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EFFECT OF FEEDING DIFFERENT LEVELS OF *Moringa Oleifera* LEAVES ON PERFORMANCE, HAEMATOLOGICAL, BIOCHEMICAL AND SOME PHYSIOLOGICAL PARAMETERS OF SUDAN NUBIAN GOATS

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ABSTRACT: The present study was designed to investigate the effects of feeding different levels of *Moringa oleifera* leaves on the performance, haematological, biochemical and some physiological parameters of Sudan Nubian goats on three different levels of *Moringa oleifera*, group A (0%) As control, group B offered (20%) and group C (50%) fed different levels of *Moringa oleifera* leaves. Thirty yearling females of Nubian goats weighted between 16.00 - 24.00 kg and their age was nearly 10 - 12 months were used in this study, the animals were divided according to their live body weight into three groups of ten each, goats were housed in pens of suitable size and were managed as any other commercial goat flock. The animals had free access to water. Forage was fed at rate of 1% of live body weight. They were fed for 6 weeks. The results showed a significant increase ($P<0.05$) on body weight in group B than the other two groups. Feed Conversion Ratio (FCR) was increased significantly ($P<0.05$) in group B and group C compared with group A. Whereas feed intake (kg/day) and Water intake (kg/day) were significantly higher ($P<0.05$) in group B than group A and C. There were the Body temperature (Tr), Respiratory Rate (RR) and Pulse rate (Pr) demonstrated significant ($P<0.05$) values in group B. On the Erythrocytes indices showed significant variations among the groups except Mean Corpuscular Hemoglobin Concentration (MCHC) in group B, which recorded high significant ($P<0.05$) in all indices of Erythrocytes when compared with the other two groups. In the other hand leukocytes indices have similar observations for all parameters except total white blood cells count (WBCs) which increased significantly ($P<0.05$) in group B (6.21 ± 0.14) than group C (4.77 ± 0.34) and group A (4.21 ± 0.09). Glucose decreased a significant different ($P<0.05$) in group B when comparable than other two groups, while Total protein and Albumin were recorded high significant different ($P<0.05$) values in group B; (7.71 ± 0.03) and Albumin (2.86 ± 0.10), respectively. When comparable than other two groups. Therefore, the study revealed that the *Moringa oleifera* leaf meal could be used to improve livestock system of small ruminants without any adverse effect on the productive performance and blood indices at the 20% diet inclusion level. However more research is needed to assure these findings.

Keywords: *Moringa oleifera* Leaves, Performance, Blood Hematology, Blood Biochemical, Physiological Parameters and Nubian Goats.

INTRODUCTION

The livestock sector plays a significant economic role in most developing countries, and is essential for the food security of populations. The productivity of farm animals in most tropical countries is generally low, mainly due to poor quality and inadequacy of available feeds. Moreover, conventional feed resources (grains, cereals, legumes, etc.) for animal production are scarce and highly expensive in many parts of the world. Thus searching for alternative unconventional feed sources that may have valuable components of animal diets is indispensable. For instance, feeding by-products from agricultural and food processing industries to livestock can be one of the solutions (Negesse et al., 2009; Szumacher-Strabel et al., 2011; Zhou et al., 2012). Protein supplementation is often important to improve livestock performance, and this needs to be done with respect to the requirements of the animal in addition to the balance of other nutrients available. However, the prices of these protein sources have been escalating continuously in recent times, whilst availability is often erratic. The problem has been worsened due to the increasing competition between humans and livestock for these protein ingredients as food. According to Odunsi, (2003) the rapid growth of human and livestock population, which is creating increased needs for food and feed in the less developed countries, demand for an alternative feed resources must be identified and evaluated. The use of tree parts as alternative feed resources for ruminant livestock is becoming increasingly important in many parts of the tropics and sub-tropics (Silanikove, 2000; Melesse et al., 2009). Moringa trees are multi-purpose trees of economic importance with several industrial and feeding values.

According to Leng (1997), the poor condition of livestock in the tropics is more likely as a result of inefficient digestion in the rumen and inefficient utilization of the nutrients absorbed from low quality feeds. Several attempts which have been made to improve the nutritive quality of this class of livestock feeds include physical, chemical and biological treatments, use of feed additives as well as supplementation with non-protein nitrogen sources such as urea and molasses (Adegbola 2002). Alkali treatment of fibrous crop residues have been well researched and proven to increase the potential feeding value of crop residues (Preston and Leng, 1997). Moreover, the possibility of using urea as a cheap readily available source of nitrogen in ruminant diets led to the expectation of rapid improvement in ruminant productivity in developing countries. However for various reasons these technologies have

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not been widely adopted as expected and animal productivity is still poor (Owen and Jayasuriya 1989). The tree fodder are important source of high quality feed for grazing ruminants and as supplements to improve the productivity of herbivores on low quantity feeds. The tree fodder from part of the complex interaction between plants, animal and crops. The positive aspects of which help to balance a plant, animal, soil ecosystem and from which there is stable source of feed (Devendra, 1993). Moringa oleifera is a well known tree in West Africa especially in semi-arid areas where it is often cultivated as a living fence around people's gardens. Leaves of the tree are noted for high content of crude protein, essential vitamins, minerals and amino acids (Makkar and Becker 1997; Gidamis et al. 2003). However, according to Akinbamijo et al. (2004), the value of the tree and its benefits as a high-quality supplement to components at low-quality roughages in ruminant feeding systems have not been fully known nor widely exploited.

