend as observed for packed cell volume with the highest values in rams fed 10% MOLM and lowest in rams fed 5% MOLM, except in mean corpuscular haemoglobin concentration where the highest mean value (33.36 g/dL) was recorded in rams fed 0% inclusion of MOLM, followed by 10% and the lowest mean (32.85g/dL) in rams fed 5% inclusion level of MOLM. The haemoglobin concentration, red blood cell, mean corpuscular haemoglobin, mean corpuscular volume, mean corpuscular haemoglobin and white blood cell, concentration values were within the reference range reported by (40), (38) and (41) for clinically healthy rams.

Table 4: Initial Hae matological Indices of Experimental Animals

PARAMETERS	DIET I (0% MOLM)	DIET II (5% MOLM)	DIET III (10% MOLM)	SEM
PCV (%)	34.00	29.67	37.00	2.03
Hb (Mg/dl)	11.33	9.73	12.33	0.67
RBC ($\times 10^{12}/\mu$ L)	12.20	10.70	13.17	0.72
MCH (pg)	92.99	91.01	93.75	0.51
MCHC (g/dL)	33.36	32.85	33.32	0.12
MCV (fL)	27.88	27.70	28.13	0.09
WBC ($\times 10^{3}/\mu$ L)	8.67	8.57	12.33	1.29

PCV= Packed Cell Volume, Hb= Haemoglobin concentration, RBC= Red Blood Cell, MCH= Mean Corpuscular Haemoglobin, MCHC= Mean Corpuscular Haemoglobin Content, MCV= Mean Corpuscular Volume, WBC= White Blood Cell, SEM= Standard Error of Mean

Table 5 shows the haematological parameters of West African dwarf rams fed varying levels of MOLM at the end of the experiment. Mean corpuscular haemoglobin was significantly (P<0.05) influenced by the varying levels of Moringa supplemented in the diets, while packed cell volume, haemoglobin concentration, red blood cell, mean corpuscular haemoglobin concentration, mean corpuscular volume and white blood cell count were not significantly (P>0.05) influenced by the dietary treatments.

The non-significant packed cell volume, haemoglobin concentration and red blood cell count values were within normal reference ranges reported in various literatures (42, 38). Ewuola *et al*., (42) reported a range of 31-38% for packed cell volume, while a range of 8-16g/dL was reported for haemoglobin concentration by (38) and (39) reported 9-15×10^{12}/µL for red blood cell count. Also, mean corpuscular volume and white blood cell count reported in this study was within the normal reference ranges reported for clinically healthy sheep. Merck (40) reported a range of 31-34g/dL for mean corpuscular haemoglobin concentration, while a range of 4-12×10^{3}/µL was reported for mean corpuscular volume by (38) and 23-48fl was reported for white blood cell count by (40) and (38).

Mean corpuscular haemoglobin values were also within the normal reference ranges of 8-12pg (38, 40) for clinically healthy sheep. Mean corpuscular haemoglobin values obtained in this study were lower than that by (43) in rams fed *Moringa* based multi nutrient block. Although the significantly different values reported in this study reduced with increasing *Moringa* inclusion corroborated the findings of (44) who reported a reduced mean corpuscular haemoglobin value in cattle consuming tannin-rich mature oak (*Quercus incana*) leaves. This suggested that the *Moringa* can be subjected to different drying treatment to reduce the activity of the phenolic compounds in it.

Table 5: Mean Haematologica l Indices of West African Dwarf Sheep Fed *Moringa oleifera* leaf meal at the end of the experiment

PARAMETERS	0% *Moringa*	5%*Moringa*	10% *Moringa*	SEM
PCV (%)	38.67	33.00	35.67	1.53
HB (g/dl)	12.87	10.97	11.90	0.50
RBC (×10^{12}µ /L)	13.83	11.87	12.83	0.53
MCH (pg)	9.32^{a}	9.24^{b}	9.27^{b}	0.13
MCHC (g/dL)	33.28	33.24	33.36	0.05
MCV (fl)	27.99	27.80	27.80	0.06
WBC (×10^{3}µ /L)	13.03	12.27	11.67	1.43

