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Influence of Supplemented Levels of *Acacia nilotica* Leaf Meal on Growth Performance, Faecal Egg Count and Haematological Parameters of West African Dwarf Bucks

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Abstract

THIS study was carried out to determine the performance of West African dwarf goats fed *Acacia nilotica* leaf meal. Thirty (30) artificially infected West African Dwarf goats were randomly divided into five (5) groups of six (6) animals per group. Each group was randomly allotted to five (5) experimental diets containing varying levels (0. 5, 10, 15 and 20 %) of *A. nilotica* leaf meal (ANLM). Faecal samples were collected and analysed weekly from each animal to determine the faecal egg count. Weight changes of the animals were taken once a week throughout the experimental period and blood samples were collected on the 1st and 56th day of the experiment. Data collected were subjected to one-way analysis of variance. Results showed significant (p<0.05) impacts of the dietary treatments on most parameters considered. Goats fed 10% and 20% inclusion diets exhibited higher final weight gain and weight gains compared to other groups. Feed conversion ratios varied across the different dietary groups. Faecal egg counts decreased significantly (p<0.05) in goats on supplemented diets compared to the control group. Packed cell volume, haemoglobin concentration and red blood cell count were elevated (p<0.05) in the supplemented groups., Mean corpuscular volume, mean corpuscular haemoglobin, and mean corpuscular haemoglobin concentration were elevated in some of the treatment with no particular trend. White blood cell counts, and its differentials were also influenced (p<0.05) by the dietary treatments, it increased in animals offered 5% ANLM and least in those fed 10% ANLM. The study concluded that ANLM enhanced infected goats' performance, reduced faecal egg counts and maintained optimal blood levels demonstrating potential pharmaceutical and nutritional benefits for production.

Keywords: *Acacia nilotica*, faecal egg count, goats, growth performance, leaf meal.

Introduction

One of the significant hinderances to ruminant production other than nutrition is endoparasites. Endoparasites have grown to be a serious concern in large-scale sheep and goat production systems, as evidenced by sales data from several nations [1]. Animal health can be negatively impacted by gastro-intestinal nematode infections [2], with these infections causing clinical and subclinical disorders, which can lead to financial loss and generally lower animal productivity [3].

Helminthiasis in particular of the intestinal parasites is more severe in tropical and subtropical regions, because of the favourable environmental circumstances that lead to a greater abundance of this class of parasites [4]. The presence of these parasites

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combined with the poor feed quality in these regions has resulted in poor productivity with increased cost of production.

The two-pronged approach to combat both nutritional and health challenges in ruminant production has resulted in a number of studies particularly the use of alternative feed resources that can boost the nutritional quality and improve health status of ruminant livestock [2]. The use of multipurpose tree species has an alternative feed source has been studied a lot. Tree species like *Moringa oleifera*, *Leucaena leucocephala*, *Newbouldia laevis*,.. etc have been experimented with mostly for their nutritional properties.

However, the recent studies into sustainable agricultural production and shift from heavy reliance on synthetic chemotherapy has resulted in a second look at these plants for their medicinal attributes [5]. In addition, these plants have a deep root in ethno medicine with various attributes ranging from antibiotic, antiparasitic and antimicrobial documented orally through generations. These oral documentations together with recent research into the constituents of these plants has revealed that these plants do possess medicinal properties due to the level of phytochemicals present in them, all of which act in various modes to improve health and productivity of livestock [5-7].

On the other hand, over-ingestion of these phytochemicals can result in toxicity which could have adverse effect on the well-being of livestock. Hence, it is important to monitor the blood levels of animals that are fed with these plants with abundant phytochemicals.