The use of fodder trees and shrubs to solve the problems of low productivity in small ruminant production has been reported by (Paterson et al., 1999; Makkar and Becker 1996; Aregheore, 2004). Some indigenous and a limited number of introduced species have been selected to serve as supplements to the low quality forage fed to these animals (Pezo et al., 1991). Most of the trials in the Humid Zone of West Africa (HZWA) conducted by the International Institute for Tropical Agriculture (IITA) and the International Livestock Centre for Africa (ILCA) involved Gliricidia sepium and Leucaena leucocephala which have shown benefits to crops production and animal improvement through alley farming and feed gardens. However, these species may have limitations in terms of productivity, palatability, presence of toxic substances and adaptability (Attah – Krah, and Reynolds, 1989; Akinbamijo et al., 2006). Also, the reluctance of smallholder farmers to adopt these tree species as supplements for small ruminant nutrition has necessitated the search for other tree species which may offer additional benefits. Moringa (Moringa oleifera Lamarck) is a slender, deciduous, perennial evergreen tree that originated in India but has spread to other regions of the world (Foidl et al., 2001). It is one of the fastest growing trees in the world with high biomass yield, high crude protein of + 25% and a balance of other nutrients in the leaves (Makkar and Becker, 1996, Foidl et al, 2001; Asaolu et al., 2010). Moringa provides food, medicine, fuel and other uses but it's potential as an important browse plant for small ruminants diet supplementation has not been fully documented (Gutteridge and Shelton, 1993; Anjorin et al., 2010). Moringa can thrive well in any region where the soil is not waterlogged (Asaolu et al., 2009). Its cultivation as human food and livestock feed in the Southern states has not been popular because information on the feeding value is scarce (Asaolu et al., 2010).

One way of utilizing fodder trees is to use them as feed to small ruminants as part of, or along with, Multi Nutrient Blocks (MNBs) (Sansoucy, 1995; Agbede and Aletor, 2004; Aye, 2007). MNBs create an effective ecosystem and increase intake and digestibility of low quality, high fiber grasses usually consumed by the small ruminants (Habib et al., 1991). *Moringa oleifera L*am (syns. Moringa pterygosperm, family Moringaceae), a non-leguminous multi-purpose tree, is one of the fastest growing trees in the world, with high crude protein in the leaves (> 20 %) (Makkar andBecker, 1996). Moringa is native to sub-Himalayan regions of India and is now naturalized in many countries in Africa, Arabia, Southeast Asia, Caribbean Islands and South America (Ramachandran et al., 1980). It offers a good alternative source of protein to humans and ruminants wherever they thrive (Nouala et al., 2006). Laboratory analysis (Makkar & Becker 1997; Asaolu, 2009) showed negligible amounts of tannins (1 to23 g/kg) in all fractions of the Moringa oleifera plant and high levels of sulphur-containing amino acids. There has been an increasing interest in the use of moringa as a protein source for livestock (Makkar & Becker, 1997; Sarwatt et al., 2004; Asaolu et al., 2009). Sarwatt et al. (2004) reported that moringa foliages are a potential inexpensive protein source for livestock feeding. The advantages of using moringa as a protein resource are numerous, and include the fact that it is a perennial plant that can be harvested several times in one growing season and also has the potential to reduce feed cost. Moringa can easily be established in the field, has good coppicing ability, as well as good potential for forage production. It can reach 12 m in height at maturity, yielding up to120 tones/ha/yr when planted very densely for use as forage (Makkar & Becker, 1997). Additionally, it is not affected by ant serious diseases in its native or introduced ranges (Parrotta, 2005).

Evaluation of the blood profile of animals may give some potentials of a dietary treatment to meet the metabolic needs of the animal 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. The various functions of blood are made possible by the individual and collective actions of its constituents – the biochemical and haematological components. Generally, both the biochemical and haematological blood components are influenced by the quantity and quality of feed and also the level of anti-nutritional elements or factors present in the feed (Akinmutimi, 2004), including elements of toxicity. They can also be used to monitor protein quality of feeds. Haematological components of blood are also valuable in monitoring feed toxicity especially with feed constituents that affect the formation of blood (Oyawoye and Ogunkunle, 1998) and Abu et al. (1988) reported that low level haemoglobin (Hb) of treatment diets could imply that dietary proteins were not of high quality. Diets containing poor protein would usually result in poor transportation of oxygen from the respiratory organs to the peripheral tissues (Roberts et al., 2000). Reduction in the concentration of PCV in the blood usually suggests the presence of a toxic factor (e.g. haemagglutinin) which has adverse effect on blood formation (Oyawoye and Ogunkunle, 1998). High WBC count is usually associated with microbial infection or the presence of foreign body or antigen in the circulating system. The haematological characteristics of livestock suggest their physiological disposition to the plane of nutrition (Madubuike and Ekenyem, 2006). Reductions in packed cell volume and red blood cell values are indicative of low protein intake or mild anemi (Lindsay, 1977). Blood chemistry constituents

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reflect the physiological responsiveness of the animal to its internal and external environments which include feed and feeding (Esonu et al., 2001; Iheukwumere and Okoli, 2002). Blood chemistry studies are usually undertaken to establish the diagnostic baselines of blood characteristics for routine management practices of farm animals (Tambuwal et al., 2002; Onyeyilli et al., 1992.; Aba-Adulugba and Joshua, 1990). The hematopoietic system is an important index of physiological and pathological status in animals and humans (Harper, 1973), since it is the one which becomes exposed to a high concentration of toxic agents first. Total serum protein has been reported as an indication of the protein retained in the animal body (Akinola and Abiola, 1991, Esonu et al., 2001), while total blood protein depend on the quantity and quality of dietary protein (Eggum, 1970). Normal range of blood sugar level indicates that animals are not surviving at the expense of body tissues (Ologhobo et al., 1992). Frandson, (1986) reported that the number of neutrophils in the blood increases rapidly when acute infection is present, hence a blood count showing this increase is useful in diagnosis of infections. He reported further that eosinophils which normally are scarce increase in numbers in certain chronic diseases, such as infection with parasites and also in allergic reactions.