[a,b,c] Means across rows with different superscripts are significantly (P<0.05) different, PCV= Packed Cell Volume, Hb= Haemoglobin concentration RBC= Red Blood Cell, MCH= Mean Corpuscular Haemoglobin, MCHC= Mean Corpuscular Haemoglobin Content, MCV= Mean Corpuscular Volume, WBC= White Blood Cell, SEM= Standard Error of Mean

The result of oocyst per gram of faeces for West African Dwarf rams fed different level of *M. oleifera* leaf meal is presented in Figure 1. At the beginning of the experiment, higher numbers of oocyst were found in all experimental animals (ranging from 3450- 3510 opg). The three dietary treatments decreased the oocyst per gram of faeces. This decrease might be attributed to the crude protein level in the diets. Albers *et al*., (45) reported that the nutritional protein level can influence the ability of an animal to maintain productivity and limit the establishment of a parasitic infection. However, animals fed 5% MOLM reduced the oocyst per gram of faeces faster, compared to animals fed 0% MOLM and 10% MOLM. This corroborates with the report of (46), who reported that the crude protein of *M. oleifera* has better quality for ruminant compared to crude protein of other of other leaves because of its high content of by-pass protein which accounted for significant reductions in the total numbers of nematode in the gastrointestinal tract. Although, animals fed 10% MOLM showed the least rate at which the oocyst per gram of faeces was reduced, this might be attributed to the slow acclimatization of the experimental animals to the diet.

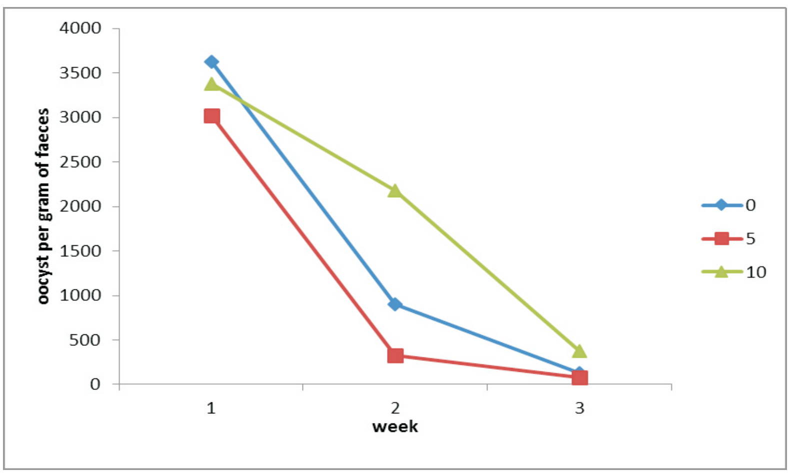

Figure 1: Result of Oocyst per gram of faeces for sheep fed different lev el of *Moringa oleifera* leaf meal

The result of Egg per gram of faeces for rams fed different level of *M. oleifera* leaf meal is presented in Figure 2. The initial's worm load ranges between 1350-1450 epg in experimental animals. Animals fed 5% MOLM supplementation reduced the egg per gram of faeces at an increased rate compared to animals fed 0 and 10% MOLM. This study agrees with (47) who reported that dietary supplements high in protein level improves the immune response of animals which acts to decrease helminthic infection. Rastogi *et al*., (48) also reported that any increase in intestinal protein supply improves the immune response against helminths.