This present study therefore aims at investigating the impact of *Acacia nilotica* leaf meal on the faecal egg count, performance and haematological profile of West African dwarf goats artificially infected with *Haemonchus contortus.*

Material and Methods

Experimental Animals

For the experiment, thirty (30) West African Dwarf (WAD) yearling goats were used. They were bought from local communities in Ogun State's Odeda Local Government. The goats averaged 6.5 kg at the onset of the experiment. Morigad® disinfectant was used to thoroughly clean and sanitize the experimental pens. The goats were kept in individual pen spaces with corrugated aluminium iron roofing and a slatted floor. Following purchase, the animals received injections of ivermectin to eradicate any ectoparasites and an oral solution of albendazole to eradicate any endoparasites. The animals received tissue culture rinderpest vaccinations to protect them from *Peste des Petit Ruminants* (PPR). *Panicum maximum* was fed to the goats *ad libitum* by cut and carry methods.

Experimental design

The thirty (30) WAD goats were split into five (5) groups, each consisting of six (6) animals. Each group was assigned at random to one of the five (5) experimental diets using completely randomized design (CRD).

Inoculation and Treatment

Third stage (L3) *Haemonchus contortus* larvae, grown from the faeces of surgically afflicted sheep, were the source of the infection in the goats. The sheep who had already contracted the infection provided faeces, which were then processed and cultivated in a lab. For the purpose of ensuring infection, the experimental animals were given the cultured samples orally on day seven. Before the study started, the goats' infections were verified by taking faecal samples from them, and the quantity of nematode eggs in those samples was counted using the flotation method (McMaster). The animals utilized were limited to those whose counts of faecal eggs above 750 eggs per gram of faeces (epg).

Experimental Diet Preparation

Acacia nilotica was used in leaf meal form to compound the experimental diets. In order to create concentration diets with different inclusion levels of the test material as mentioned above, five (5) experimental diets were created utilizing 0, 5, 10, 15, and 20% inclusion levels of *A. nilotica* leaf meal (ANLM) together with other feed ingredients (Table 1).

Data Collection

Weight changes and feed intake

Feed intake: known quantity of feed at 3% of body weight was offered to individual animals on daily basis throughout the 56 days of the experiment, while the left over the following day was recovered and weighed to determine daily feed intake. The average daily feed intake was calculated as follows:

$$\text{Average daily feed intake (kg DM)} = \frac{\text{total feed offered} - \text{total feed left over}}{\text{number of days}} \; (kg\ DM/day)$$

Weight gain: each goat was weighed at the onset of the experiment before morning feeding, and at 7-day interval throughout the experimental period. Feed conversion ratio was also calculated using the formula:

$$FCR = \frac{\text{feed intake (kg)}}{\text{weight gain (kg)}}$$

Parasite egg count

At the beginning of the experiment, a sample of faeces was taken straight from the rectum of the experimental animals in order to calculate the faecal egg count (FEC), which is a measure of the first infestation of parasites. Throughout the experimental phase, daily faecal samples were taken to assess the FEC as a measure of the subjects' gastrointestinal load.. The postgraduate laboratory of the Department of Animal Production and Health, Federal University of Agriculture, Abeokuta, was where the faeces samples taken to in order to calculate the FEC (eggs per gram of faeces).

A modified Wisconsin salt flotation technique, as described by [8] was applied to the faecal samples that were obtained. Three grams of pulverized faeces were combined with forty-two millilitres of floatation fluid, which is a saturated solution. Following filtering, a subsample was moved into each of the two compartments of the McMaster counting chamber and left for five minutes. All of the eggs were in focus against the higher slide as they ascended to the top. The number of eggs per gram in the original sample is represented by multiplying the number of eggs inside each ruled region by 50.

Blood sample collection

Using a hypodermic needle and syringe, a sample of approximately 5 millilitres of blood was taken directly from each animal's jugular vein on the first and 56th day of the experiment. In order to prevent coagulation, the blood samples were collected and placed into sample bottles containing EDTA (Ethyl Dimethyl Tetra Acetic Acid) as an anticoagulant. The bottles were then gently rolled to ensure that the blood and EDTA were properly mixed. Blood samples were analysed for packed cell volume (PCV) and haemoglobin (Hb) concentration as soon as they were collected following a standard procedure [9]. After the proper dilution, the Neubauer haemocytometer was used to measure the amounts of red blood cells (RBC), white blood cells (WBC), and differential WBC counts [10]**.**

Statistical Analysis

All data generated were subjected to One-way Analysis of Variance as found in SPSS (2006), while significant means ($p<0.05$) were separated using the Tukey's test as contained in the same statistical package.