The aims of this study are to evaluate the feed value of *Moringa oleifera* leaves as feed supplements for small ruminant and to evaluate its effects on some physiological parameters, Hematological indices (Erythrocytes and leukocytes indices) and some blood metabolism profile of Nubian goats in White Nile State, Sudan.

MATERIALS AND METHODS

Animals and experimental design

Thirty yearling (10 – 12 month) females of Nubian goats their body weight was from 16.00 to 24.00 kg were used in this study. The animals were purchased from local small ruminant market in Maatog near Eldweem city (Latitudes 130 and 290 North, Longitudes 200 and 320 East); they bear the typical characteristic of the indigenous Nubian breed. They were deep lopping ears and short tapering tail. The coat color was black. The animals were housed in un-shaded goat's pen; at the Faculty of Science, University of Bakht Alruda. For two week to adapt period to the compared of the study.

The animals were dosed with Ivermectin against endoparasite and Ectoparasite animals; 0.2ml per/kg body weight; with drawl period. The animals were then divided at three groups each of ten animals according to their live weight. first groups range was weight 16.44 kg; used as control (zero Moringa leave fed). The second group was 16.90 and the 3rd group was 16.00 kg; they fed different levels of *Moringa oleifera* leaves (0%, 20% and 50%; respectively).The period of this study was 45 days.

Ingredients and Chemical analyses:-

The animals were fed according to relevant standards for the group. The rations were offered add libitum throughout the experimental period. Composition (%) of the Experimental ration fed to Nubian goats different levels of *Moringa oleifera* leaves, where the moringa leaves were modify with sorghum hay as complementary ingredients up to 100 %; as Described below:

Group A: Moringa leaves 0% + Sorghum Hay 54%.
Group B: Moringa leaves 20% + Sorghum Hay 34%.
Group C: Moringa leaves 50% + Sorghum Hay 4%.

The Chemical compositions of ingredients were derived from FAO's Animal Feed Resources Information System (1991-2002) and from Bo Gohl's Tropical Feeds (1976-1982) as shown in table (2).

Experimental feeds procurement and processing:-

Fresh leaves were harvested from available trees regardless of tree age, from the Faculty of Science farm, University of Bakht Alruda on April 2013 in dry season and the leaves were trimmed from its twigs on a plastic sheet. The trimmed leaves were then finally spread thinly on plastic sheet under shade for 72 hrs and mixed regularly to ensure uniform drying for safe storage. The air dried moringa leaves were finally transported to the experimental site, where the mean ambient temperature was raining between 25°C and 39°C.

Feedlot performance:

Body weight

The animals were weighed firstly and weekly until the end of the six week, and weighed at the end of the experiment. The animals were weighed individually by the pan balance.

Feed Intake and water Intake

Feed and water were offered approximately at the same time in the morning (09.00 hr). The food offered was weighed in a single pan balance - to the nearest 100g. The food and water was offered in the fodder basins and the remaining amounts from the previous day were measured, so that the amounts of food and water consumed were determined.

Body temperature, Respiratory Rate and Pulsed rate:

Measurements of rectal temperature (Tr), respiration rate (RR) and pulse rate (Pr) were recorded daily in the morning (09.30 hr) before feeding. Tr was measured to the nearest 0.1 °C using a clinical thermometer inserted

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into the rectum for 1 min. RR was measured by counting the flank movements for 1min. Pr was measured by hand femoral vein for 1 min.

Blood collection and analyses

Blood was collected from the jugular vein of the experimental animals at the first of study, and at the end of termination of the experiment (At the six week before feeding at 09.30 hr) in a vial containing ethylene diamine tetra-acetic acid (EDTA). 5ml of whole blood was collected aseptically from the jugular vein using disposable needles 2ml of the blood in EDTA containing vacutainer tubes (BDvacutainer, Bell industrial Estate, plymouth, Uk) the remands was placed in plain tube for serum analyses. The EDTA tubes were immediately capped and the content was mixed gently for a period of one minute by repeated inversion or rocking. Blood samples were analyzed immediately after collection for packed cell volume (PCV) and haemoglobin (Hb) concentration as described by Benson et al., (1989) and Jain, (1993). Red Blood Cells (RBCs), White Blood Cells (WBCs) 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 Concentration (MCHC), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Volume (MCV) were calculated from RBC, Hb and PCV values as described by (Simon and Casmir 2001).

Serum was obtained by allowing the blood to clot in room temperature for 2 hours, centrifuged, and collected into plain sealed tube and then stored at -20 ^{0}C until analyzed. Serum total protein was determined by the biuret reagent method according to King and Wooton (1965), Albumin was determined as described by Toro and Ackermann (1975). **BCG method:** Plasma Glucose level was determined by Enzymatic, calorimetric, GOD-PAP method according to Trinder, (1969).