The reduction in both oocyst per gram of the faeces and egg per gram of the faeces in the present study can be hinged on the fact that particular plant secondary metabolites, could have direct or indirect effects on worm populations (49; 50; 51). Also, feeding proteinious diet above the nutritional requirement has been found to improve the resilience and resistant of sheep to gastrointestinal nematodes or worm population (52). This can justify the non-significant nature of most of the growth performance parameters considered in this experiment as the nutrient meant for growth might have been used in building immunity or used up by the worm population

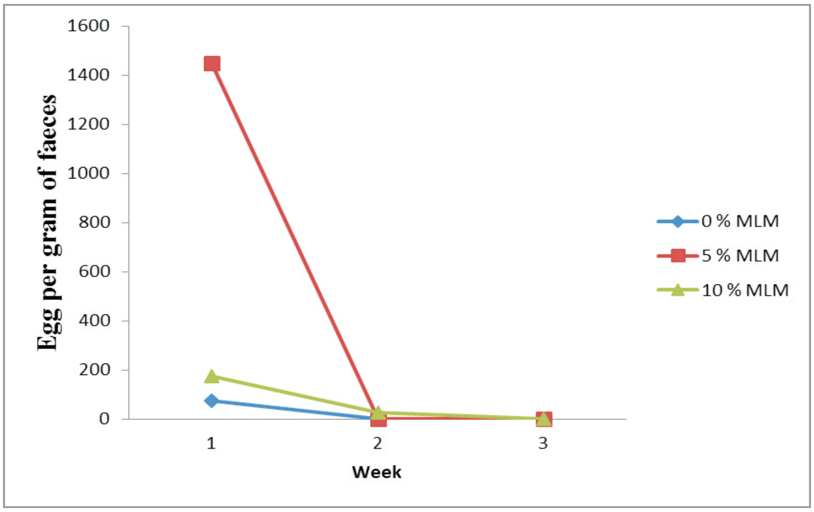

Figure 2: Result of Egg per gram of faeces for sheep fed different level of *Moringa oleifera* leaf meal.

Conclusion and Application

Based on the result of this study,

1. It is evident that inclusion levels of *Moringa oleifera* leaf meal in the diet of West African dwarf rams might increase their feed intake and dry matter intake as well as other performance characteristics, with no impairment in health status and reduction in the worm burden.
2. It can also be supplemented in the diet to reduce the worm load to reduce the worm burden of naturally infected sheep.

References

1. Peacock, C.P., (1996). Improving goat production in the tropics. A manual for development workers.
2. Aregheore, E.M. (2000) Chemical composition and nutritive value of some tropical by – product feedstuffs for small ruminants – In vivo and in vitro digestibility. Animal feed science and technology 85(1): 99 – 109.
3. Sarwatt, S.V., Milang'ha, M.S., Lekule, F.P. and Madalla, N. (2004). *Moringa oleifera* and cotton seed cake as supplements for smallholder dairy cows fed Napier grass. *Livestock research for rural development*. 16 Art.# 38.http//www.cipac.org.co//Irrd16 /6/sarw16038.htm Accessed on 01/02/2006.
4. Mendieta-Araica, B., Sporndly, R., Sanchez, N.R., Sporndly E. (2011) Moringa (*Moringa oleifera*) leaf meal as a source of protein in locally produced concentrates for dairy cows fed low protein diets in

tropical areas. *Livestock Science,* 137 (1): 10–17.