Results

Growth performance of artificially infected West African Dwarf goats fed diets containing varying levels of Acacia nilotica leaf meal.

The growth performance of artificially infected West African Dwarf goats fed diets containing varying levels of *Acacia nilotica* leaf meal is presented in Table 2. All the parameters considered were significantly influenced by the treatments. Goats offered 10% and 20% inclusion diets had significantly ($p<0.05$) higher mean values (8.16 and 9.06 kg) respectively, for final weight, while animals receiving the control diet recorded the lower mean value (7.00 kg). Weight gain, average weight gain and metabolic weight followed a similar trend having higher mean values (1.89 kg, 33.79 g/day, 13.91 $kgBW^{0.75}$ and 2.40 kg, 42.88 g/day, 16.33 $kgBW^{0.75}$) in animals fed 5% and 20% dietary inclusion of *A. nilotica* respectively, however, the lower mean values (0.75 kg, 13.43 g/day 6.92 $kgBW^{0.75}$ and 0.95 kg, 17.03 g/day, 7.83 $kgBW^{0.75}$) were recorded in animals offered 0% and 15% inclusion of *A. nilotica* in their diets, respectively.

Dry matter intake was highest (265.40 g/day) in goats fed 10% inclusion diets, while the lowest value (186.51 g/day) was recorded in goats offered 15% inclusion diets. Animals fed on 15% inclusion diets had the higher feed conversion ratio value (24.60), while goats offered 5% and 20% recorded mean values (5.87 and 6.41) Kg feed intake/Kg gain, respectively.

Faecal egg count of artificially infected West African Dwarf goats fed diets containing varying levels Acacia nilotica leaf meal.

Figure 1 shows the faecal egg count of infected West African Dwarf goats fed diets containing varying levels *A. nilotica* leaf meal at the onset and culmination, and on weekly basis throughout the experiment, respectively. All goats fed the varying diets had steeper reductions in their faecal egg counts except for the control which had the least reduction.

Red blood cell composition of artificially infected West African Dwarf goats fed diets containing varying levels of A. nilotica leaf meal

Table 3 shows the red blood cell composition of artificially infected WAD goats fed diets containing varying levels of *A. nilotica* leaf meal. All parameters considered at the beginning of the experiment were not significantly differed, however, at the end of the experiment significant differences were observed in the parameters considered across the treatments. Packed cell volume had mean values (33.63 and 30.38 %) in goats fed 10 and 20 % inclusion diets respectively, while the 0% and 15% inclusion groups recorded the lower values (24.13 and 24.75 %), respectively. Haemoglobin concentration was lower in goats fed the control diet compared to the other supplemented groups. Red blood cell count was lower in goats fed 5 % ANLM inclusion diet, compared to other supplemented groups and the control. Mean corpuscular volume recorded the lower mean value (16.10 fl) in goats fed 10% inclusion of *A. nilotica* leaf meal diet compared to the control and other supplemented groups. The higher mean values (7.79 and 7.28 pg) were recorded in goats fed 5 and 10 % ANLM inclusion diet for mean corpuscular haemoglobin. Mean corpuscular haemoglobin concentration had higher mean values (37.02, 38.91 and 37.98 g/dL) in the 0, 5 and 15 % treatment groups, respectively, while the lower mean values (32.69 and 32.86 g/dL) were recorded in the 10 and 20 % groups, respectively.

White blood cell counts, and its differentials of artificially infected West African Dwarf goats fed varying levels of A. nilotica leaf meal.

Table 4 shows the white blood cell count and its differentials of West African dwarf goats artificially infected goats fed varying levels of *A. nilotica* leaf meal. At the inception of the experiment, only the eosinophil count was significantly differed across the treatment groups, having significantly ($p<0.05$) mean value (0.00 %) in the 15 % treatment group, compared to the other groups.