Statistical analysis:-

The data obtained from the growth performance and blood samples collected from the Nubian goats fed different levels of *Moringa oleifera* leaves (0%, 20% and 50%), had been subjected to standard methods of statistical analysis was performed using windows based SPSS (Version 16.0, 2007). The analysis of variance (ANOVA) test was used and Statistical significance was considered when P<0.05.

RESULTS

Chemical composition of the experimental feeds:-

The chemical composition of feeds used in this experiment is shown in Table 2. The Crude Protein content of *Moringa oleifera* leaves was high (20.9%) compared with Sorghum leaves (7.5%) also Crude fiber was low in *Moringa oleifera* (18.5%) leaves than Sorghum leaves (32.3%). The neutral detergent fiber (NDF) (28.5%) and acid detergent fiber (ADF) (18.1%) contents of *Moringa oleifera* leaves were very low compared as that of Sorghum leaves (68.7%), (44.0%) respectively.

Feedlot performance of Nubian goats fed different levels of *Moringa oleifera* leaves:-

Effects of feeding different levels of *Moringa oleifera* leaves three levels on the performance of Sudan Nubian goats on group A as control (0%) Moringa leaves; group B and group C fed *Moringa oleifera* leaves (20% and 50%, respectively). As shown in Table 3 a significant improvement (P<0.05) of body weight was noted at the end of experiment in group B than the other groups and has been observed from week 3 to week 6 as shown in (Figure 1). Total gain (kg) and Average daily gain (kg) increased significantly (P<0.05) in group B when compared with group A and C. Feed conversion ratio (FCR) increased significantly (P<0.05) in group B than group A and C. Feed intake (kg/day) and Water intake (kg/day) were significantly higher (P<0.05) in group B than group A and C.

Body temperature (Tr), Respiratory Rate (RR) and Pulsed rate (Pr) of Nubian goats fed different levels of *Moringa oleifera* leaves:-

Body temperature (Tr), Respiratory Rate (RR) and Pulse rate (Pr) demonstrated high significant (P<0.05) values in group B than the control group and group C; (39.18 ± 1.27oc), (18.83 ± 0.14beats/minute) and (78.32 ± 0.27beats/minute), respectively, as shown in Table 4.

Blood constituents of Nubian goats fed different levels of *Moringa oleifera* leaves:-

Blood constituents changes in the composition of Nubian goats fed different levels of Moringa oleifera leaves meal based diet for 6 weeks is presented in Tables 5, 6 and 7.

Erythrocytes indices: All parameters showed significant variations among the groups except Mean Corpuscular Hemoglobin Concentration (MCHC) in group B, which showed high significant (P<0.05) when observed with other two groups (Table 5).

Leukocytes indices: Similar observations have been seen in all parameters except total white blood cells count (WBCs) which increased significantly (P<0.05) in group B (6.21 ± 0.14) than group C (4.77 ± 034) and group A (4.21 ± 0.09).

Glucose decreased significantly (P<0.05) in group B when compared with other two groups (A and B), while T. protein and Albumin recorded higher significant (P<0.05) values in group B when compared with group A and C; (7.71 ± 0.03) for T. protein and (2.86 ± 0.10) for Albumin.

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Table 1 - Percentage of the Ingredient compounds of the diets.			
Ingredients (%)	Group A (0%)	Group B (20%)	Group C (50%)
Moringa oleifera leaves	0	20	50
Sorghum leaves	54	34	4
Sorghum Grain	5	5	5
Groundnut Cake	20	20	20
Groundnut Hay	20	20	20
Common Salt	1	1	1

Table 2 - Chemical composition of the experimental diets.					
Main analysis (% DM)	*Moringa oleifera* leaves	Groundnut Cake	Groundnut Hay	Sorghum Hay	Sorghum Grain
Dry matter (% as fed)	42.7	91.3	89.4	90.0	87.4
Crude protein	20.9	11.2	14.6	7.5	10.8
Crude fiber	18.5	33.6	27.1	32.3	2.8
NDF	28.5	51.8	45.1	68.7	11.0
ADF	18.1	43.8	37.1	44.0	4.3
Lignin	7.0	10.2	6.5	6.2	1.1
Ether extract	3.8	1.6	2.3	1.4	3.4
Ash	10.5	1.1	8.7	8.8	2.1
Gross energy	18.2	10.3	18.4	17.9	74.5
Calcium (g/kg DM)	26.4	11.0	21.7	1.8	0.3
Phosphorus (g/kg DM)	2.6	1.5	4.9	1.7	3.3

The contents of this table are currently derived from FAO's Animal Feed Resources Information System (1991-2002) and from Bo Gohl's Tropical Feeds (1976-1982); Last updated on 24/10/2012; From (http://www.feedipedia.org/content/feeds); DM = dry matter; NDF = neutral detergent fiber; ADF = acid detergent fiber.