5. Mendieta-Araica, B., Sporndly, R., Sanchez, N.R. and Sporndly E. (2011). Moringa (*Moringa oleifera*) leaf meal as a source of protein in locally produced concentrates for dairy cows fed low protein diets in tropical areas. *Livestock Science* ,137 (1): 10–17.
6. Bangani, N. M., Botha, J. A., Muller, C. J. C. and Cruywagen, C. W. (2000). The production performance of lactating Jersey cows receiving varying levels of Lucerne hay and oat silage as roughage sources. *South African Journal of Animal Science*, 30 (Supplement1) http://www.sasas.co.za/30(Supplement%201)pdf/Bangani.PDF
8. Ndemanisho E. E., (1996). The use of *Leucaena leucocephala* (LAM) de wit forage as a protein supplement for dairy goats. PhD thesis, SUA, Morogoro.
9. Roothaert, R. L. and Paterson, R. T., (1997). Recent works on the production and utilization of tree fodders in East Africa. *Animal Feed Science and Technology,* 69: 39 – 51.
10. Leng, R. A., (1999) Feeding strategies for improving milk production. In: Falvey, L. and Chantalakhana, C. (editors.) *Smallholder Dairying in the Tropics*. ILRI (International Livestock Research Institute), Nairobi, Kenya. 462 pp.
11. Makkar, H. P. S. and Becker, K. (1997). Nutrients and anti-quality factors in different morphological parts of the *Moringa oleifera* tree. *Journal of Agricultural Sciences* (Cambridge), 128, 311-322.
12. Ramachandran, C., Peter, K.V. and GopalKrishanp, K., (1980). Drumstick (*Moringa oleifera*); A multipurpose Indian vegetable. Economic botany, 34 (3, 27 – 283).
13. Anwar, F., S. Latif, M. Ashraf and A.H. Gilani, (2007). *Moringa oleifera*: A food plant with multiple medicinal uses. Phytother. Res., 21: 17-25.
14. Kumar, A.K., Chalamaiah, M., Kumar, R.R. and Babu, K.N. (2009).Preliminary studies on biotransformation of drumstick (*Moringa oleifera*) and watermelon (*Citrullus lanatus*) seed oils using Baker's Yeast. *Asian J. Biol. Sci*., 2: 118-123.
15. Bennett, R.N., Mellon, F.A., Foidl, N., Pratt, J.H., DuPont, M.S.,Pand erkins, L. (2003). Profiling glucosinolates and phenolics in vegetative and reproductive tissues of the multi-purpose trees *Moringa oleifera* L. (Horse radish tree) and *Moringa stenopetala*. *J Agric Food Chemistry,* 51: 3546–3553.
16. Aslam, M., Anwar, F., Nadeem, R., Rashid, U., Kazi, T. G., Nadeem, M. (2005). Mineral composition of *Moringa oleifera* leaves and pods from different regions of Punjab, Pakistan. *Asian J. Plant Sci*ience, 4: 417 – 421 10.3923/ajps.2005.417.421.
17. Manguro, L.O.A. and Lemmen, P. (2007). Phenolics of *Moringa oleifera* leaves. *Natural Prod Res* 21: 56–68.

18. Amaglo, N.K., Bennett, RN, Lo Curto R.B, Rosa EAS, Lo Turco V, Giuffrida, A, Lo Curto A, Crea, F. And Timpo, GM (2010). Profiling selected phytochemicals and nutrients in different tissues of the multi-purpose tree *Moringa oleifera* L. grown in Ghana. *Food Chem.* 122:1047- 1054.
19. Gowrishankar, R., Kumar, M., Menon, V., Divi, S. M., Saravanan, M., Magudapathy P., Panigrahi B. K., Nair K. G., Venkataramaniah K. (2010). Trace element studies on *Tinospora cordifolia* (Menispermaceae), *Ocimum sanctum* (Lamiaceae), *Moringa oleifera* (Moringaceae), and *Phyllanthusniruri* (Euphorbiaceae) using PIXE. Biol. *Trace Elem. Res*.133, 357–36310.1007/s12011-009-8439-1.
20. AOAC, (2012). Guidelines for Standard Method Performance Requirements; 19th Edition of the AOAC International Official Methods of Analysis
21. Jain N. C. (1993). *Essentials of Veterinary Haematology*. Lea and Ferbeiger, Pennsylvania, U.S.A. 7pp.
22. Duncan D. B. (1955). Multiple range and multiple F tests. *Biometrics,* 11:1-42.
23. Waldroup, W.P. and Smith, K. (2008) Fact sheet soyabean use – poultry soyabean meal information centre http://www.soymeal.org/pdf/poultry soybean use. pdf
24. Ogbe, A. O and Affiku, J. P. (2011). Proximate study of mineral and antinutrient composition of *Moringa oleifera* leaves harvested from Lafia, Nigeria: Potential benefits in poultry nutrition and health. *Journal of Microbiology, Biotechnology and Food sciences*. 1(3):296-308.
25. Stelwagen, K. (2003) Milk secretion and biosynthesis/lactose. In: Roginski H, Fuquay J.W., Fox P.F. (Eds.). *Encyclopaedia of Dairy Sciences, Vol. 3*. Academic Press, New York, pp. 1842– 1847.
26. Chandan, R.C. (2006). History and consumption trends. In: Manufacturing Yogurt and Fermented Milks (Ed. Chandan, R.C.). Blackwell Publishing, Ames, IA, USA, pp. 3 – 15.
27. Morton, J.F. (1987). *Fruits of Warm climates.* Ackee, Miami, FL., pp 269-271.
28. Abubakar, M., Adegbola, T.A. and Abubakar, M.M. (2005). Effect of varying levels of groundnut haulms and cowpea shell on the Performance of Weaner Red Sokoto goats. *Nigerian Journal of Animal Production,* 32:274 – 279.
29. Fasae, O. A., Alokan, J.A. and Onibi, G.E. (2005). Feed intakes of Yankasa sheep fed varying levels of *Leucaena leucocephala* leaf residues. *Nigerian Journal of Animal Production, 32 (1): 88 – 93.*
30. NRC, (1984). *Nutrient Requirements of Poultry.* 8th Rev. Edn., National Academy Press, Washington,
31. Norton, B. W. (1994): The nutritive value of tree legumes, In:

Gutteridge R C and Shelton M (eds). *Forage tree legumes in tropical Agriculture*. CAB International, Wallingford, pp. 177 - 191.

32. Arigbede, O.M., Olanite J.A. and Bamikole M.A. (2005). Intake, performance and digestibility of West African Dwarf goats supplemented with graded levels of *Grewia pubescens* and *Panicum maximum. Nigerian Journal of Animal Production*, 32(2): 293 – 300.
33. Odeyinka, S.M. and Ademosun, A.A. (1995). The effects of the levels of feed offer on the intake, digestibility and growth rate of West African dwarf goats fed *Gliricidia sepium* and *Leucaena leucocephala. Nigerian Journal of Animal Production*, 22(2): 164-168.
34. Richter, N., Perumal, S., Klaus, B. (2003). Evaluation of nutritional quality of Moringa (*Moringa oleifera* Lam.) leaves as an alternative protein source for Nile tilapia (*Oreochromis niloticus* L.). *Aquaculture*, 217: 599 – 611.
35. M'hamed, D., ,Faverdin, P. and Verite R. (2001). Effect of the level and source of dietary protein on intake and milk yield in dairy cows. Ruminant Resources 50:205-211.
36. Tripathi, M.K., Karim, S., Chaturvedi, O.H. and Singh, V.K. (2006). Effect of *ad libitum* tree leaves feeding with varying levels of concentrate on intake, microbial protein yield and growth of lambs. *Livestock Research for Rural Development. Volume 18, Article #179.* Retrieved November 22, 2011, from http://www.lrrd.org/lrrd18/12/trip18179.htm
37. Tyler, R.W., Luce, W.G., Johnson, R.K., Maxwell, C.V., Hintz, R.L. and Walters, L. E. (1983). The effect of level of crude protein on performance of growing boars. *Journal of Animal. Science*. 57: 354 – 372.
38. Research Animal Resource [RAR]. (2009). *Reference values for laboratory animals: Normal haematological values*. RAR Websites, RAR, University of Minnesota. Retrieved from http://www.ahc.umn.edu/rar/refvalues.html.
39. Merck Manual (2011). *Haematological reference ranges.* Merck Veterinary Manual. Retrieved from http://www.merckmanuals.com/
40. Merck Manual (2012). *Haematological reference ranges.* Merck Veterinary Manual. Retrieved from http://www.merckmanuals.com/
41. Kiran D., Penner, G. B. and Mutsvangwa, T. (2011). Feeding oscillating dietary crude protein concentrations increase nitrogen utilization in growing lambs and this response is partly attributable to increased urea transfer to the rumen. *The Journal of Nutrition*.141 (4):560-567.
42. Ewuola E.O., Jimoh, O.A., Atuma O.V., Sodipe O.D. (2012).