However, at the culmination of the experiment all the parameters considered were significantly ($p<0.05$) influenced by the treatments, except for eosinophil count. The white blood cell count had significantly ($p<0.05$) highest value ($11.00\times10^{9/L}$) in goats offered 5 % inclusion of *A. nilotica,* while the least value ($7.25\times10^{9/L}$) was recorded in the 10% treatment group. Neutrophil count recorded value (33.75%) in the control group compared to the other supplemented groups. Goats in the control and 10 % group had the highest lymphocyte count (65.88 and 64.88 %), while goats offered 15% dietary inclusion of *A. nilotica* had the lowest value (59.88%). Basophil count was lower in goats fed 5 and 10 % ANLM diets compared to the control and supplemented groups. Monocyte count was higher (1.00 and 0.63 %) in goats offered 15 and 20 % *A. nilotica* leaf meal inclusions compared to the other supplemented groups and control.

Discussion

The potentials of shrubs and multipurpose trees are not limited to the medicinal attributes they possess, but rather all physiological processes for optimum performance. Several reports of various plants which have been used in feeding trials have been documented. Plants like *Moringa oleifera, Newbouldia laevis* [11], and aquatic plants like *Eichhornia crassipes* [12, 13] have not been left out in the search for alternative feed resources. Plants rich in secondary metabolites have been credited by researchers [14, 15] to have various nutritional benefits such as improving fatty acid profile and reducing enteric methane production and are gaining recognition as being suitable for potential increase in ruminant production. The abundance of plant secondary metabolites (PSM) in multipurpose tree species like *Acacia nilotica* used in this study, their nutritional profile containing significant level of nutrients important for substantial increase in production parameters, coupled with their all-year-round availability further makes these tree species economically important.

The growth response (final weight and weight gain) documented in this study corresponds with that of other authors [16] who fed different species of Acacia (*Acacia seyal*) to sheep and observed an increasing weight gain with increase in inclusion levels. In addition, Yusuf *et al*. (2016) reported a significant increase in weight gain with increase in *Moringa oleifera* diets fed to WAD sheep. A similar observation was documented in another experiment [17] where an increase weight gain in Red Sokoto goats fed *A. nilotica* pods was documented. The result observed in this study could be as a function of higher crude protein (12.80 %) levels, as well as the PSM which has antibiotic and antioxidative capabilities to promote growth and ensures better immune response for optimal production [18] with increasing inclusion of *A. nilotica* leaf meal in the diets. This could possibly be responsible for the higher growth performance exhibited by the animals in the 20% ANLM treatment group. The findings of this study indicate that, because ANLM includes a significant amount of important nutrients, adding up to 20% of it to the diet of goats may increase livestock performance in terms of body weight changes and high yields of high-quality products. The dual action of tannin components in the fed diets serving both nutritional and medicinal purposes may be responsible for higher performance results recorded in this study. It was documented by different researchers [19, 20] that the competition for nutrients between gastrointestinal nematodes (GIN) and their hosts often leads to reduced growth performance. Since the results indicated reduced FEC, this depicts that feeding *A. nilotica* to animals could enhance inhibition of both worm eggs and larvae development.

Although, optimal production assessment is hinged on the inverse relationship between feed intake and weight gain, as it is more beneficial in production terms to eat less and gain more. Thus, it can be opined that PSM levels present in the fed diets was able to combat the *H. contortus* present in the goats, while ensuring better utilization of the consumed feed as evident in most of the supplemented groups.

