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Impact of black plum (*Vitex doniana*) leaf meal on blood biochemistry, hormone and cholesterol level of West African dwarf goat-bucks

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***Target Audience:** Animal scientists, Extension officers, Goat producers, Meat processors*

Abstract

Fifteen (15) West African Dwarf (WAD) goat-bucks with average initial weights of 10±0.53kg were used in an experiment to investigate the effect of varying levels of Vitex doniana leaf meal on the blood profiles, hormone and cholesterol level of WAD goat-bucks. The animals were randomly assigned to five dietary treatments consisting of graded levels of Vitex doniana in a Completely Randomized Design experiment which lasted twenty-eight (28) days. At the end of the feeding trial, blood samples were collected from the jugular veins of the animal for the determination of haematological and serum biochemical characteristics using standard laboratory methods. The Vitex doniana leaf had a crude protein of 8.53, crude fibre of 7.15, crude fat of 6.44 and ash of 8.26 percent and were moderately high in flavonoids 20.82, phenols 96.14, saponin 6.48mg/100g with slight presence of alkaloids, tannins, terpenoids, steroids and anthraquinones. The effects of graded levels of Vitex doniana leaf meal on haematology of WAD goat-bucks reveals that red blood cell (RBC) significantly ($p<0.05$) increase with concurrent increase in Vitex doniana leaf meal whereas the haemoglobin (Hb) and packed cell volume (PCV) reduced with the addition of the leaf meal. Other parameters were not significantly ($p>0.05$) different from the control, although it varies with increase in the leaf meal addition. The serum biochemistry of West African dwarf bucks showed that total protein (TP), albumin (ALB), urea and glucose significantly increased with increase in Vitex doniana leaf meal. Alkaline phosphatase (ALP), Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST) was significantly ($p<0.05$) influenced by the increase in Vitex doniana leaf meal inclusion. The ALT and AST were not significantly ($p>0.05$) different from the control in treatment D. Phytochemical results shows Vitex doniana has high content of phenol, flavonoid and saponin; it significantly increase total cholesterol and low density lipoprotein with a reduction in high density lipoprotein with 20g/kg feed while triglyceride and high density lipoprotein were high with 10g/kg feed. It significantly reduced luteinizing hormone while causing an increase in follicle stimulating hormone, testosterone and prolactin with 15g/kg. The administration of 15g inclusion level of Vitex doniana leaf meal increases the reproductive performance while administration of 10g inclusion level helped to lower the cholesterol level in WAD bucks with no conspicuous adverse effects and their health status was not compromised. All the haematological and serum biochemical characteristics of the bucks were within the normal/ standard blood ranges for apparently healthy bucks. The study therefore concludes that farmers can supplement feed with up to 20% Vitex doniana leaf meal in formulated diets meant for goats, without fear of compromising haematopoietic processes.

***Key words**: Blood, Feed, leaf-meal, WAD goat-bucks.*

Description of Problem

Production of ruminant animals in developing African countries is often characterized with low level of efficiency. The apparent inefficiency of ruminant production has been attributed to unfavourable climate,

disease prevalence and feed shortage especially during dry seasons. The first two factors tend to encourage adoption of intensive ruminant farming system which can further aggravate the problem of inadequate feed supply. The cost of feed accounts for about 60% of total intensive production cost compared to 40% value under extensive production system (2). A large reduction in feed cost is achievable by the use of unconventional feed resources such as fodder or shed tree leaves to bring about improvement in ruminant production efficiency in the resource poor developing countries like Nigeria. Utilization of leaves from browse trees such as African Black Plum (*Vitex doniana)* especially during the dry season period, could serve as a viable option to address the lingering feed scarcity to livestock in Nigeria (9). *Vitex doniana* tree is a good source of food and fodder for livestock in different parts of Nigeria (11). Despite information on general feeding management of goats in Nigeria, there is little information on the utilization of *Vitex doniana* dry leaves in the feeding management of West African Dwarf bucks. Therefore, knowledge of the utilization of graded level of *Vitex doniana* in combination with other feed resources, to improve the general performance of WAD goat-bucks is needed in order to address unrelenting feed shortages in Nigeria. As a result of these arising nutritional issues, *Vitex doniana* dry leaves were used in this study to investigate the possibility of including graded levels of the leaves to improve the productivity of goats using local resources available and at least costs.