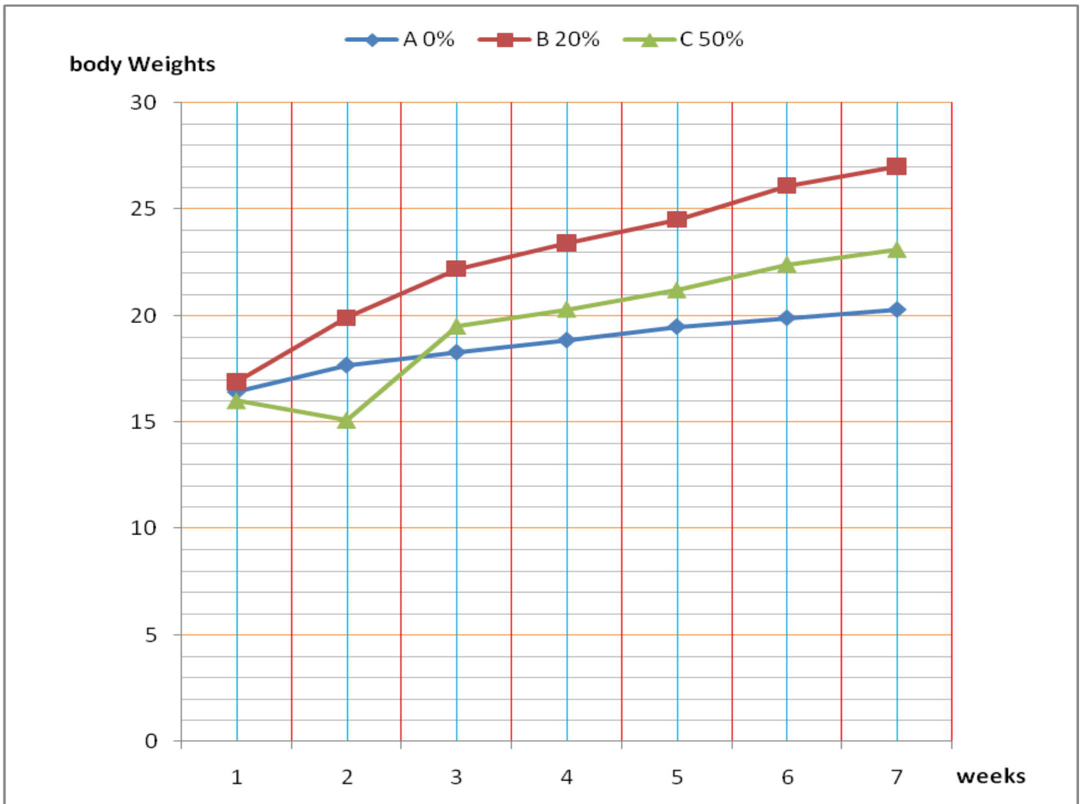

Figure 1 - Indicates the increasing of weekly body weight of Nubian goats fed different levels of *Moringa oleifera* leaves. The body weight has noted the increase significant on the (3,4,5 and 6) weeks in the study in all the groups, where the group (B) recorded high significant difference (P<0.05), compared with the other two groups (A and C).

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Table 3 - Overall performance of Nubian goats as affected by graded levels of Moringa oleifera leaves.			
Parameter	**Moringa 0%**	**Moringa 20%**	**Moringa 50%**
Experimental period (days)	45	45	45
Number of animals	10	10	10
Initial weight, kg	16.44 ± 2.06	16.90 ± 0.66	16.00 ± 0.92
Final weight, kg	20.30 ± 2.17 a	27.00 ± 0.78 b	23.10 ± 1.00a
Total gain, kg	3.86 ± 0.17 a	10.10 ± 0.27 b	7.10 ± 0.60 c
Average daily gain, kg	0.08 ± 0.004 a	0.22 ± 0.006 b	0.15 ± 0.014 c
Feed intake(DMI), kg/day	0.30 ± 0.01a	1.58 ± 0.02 b	1.01 ± 0.02c
Feed conversion ratio (FCR)	3.75 ± 0.67 a	7.18 ± 0.24 b	6.73 ± 0.46 b
Water intake, kg/day	1.13 ± 0.02 a	1.46 ± 0.03 b	1.31 ± 0.03c
Kg water intake DMI	0.87 ± 0.01a	0.93 ± 0.02 a	1.30 ± 0.03 b

[a,b,c] means along the same row with different superscripts are significantly different from each other. (P<0.05).

Table 4 - The means and standard errors of some physiological parameters as affected by dietary intake of *Moringa oleifera* leaves.			
Parameter	**Moringa 0%**	**Moringa 20%**	**Moringa 50%**
Rectal temperature (Tr) °c	38.59 ± 0.37^{a}	39.18 ± 1.27^{b}	38.87 ± 0.39^{b}
Respiratory rate (RR) beats/minutes	16.38 ± 0.21^{a}	18.83 ± 0.14^{b}	16.34 ± 0.23^{a}
Pulsed rate (Pr) beats/minutes	74.38 ± 0.29^{a}	78.32 ± 0.27^{b}	75.12 ± 0.29^{a}

[a,b] means in the same row with different superscripts are significantly different from each other (P<0.05).