It was opined that there is need for more *in vivo* testing of plants purported to have anthelminthic properties, since *in vitro* assays puts the parasites in direct contact with the metabolites which are in concentrated forms [21]. Faecal egg count is a fast, simple, and easy method of estimating the worm burden in infected animals. The results of this study revealed significant decrease in faecal egg count with increasing level of *A. nilotica* incorporation in the diets of experimental animals. A similar study [22] on sheep infected with *Trichostrongylus* nematodes fed dried *A. nilotica* seeds showed a significant decrease in faecal egg count with increasing level of inclusion. However, another study [23] on Boer goats infected with *H. contortus* and fed dried *Acacia karoo* and *Acacia nilotica* documented *A. nilotica* as having no effect on faecal egg count of infected animals. Lower worm burden and faecal egg count may imply that the PSMs present in ANLM suppressed the viability of already established nematodes. This result may be attributed to the action of the many PSMs (most especially tannin) on the prolificacy of nematodes. Tannins have been reported severally as one of the secondary metabolites responsible for anthelmintic properties ascribed to various plants [6, 24 - 26]. Its mode of action was reported to include impairing crucial activities such as reproduction and feeding, and damage to the parasites' carapace's integrity [27]. These include the possibility of ion channel development, complexion with proteins, polysaccharides, and enzyme inhibition. These actions may disrupt helminths' normal biochemical and physiological functions resulting in nutrient deprivation, structural modifications, neuromuscular disruptions, and other impacts [5]. It has been documented that most of these modes of actions are known targets for routinely used anthelmintics [7, 28]. It can be deduced from the results of this study that inclusion of ANLM in WAD goat diets is capable of mitigating *H. contortus* population in infected animals, thereby reducing faecal egg count and subsequently the deleterious effect of *H. contortus* on the performance of the animals.

The detrimental effects of gastrointestinal nematode infections especially *H. contortus* cannot be overemphasized. Disease conditions caused by nematode infections are usually most observed in performance, faecal egg count and blood profile of animals as *Haemonchus* majorly feeds on the blood of their hosts, thereby predisposing them to secondary infection and other diseases [29]**.** While faecal egg count is the easiest way to assess the presence of worm burden on the animal, haematological assay actually shows the indirect effect of these parasites on animals. Goats' haematological characteristics provide insight into the quality and quantity of nutrients they receive from their diet. Since it is used to diagnose illness and/or parasite infection in animals, it is also a crucial metric when it comes to infected goats [30, 31]. Red blood cells (RBCs) deliver oxygen throughout the body through haemoglobin (Hb), although packed cell volume (PCV) indicates the percentage of RBCs in the blood. Certain disorders may be indicated by an excess or deficiency of red blood cells.

Often, there is concern about feeding PSM-rich plants to animals due to poisoning. It is therefore imperative to monitor blood levels of animals to ensure that the test samples do not adversely affect the organ and general health status of the animals. In this study, the level of infection was low to express subclinical signs of infection as evident in the non-significantly different values recorded at the beginning of the study. Results obtained at the end of the experiment, showed that all the haematological parameters determined were within the recommended range for healthy goats as reported by several authors [32, 34]**.** A similar result was observed when *A. nilotica* pod meal was fed to growing male goats [35]. This could be attributed to the rich nutritional profile of the fed diets in the supplemented groups, the action of PSMs (especially tannin) in improving protein bypass in the rumen to make more protein available for absorption and utilisation, and the potential anthelmintic effect of the PSMs on adult *H. contortus* which would naturally compete for nutrients by feeding on the blood from the abomasal walls. These results further affirm the significance of ANLM in goat diets through improved performance, reduced faecal egg count with attendance improved in health status by mitigating the negative effects of the worm and subsequently aiding normal RBC production.

The primary function of white blood cell (WBC/leucocytes) is to provide mobile system of protection for the body and is affected by factors such as diseases, age, pregnancy, parturition, lactation, nutritional status, stress and/or excitement [36]. Often, parasitic infection triggers automatic immune response from the host leading to elevated WBC over red blood cells to combat the infection, which may result in anaemia. The results obtained in this study at the termination of the experiment revealed that WBC counts and its differentials were within the recommended range. The action of the fed diets both nutritionally and therapeutically could be responsible for the balanced level of WBC observed in the supplemented groups, by mitigating the negative actions of the nematodes on the animals and nutritionally supporting the animal while combating the parasites itself.

The reduced, but significantly different WBC values at the end of the experiment were within the normal reference range by Merck (2012) for healthy goats. In relation to this present study, a related study documented a decrease in WBC of Red Sokoto goats fed tannin-rich *Pterocarpus erinaceus* forage diets [37]. This could be due to the actions of PSMs in combating various forms of infections thus, reducing the natural response of the body in combating these infections in the animals if PSMs were absent in their diets.