Haematological and Serum Biochemical Response of Growing Rabbits fed Graded Levels of *Moringa oleifera* leaf meal. *World Rabbit Science Association. Proceedings 10 th World Rabbit Congress – September 3 - 6, 2012– Sharm El-Sheikh –Egypt, 679 - 683*

43. Adegun M.K., Aye, P.A. and Dairo, F.A.S. (2011). Evaluation of *Moringa oleifera, Gliricidia sepium* and *Leucaena leucocephala* - based multinutrient blocks as feed supplements for sheep in South Western Nigeria. *Agriculture and Biology Journal of North America.* Pp: 2151-7517, ISSN Online: 2151-7525, doi:10.5251/abjna.2011.2.11.1395.1401 © 2011, ScienceHuβ, http://www.scihub.org/ABJNA.

44. Garg, S. K., Makkar, H. P. S., Nagal, K. B., Sharma, S. K., Wadhwa, D. R. and Singh, B., (1992). Oak (*Quercus incana*) leaf poisoning in cattle. *Vet. Hum. Toxicol*., 34 (2): 161-164.

45. Albers, G.A.A., Gray, G.D., Piper, L.R., Barker, J.S.F., Le Jambre, L.F. and Barger, I.A. (1987). The genetics of resistance and resilience to *Haemeonchus contortus* infection in young merino sheep. Int. J. Parasitol. 17:1355 -1363.

46. Becker, K. (1995). Studies on utilization of Moringa oleifera leaves as animal feed. Institute for Animal Production in the Tropics and Subtropics, University of Hohenheim, Stuttgart, 480: 15.

47. Arsenos, G, Fortomaris, P., Papadopoulos, E., Sotiraki, S, Stamataris, C., Zygoyiannis, D. (2009). Growth and meat quality of kids of indigenous Greek goats (*Capra prisca*) as influenced by dietary protein and gastrointestinal nematode challenge. Meat Sci. 82:317-323.

48. Rastogi, T, Bhutda V, Moon K, Aswar P.B. and Khadabadi S.S. (2009). Comparative studies on antihelminth activity of Moringa oleifera and Vitexnegundo. *Asian J. Res. Chem*. 2:181-182.

49. Athanasiadou, S., Kyriazakis, I., Jackson, F., (2003). Can plant secondary metabolites have a role in controlling gastro intestinal nematode parasitism in small ruminants? In: *Proceedings of the VI International Symposium on the Nutrition of Herbivores*, 19–24 October 2003, Merida, Mexico.

50. Min, B.R. and Hart, S.P., (2003). Tannins for suppression of internal parasites. *Journal of Animal Science,* 81 (Suppl. 2), E102–E109.

51. Waghorn, G.C., McNabb, W.C., (2003). Consequences of plant phenolic compounds for productivity and health of ruminants. *Proc. Nutr. Soc*. 62, 383–392.

52. Hoste, H., Torres-Acosta, J.I., Paolmi, V., Aguilar-caballero, A., Etter, E., Lefrileux, Y., Chartier, C. and Broqua, C. (2005). Interaction between nutrition and gastrointestinal infections with parasite nematodes in goats. *Small*

Ruminant Research 60: 141-151.

53. Odee D. (1998). Forest biotechnology research in dry lands of Kenya: the development of *Moringa* species. *Dryland Biodiversity*, 2: 7-8.

54. Fasae, O.A., Adu I.F., Aina, A.B.J. and Dipeolu M.A. (2011). Growth performance, carcass characteristics and meat sensory evaluation of West African Dwarf sheep fed varying levels of maize and cassava hay. *Tropical Journal of Animal Health production*, 43:503-510.

55. Google Maps. (2014). *Royal Roads University*. Retrieved from https://www.google.com/maps/d/viewer?mid=ziZA4YH0pTUs.ktJc02G0F-O4&ie=UTF8&oe=UTF8&msa=0.

56. Odedire, J.A. and Babayemi, O.J.. (2008). Comparative studies on the yield and chemical composition of *Panicum maximum* and *Andropogon gayanus* as influenced by *Tephrosia candida* and *Leucaena leucocephala*. Livestock Research for Rural Development 20 (2) 2008.