Table 5 - The means and standard errors of Erythrocyte indices as affected by dietary intake of *Moringa oleifera* leaves.			
Indices	**Moringa 0%**	**Moringa 20%**	Moringa 50%
RBCs. (×10^{6} / µL)	11.19 ±0.08^{a}	13.33 ± 0.14^{b}	11.85 ± 0.16^{c}
Hemoglobin (g/dl)	8.32 ± 0.03^{a}	10.46 ± 0.09^{b}	9.21 ± 0.15^{c}
PCV (%)	23.60 ± 0.37^{a}	31.50 ± 1.09^{b}	26.80 ± 0.77^{c}
MCV (fl)	21.14 ± 0.44^{a}	23.53 ± 0.67^{b}	22.56 ± 0.53^{b}
MCH (pg)	7.35 ± 0.07^{a}	7.80 ± 0.05^{b}	7.64 ± 0.11^{b}
MCHC (g/dl)	35.27 ± 0.64	34.21 ± 0.99	34.41 ± 0.64

[a.b.c] means along the same row with different superscripts are significantly different from as before (P<0.05).

Table 6 - The means and standard errors of leukocytes Indices of Nubian goats as affected by dietary intake of Moringa oleifera leaves.			
Indices	**Moringa 0%**	**Moringa 20%**	**Moringa 50%**
Total WBCs (×10^{3}/ µL)	4.21 ± 0.09^{a}	6.21 ± 0.14^{b}	4.77 ± 034^{c}
Lymphocytes (%)	55.40 ± 1.27	55.70 ± 0.78	55.30 ± 0.65
Neutrophils (%)	35.90 ± 1.38	35.80 ± 0.83	36.30 ± 0.62
Monocytes (%)	2.39 ± 0.45	1.80 ± 0.42	2.20 ± 0.47
Eosinophils (%)	5.90 ± 0.28	5.90 ± 0.23	5.80 ± 0.33
Basophils (%)	0.50 ± 0.17	0.70 ± 0.21	0.40 ± 0.16

[a.b.c] means along the same row with different superscripts are significantly different from as before. (P<0.05).

Table 7 - The means and standard errors of some plasma constituents as affected by dietary intake of Moringa oleifera leaves.			
Parameter	**Moringa 0%**	**Moringa 20%**	**Moringa 50%**
Glucose (mg/dl)	78.80 ± 1.5^{a}	60.60 ± 0.76^{b}	75.80 ± 1.69^{a}
Total protein (g/dl)	6.57 ± 0.55^{a}	7.71 ± 0.03^{b}	6.93 ± 0.14^{c}
Albumin (g/dl)	2.16 ± 0.30^{a}	2.86 ± 0.10^{b}	2.53 ± 0.12^{c}

[a.b.c] means along the same row with different superscripts are significantly different from each other. (P<0.05).

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DISCUSTION

The tree, *M. oleifera* (Moringaceae), is cultivated widely all over the world (Odee, 1998; Jed and Fahey, 2008) and used for various purposes, one of which is as a feed supplement to livestock (Martin, 2007; Fadiyimu et al., 2010). In this study, Nubian goats were used to test the different levels of *Moringa oleifera* leaves (0%, 20% and 50%) via its effect on the animals' body weights as well as on blood parameters.

Composition (%) of the Experimental ration fed to Nubian goats different levels of *Moringa oleifera* leaves, where the moringa leaves were added with sorghum leaves as a complementary ingredients up to 100 %; the chemical composition of feeds used in this experiment was shown in Table 2. The Crude Protein (CP) content of moringa leaves were high compared to Sorghum Hay and the Crude fiber was low in moringa leaves than Sorghum Hay. The NDF and ADF contents of moringa leaves were very low compared to that of Sorghum Hay. But calcium contents were higher in *M. oleifera* leaves (26.4 g/kg DM) in comparison to the Sorghum leaves (1.8 g/kg DM). As mixing of moringa leaves with other fodders can also contribute towards better livestock performance and good-quality products. It was reported that the mixing of M. stenopetala leaves with grass improved DMI, body weight, and nitrogen retention capacity in male sheep (Gebregiorgis et al., 2012). The crude protein of *Moringa oleifera* has been reported by (Becker, 1995) to be of better quality for ruminants because of its high content of by-pass protein. Higher proportions of by-pass protein have been also reported to result in faster weight gains in livestock (McNeill et al., 1998).

The results on Table 3 showed the dry matter intake as percent (DMI kg/day) of body weight (BWT) were higher for the group B (1.58± 0.02) than groups A (0.30 ± 0.01) and C (1.01± 0.02), respectively. Although, there is significant difference between the three groups, the results were in agreement with the finding of Alan (1988), who noted that for the same breed the DMI% of body weight ranged between 3-5% of BWT. However, the obtained results were higher than that reported by Charray et al. (1992) who mentioned that the DMI% were 2.5% of BWT for Nubian goats. The findings of the weight gain in this study were significantly higher for group B (10.10 ± 0.27g/day) than groups A (3.86 ± 0.17g/day) and C (7.10 ± 0.60g/day), respectively. The highest body weight gain of goats in group B support earlier findings that *M. oleifera* is of a high nutritional value (Ram, 1994; Makkar and Becker, 1996; Anwar et al., 2007). Increase in the body weight of the goats in current study might be due to the fact that *M. oleifera* is rich in amino acids, vitamins and minerals particularly iron (Subadra et al., 1997; Faye, 2011). However, all in best the significant increase of body weight and is captivity, were the energy expenditure is minimal (Fadi et al., 2010).