The reduced and significantly different neutrophil values observed at the end of the experiment were within the normal reference value for healthy goats [31, 33], which maybe as a direct result of the variations observed for WBC. The lymphocyte count observed in this study was also within the reference range for clinically healthy goats [33].

Eosinophil, basophil and monocyte values reported in this study were within recommended range for clinically healthy goats [31, 33]**.** However, these values are lower than those reported [34] in a study that focused on feeding *A. nilotica* pod meal to growing male goats. Eosinophil functions include but not limited to trapping substances and anti-parasitic activities. The stable WBC, basophil, monocytes, and other differential count can be hinged on the curtailing action of the supplemented Acacia as well as the embedded PSM which helped the animals combat the infection. This shows that inclusion of ANLM in goat diets had no deleterious effect on the health status of the animals.

Conclusion

The efficacy of *Acacia nilotica* in leaf meal form as a suitable antihelminth and potential nutritive alternative *in vivo* especially for diseased ruminants has been reflected in the results obtained in this study. The reduced faecal egg count, improved performance and optimal blood parameters under diseased conditions affirms the potentials of *A. nilotica* as a suitable alternative in feeding and treating nematode infections in ruminants.

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Authors contribution

Yusuf, Azeez Olanrewaju, Sonibare Adekayode Olanrewaju and Sowande Olusiji Sunday conceptualize the project idea and monitor the research throughout the project duration of the project. Owolabi Ayobami John is the PhD student on the research. He carried out the field and laboratory research while Taiwo Ajayi Olufemi was in charge of most of the laboratory activities. Yusuf, Azeez Olanrewaju proofread the first and second draft of the manuscript before being forwarded to Sowande Olusiji Sunday for final draft reading.

Conflict of Interest

The authors declared that there is no contrasting interest in the course of this research.

TABLE 1. Gross Composition of the Experimental Diet (%)

Ingredients	Inclusion Levels (%) of ANLM				
	0 ANLM	5 ANLM	10 ANLM	15 ANLM	20 ANLM
Palm Kernel Cake	15	14	13	12	11
Cassava Peels	20	19	18	17	16
Rice Bran	30	29	28	27	26
Wheat Offal	17	16	15	14	13
Maize	15	14	13	12	11
Acacia nilotica Leaf Meal	0	5	10	15	20
Bone Meal	1	1	1	1	1
Salt	2	2	2	2	2
Total	100	100	100	100	100
Determined Analysis (%) on air dried basis					
Dry Matter	89.51	87.47	91.39	90.06	88.26
Crude Protein	15.75	16.18	16.35	16.59	16.85
Crude Fibre	10.45	7.62	8.12	7.79	7.20
Ash	7.17	6.52	8.28	6.45	8.69
Crude Fat	6.93	4.09	5.29	5.84	6.86
Nitrogen Free Extract	49.21	53.06	53.35	53.39	48.66
Neutral Detergent Fibre	36.7	40.40	33.60	34.80	41.10
Acid Detergent Fibre	21.60	19.30	22.40	18.90	23.80
Acid Detergent Lignin	5.50	5.90	5.90	6.20	5.40

ANLM: *Acacia nilotica leaf meal.*

TABLE 2. Growth Performance of artificially infected West African Dwarf Goats fed Varying Levels of *Acacia nilotica* Leaf Meal

Parameters	0% ANLM	5% ANLM	10% ANLM	15% ANLM	20% ANLM	SEM
Initial Weight (kg)	6.25	6.68	6.56	6.37	6.66	0.19
Final Weight (kg)	7.00^{b}	8.58^{ab}	8.16^{ab}	7.32^{ab}	9.06^{a}	0.31
Weight Gain (kg)	0.75^{b}	1.90^{a}	1.60^{ab}	0.95^{b}	2.40^{a}	0.17
Average Weight Gain (g/day)	13.39^{b}	33.93^{a}	28.57^{ab}	16.96^{b}	42.86^{a}	3.00
Concentrate mixture Feed Intake (g/day)	189.60^{bc}	197.63^{abc}	241.52^{a}	169.73^{c}	224.58^{ab}	8.38
Total Dry Matter Intake (g/day)	208.35^{bc}	217.17^{abc}	265.40^{a}	186.51^{c}	246.79^{ab}	9.21
Feed Conversion Ratio	15.56^{a}	6.40^{b}	9.29^{b}	11.00.60^{ab}	5.76^{b}	2.17

$^{a, b, c}$ Means across rows with different superscripts are significantly (p<0.05) different.