The feed conversion ratio values was 3.75 for (control) obtained in this study was similar to 2.63- 4.00 reported by earlier researchers in the tropics (Ayers et al., 1996; Okorie, 2003), 7.18 (group B) and 6.73 (group C) - Table 3. Were higher than the 2.63- 4.00 but they were generally better than that of 5.32 – 5.63 as reported by Eustace et al. (2003). Generally poor FCRs obtained were probably due to the relatively low growth rates. Genetic values might have also contributed to the lower FCRs values recorded (Ayers et al., 1996; Okorie, 2003). Murro et al. (2003) reported that *Moringa oleifera* dried leaves 20% of total diet Growing sheep and goats, 20% improvement in growth rate but poorer feed conversion.

The physiological parameters of the Nubian goats are shown in Table 4. The Mean rectal temperature were significantly ($P<0.05$) different from each other in groups. The rectal temperature was constant and fell within the normal range for sheep and goats (32.60 ^{0}C to 39.60 ^{0}C); (Aye, 2007). The mean respiratory values were significantly ($P<0.05$) different from each other in groups. (16.38 ± 0.21) in group A and (18.83 ± 0.14), (16.34 ± 0.23) in group B and C, respectively. The mean pulse rates were significantly ($P<0.05$) different from each other in groups (A, C and B). The pulse rates fall within normal range reported as 70 - 90 pulse/minute for sheep and goats (Kaushish, 2010). The highest values of these physiological parameters was only notes in group B, this could be attributed to that *M. oleifera* is of high and better nutritional value as signs of health and more productive animals (Anwar et al., 2007; Ikhimioya and Imasuen, 2007 and Addass et al., 2010).

Table 5, indicates the Erythrocyte Indices of Nubian goats fed different levels of *Moringa oleifera* leaves. Past reports revealed that haematological constituents are always a reflection of animals responsiveness to their initial and external environment (Isikwenu et al., 2012), hence this constituents are important in diagnosing the functional status of an exposed animal to suspected toxicant. All parameters showed significant variations among the groups except (MCHC) in group B, which they marked high significant ($P<0.05$) in all indices of Erythrocytes when compared to other two groups (A and C). Red Blood Cell (RBCs) counts were also high and followed a trend similar to that observed for Hb; indicating that none of the *Moringa oleifera* leaves supplements has effected on a resulted of hemoglobin, they have been described by Foster and Smith (2011), final higher RBC values, as observed for animals on *Moringa oleifera* leaves supplementation, had been attributed in some earlier studies to a higher plane of nutrition. The highest RBCs recorded in group B corresponded with the highest values of PCV and Hb concentration observed in group B, suggesting their superiority in terms of their capability of supporting high oxygen carrying capacity of the blood, also Foster and Smith (2011) reported that physiological stress free and absence of anemia related diseases which might be due to iron deficiency. The obtained RBC, Hb and PCV values in this study were similar to their values obtained by Okoruwa et al. (2013). West African dwarf bucks fed *pannisetum purpureum* and *unripe plantain* peels. However The obtained Hb values of 8.32, 10.46 and 9.21 g dL-1 for group A, B and C respectively, fell within the normal range values (7.00 to 15. 00 g dL-1) as reported by Tambuwal et al. (2002) for WAD goats and Sudanese goats by (Babeker and Elmansoury, 2013), the increase of Hb in this study would have translated to an advantage in favor of the animals on *Moringa oleifera* leaves supplementation. Such an observation was regarded by Opara et al. (2010) as an advantage in terms of the blood's oxygen-carrying

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capacity. A deficiency of haemoglobin in the red blood cells decreases blood oxygen-carrying capacity, leading to symptoms of anemia (Aaron et al., 2003). The PCV was significantly high (P<0.05) in group B (31.50 ± 1.09) and (23.60 ± 0.37), (26.80 ± 0.77) in groups A and C, respectively. The observed PCV values fell within the range of 21.0-36.9% reported for clinically-healthy WAD goats (Taiwo and Ogunsanmi, 2003; Daramola et al., 2005). It should be noted that only *Moringa oleifera* dried leaves supplementation resulted in a significant (P<0.05) increase in PCV at the end of the study; suggesting that *Moringa oleifera* dried leave offered the grazing animals a better plane of nutrition. Such high PCV values have been regarded (Addass et al., 2010) as signs of healthy and high productive animals. Ikhimioya and Imasuen, (2007), reported that only goats on *Moringa oleifera* dried leaves supplementation could probably have a high tendency for a return of PCV to normal level following an infection through compensatory accelerated production; as they were the only animals with PCV value above 32% documented by Frandson, (1974) to be normal for circulatory system in goats. The mean corpuscular haemoglobin (MCH) and mean corpuscular volume (MCV) was not significantly (P<0.05) different from diet B and C. But diet A was significantly (P<0.05) lower than diets B and C. The mean corpuscular haemoglobin concentration (MCHC) were not significantly different (P<0.05) among all the groups, but the MCV and MCH were significantly (P<0.05), different from groups B and C when comparable with group A, respectively. The MCHC was not significantly (P<0.05) different from each other in groups.

Table (6), represent the leukocyte Indices of Nubian goats fed varying levels of *Moringa oleifera* leaves. The total white blood cells (TWBCs) was significantly (P<0.05) high in diet B (6.21± 0.14 x103/µ) when compared with diet C (4.77± 0.03 x103/µ) and A (4.21± 0.09 x103/µ), respectively. This results means that goats on diets B remained healthy, because the number of TWBC counts on the normal range. Konlan et al., (2012) reported that WBC offer explanation for defense mechanism of animal. Also the obtained WBC values are within earlier reported ranges for WAD goats (Daramola et al., 2005) and Sudanese goats by (Babeker and Elmansoury, 2013). West African Dwarf goats seem to possess protective system, providing a potent and rapid defense against any infectious agent and this is probably the physiological basis for the adaptation of this species to this ecological zone characterized by high prevalence of diseases (Opara et al., 2010). White blood cell differentional, lymphocyte, neutrophils, monocyte, eosinophils and basophils were not significantly different among all groups.