TABLE 3. Haematological Indices of West African Dwarf Goats Artificially Infected with *Haemonchus contortus* and fed Varying Levels of *Acacia nilotica* Leaf Meal (ANLM)

Parameters		0% ANLM	5% ANLM	10% ANLM	15% ANLM	20% ANLM	SEM	Reference Range
Packed Cell Volume (%)	Initial	25	25.67	24.67	24.67	26.33	0.95	22-38^{+}
	Final	24.13^{b}	28.38^{ab}	33.63^{a}	24.75^{b}	30.38^{a}	1.02	
	Difference	-0.87	2.71	8.96	0.08	4.05	0.07	
Haemoglobin (g/dL)	Initial	11.97	12.33	11.8	11.73	12.53	0.46	7-15*
	Final	8.81^{b}	10.76^{a}	10.95^{a}	9.14^{b}	9.98^{ab}	0.24	
	Difference	-3.16	-1.57	-0.85	-2.59	-2.55	-0.22	
Red Blood Cell ($\times 10^{12/L}$)	Initial	1.57	1.27	1.99	4.85	1.46	0.61	8-18^{+}
	Final	14.55^{ab}	14.22^{b}	15.48^{ab}	15.65^{ab}	17.10^{a}	0.39	
	Difference	12.98	12.95	13.49	10.8	15.64	-0.22	
Mean Corpuscular Volume (fl)	Initial	15.97	15.63	17.3	17.9	16.1	0.77	16-25
	Final	16.77^{ab}	20.74^{ab}	22.48^{a}	16.10^{b}	18.04^{ab}	0.91	
	Difference	0.8	5.11	5.18	-1.8	1.94	0.14	
Mean Corpuscular Haemoglobin (pg)	Initial	7.6	7.53	8.27	8.47	7.63	0.36	5.2-8
	Final	6.13^{b}	7.79^{a}	7.28^{ab}	5.90^{b}	5.95^{b}	0.26	
	Difference	-1.47	0.26	-0.99	-2.57	-1.68	-0.1	
Mean Corpuscular Haemoglobin Concentration (g/dL)	Initial	47.87	48.1	47.87	47.5	47.53	0.16	30-36
	Final	37.02^{ab}	38.91^{a}	32.69^{b}	37.98^{a}	32.86^{b}	0.81	
	Difference	-10.85	-9.19	-15.18	-9.52	-14.67	0.65	

$^{a, b}$ Means across rows with different superscripts are significantly (p<0.05) different.

*Daramola *et al*. (2005)

$^{+}$Merck Manual (2012)

TABLE 4. White Blood Cell and Differentials Count of West African Dwarf Goats Artificially Infected with *Haemonchus contortus* and fed Varying Levels of *Acacia nilotica* Leaf Meal

Parameters		0% ANLM	5% ANLM	10% ANLM	15% ANLM	20% ANLM	SEM	Reference Range
White Blood Cell ($\times10^{9/L}$)	Initial	13.27	14.20	11.93	11.17	14.60	0.98	4-13[+]
	Final	8.05[bc]	11.00[a]	7.25[c]	8.69[bc]	9.24[b]	0.35	
	Difference	-5.22	-3.20	-4.68	-2.48	-5.36	-0.63	
Neutrophils (%)	Initial	44.33	40.00	37.33	39.33	40.67	5.51	30-48[+]
	Final	33.75[b]	37.25[ab]	34.38[ab]	39.13[a]	36.38[ab]	0.7	
	Difference	-10.58	-2.75	-2.95	-0.20	-4.29	-4.81	
Lymphocytes (%)	Initial	53.33	59.00	61.67	59.67	58.00	1.53	47-82*
	Final	65.88[a]	61.63[bc]	64.88[ab]	59.88[c]	62.00[abc]	0.70	
	Difference	12.55	2.63	3.21	0.21	4	-0.83	
Eosinophils (%)	Initial	1.00[a]	0.67[ab]	0.67[ab]	0.00[b]	0.67[ab]	0.13	0.05-0.65[+]
	Final	0.00	0.38	0.38	0.00	0.38	0.07	
	Difference	-1.00	-0.29	-0.29	0.00	-0.29	-0.06	
Basophils (%)	Initial	0.33	0.33	0.00	0.33	0.00	0.11	0-1[+]
	Final	0.25[ab]	0.00[b]	0.00[b]	0.25[ab]	0.63[a]	0.08	
	Difference	-0.08	-0.33	0.00	-0.08	0.63	-0.03	
Monocytes (%)	Initial	1.00	0.00	0.33	0.67	0.67	0.17	0-1*
	Final	0.38[b]	0.38[b]	0.38[b]	1.00[a]	0.63[ab]	0.08	
	Difference	-0.62	0.38	0.05	0.33	-0.04	-0.09	

[a, b, c] Means across rows with different superscripts are significantly ($p<0.05$) different.
*Daramola *et al*. (2005)
[+]Merck Manual (2012)

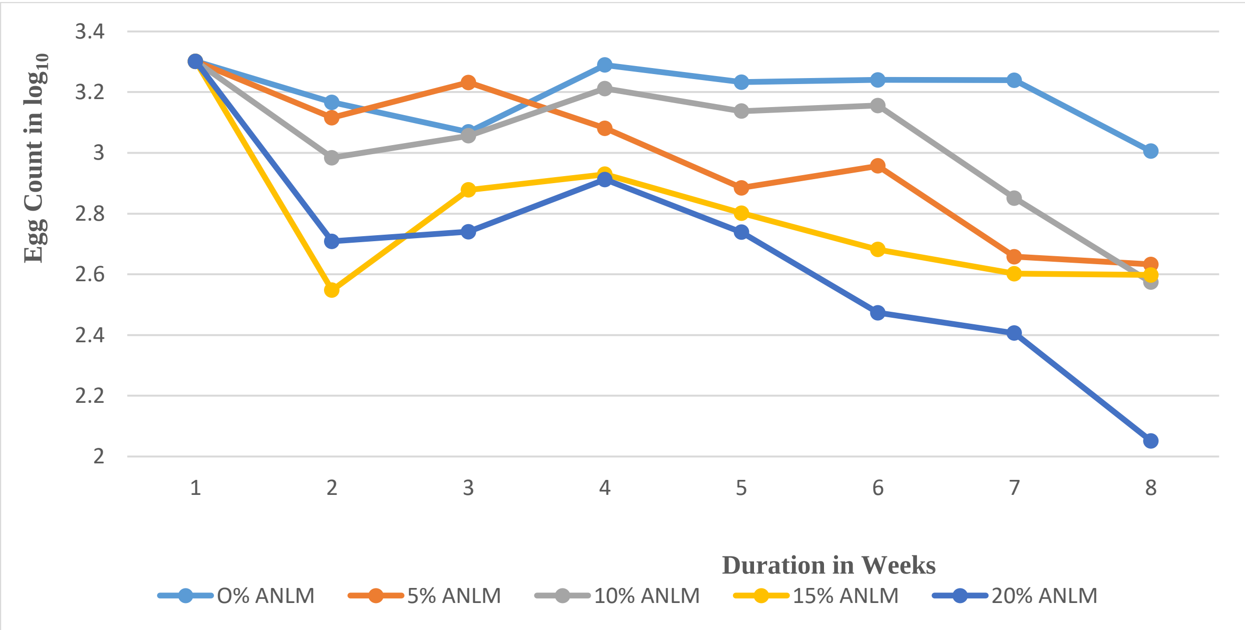

Fig. 1. Weekly trend of the faecal egg count (egg/gram) of West African Dwarf goats fed varying levels of *Acacia nilotica* leaf meal.

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