The result on table (7) shows the examination of some biochemical indicators contributes to the knowledge of metabolic profiles in feedlots performance of Nubian goats and their possible disorders, whether of a latent or clinical nature. The concentration of glucose determined in this study was decreased significantly in group B (60.60 ± 0.76 mg/dl) when compared with groups A (78.80 ± 1.50mg/dl) and group C (75.80 ± 1.69 mg/dl), respectively. The present glucose value was in agreement with that and the normal range (50-75mg/dl) of goats, which reported by Dhanotiya (2004). However, they were higher than those obtained by (Babeker and Elmansoury, 2013) 65.20 mg/dl and Turner et al., (2005) 66.3 mg/dl; this difference may be attributed to the difference in breed, age or feed consumed; (Mbass and Poulsen, 1991). Since the levels were within the variation range (50-75mg/dl) indicated for healthy goats (Zubcic, 2001; Dhanotiya, 2004), it thus appears plausible to infer that the observed depressed serum glucose in group B is not due to Moringa leaf meal intoxication, but that the dietary energy was sufficiently utilized for growth and the animals were not surviving at the expense of body tissues (Ologhobo et al., 1992). The low glucose level observed indicates that it is suitable for human diabetic consumption, as the presence of flavonoid also correlates with the reports of (Farooq et al., 2007) who stated that the *M. oleifera* plant is one of the highly potential antidiabetic plants, probably because of the presence of the ability of its compounds and some flavonoids to inhibit a-amylase activity to regulate the amount of glucose in the blood.

The concentration of the total protein and albumin reported in this study was significantly difference between all the groups. These results were comparable to the normal range of goats (6.4-7g/dl) reported by Dhanotiya (2004). However, the present results were lower than (9.8 g/dl) reported by Ibrahim et al., (2005) and (7.48 g/dl) reported by Zubcic (2001). This is differences may be due to the influence of breed, age or feed of these goats (Mbassa and Poulsen, 1991). Also the results of albumin on the normal range (2.7-3.9g/dl), which reported by Dhanotiya, 2004), (3.3 .5g/dl) reported by Ibrahim et al., (2005) and (3.3 +6.1g/dl) noted by Zubcic; (2001). The superior values obtained for the diet of group B show that the high level of total protein and albumin is safe and beneficial, and not detrimental, because the levels of some chemical composition of moringa leaves are beneficial as they impact some qualities of rumen undegradable protein, thus improving protein availability and utilization (Garg et al., 1992). Moringa leaves are also a good protein source that is a convenient substitute of some meals (soybean and rapeseed) for ruminants, and they are able to improve the microbial protein synthesis in the rumen (Soliva et al., 2005).

Conclusion

Moringa can help small and medium-scale farmers overcome shortages of good quality feeds and therefore sustain and improve their livestock productivity. The results of this study recorded that supplementation of *Moringa oleifera* leaves 20% – based multi nutrient blocks in small ruminants' diet is rapid growth performance and facing death challenges to the animals. Under Tropical Dry season conditions and when phosphorus and potassium are available in the soil, Moringa can maintain high biomass yield over time but this requires nitrogen to be supplied in sufficient amounts to cover that removed at harvest. *Moringa oleifera* leaves supplementation offered grazing Nubian goats a better plane of nutrition relative to the two reference supplements, thereby supporting higher growth rates. The hematological indices indicate that the animals on *Moringa oleifera* leaves supplementation 20% were healthier and with a greater capacity to return to normal health following an infection. An adoption of the *Moringa oleifera* leaves technology by small ruminant keepers in the tropics could therefore be a panacea to the

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nutritional and health hardships faced by the animals during the usually long dry season. Based on the result of this present study most hematological and biochemical values obtained were within the normal range reported for goats. The use of varying levels of *Moringa oleifera* leaves 20% in this study have demonstrated to be potential sources of readily available energy and protein that would go along way infilling feed shortage gaps without any adverse effect on the Nubian goats. The responses in terms of energy utilization and hematological traits by Nubian goats proved to be more effective and efficient in diet B compared to diets A and C.

Recommendations:

1- Research to support improved production techniques of the moringa plant is, however, needed to enable farmers produce the meal at dry season at lower cost for economic use in animal feeding.

2- Moringa leaves meal is non-toxic to goats at least at the level of 20%.

3- Moringa leaf meal could be used to improve daily weight gain, body weight and dry matter intake (DMI) of small ruminants at the 20% diet inclusion level.

4- Moringa leaves meal (MOLM) has the potential to decrease glucose level in goats blood plasma.

5- The results of this study clearly show that supplementation of *Moringa oleifera* –based multi nutrient blocks in small ruminants' diet can enhance better performance and pose no health challenges to the animals. *Moringa oleifera* compares favorably with Groundnut Hay and sorghum Hay nutritionally and can enhance the performance of goats as protein supplements in white Nile state in Sudan.

6- Moringa leaves meal (MOLM) has the potential to evaluate some blood parameters in goats such as haemoglobin, haematocrit, White blood cells and Red blood cells.

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