The aim of the present work seeks to explore the potential of *Vitex doniana* (black plum) leaves, which presently are of little economic value for goat feeding under intensive system of production.

Table 1: Composition of experimental basal diet

Ingredients	% Inclusion
Maize	30.00
Groundnut cake	14.00
Wheat offal	33.00
Rice bran	10.00
Palm kernel cake	10.00
Table Salt	1.00
Premix	0.25
Limestone	1.00
Bone meal	0.75
Total	100.00

Materials and Methods

Site and Period of the Study

Feeding trials and laboratory analyses were conducted in the Livestock unit of the University Farm and the Animal Production Laboratory respectively at the Department of Animal Production, University of Ilorin located on Latitude 08^{o} 29`N; Longitude 004$^{o}$ 35`E; Elevation 308 m, having a mean annual rainfall of 98.75 mm that is spread largely over the months of May to October.

Collection and Processing of *Vitex doniana* Leaves

Fresh leaves were collected from *Vitex doniana* (Black plum) trees on the University of Ilorin farm during the dry season months of November and December. Leaf samples were identified at the Department of Plant Biology Herbarium, Faculty of Life Science, University of Ilorin and a sample deposited with assigned voucher number. The leaves were subsequently air-dried for 10 days and kept inside jute bags in a well ventilated open shed that was protected from rain and direct rays of sunlight. The leaves were later processed by grinding in a hammer mill to pass through 2 – mm sieve and kept in jute bags for subsequent feed formulation. Samples of the leaves were analyzed for gross energy, dry matter and chemical components (Table 2).

Table 2: Proximate composition of experimental diets and *Vitex doniana* leaf meal

Parameter (%)	A	B	C	D	E	V
Dry matter	84.62	91.46	90.88	90.98	91.51	92.75
Moisture content	15.38	8.54	9.12	9.02	8.49	7.25
Crude fat	3.94	4.98	2.91	4.39	5.42	6.44
Crude protein	16.19	16.59	19.69	16.79	15.31	8.53
Crude fibre	6.05	13.40	8.35	9.03	9.14	7.15
Ash content	8.69	10.23	8.33	9.50	8.56	8.26

Where A is the control (basal diet without *Vitex doniana* leaf meal), B (basal +5g *V. doniana*), C (basal +10g *V. doniana*), D (basal +15g *V. doniana*), E (basal + 20g *V. doniana*), V (*Vitex doniana* leaf meal)

Feed Formulation and Processing

The leaves were mixed with crushed maize, soy bean meal, bone meal and sodium chloride in the different inclusion levels of 0, 5, 10, 15 and 20g/kg of leaves to feed as indicated in Table 1and 2. The resultant feeds were processed into crumbles to reduce dustiness, facilitate handling and encourage intake by animals. Each feed was wetted with about 2% (*v/w*) clean drinking water and sun-dried on concrete slab for 5 – 6 hours.

Experimental Design and Animal Management

A 28 – day growth and nutrient digestibility trial was conducted with fifteen weanling male West African Dwarf goats of average initial live weight of 10.50 ± 0.34 kg. The goats were divided into five dietary treatments of three bucks each in a completely randomized design. Animals in treatment A (control) were fed formulated diet without *Vitex doniana* leaf meal while the other four treatment (B, C, D and E) had *Vitex doniana* leaf meal in varying inclusion level of 5, 10, 15 and 20g/kg of feed respectively. Each animal were fed 300g/day of the formulated feed throughout the experimental period. *Panicum maximum* were also provided in abundance for the bucks.

On the 28th day, blood was collected by jugular vein puncture with hypodermic needles and syringe from three animals per treatment into two (2) clean sample bottles, one with an anticoagulant, Ethylene Diamine tetra Acetate (EDTA) for haematological analysis and the other without EDTA for serum biochemical analysis. All haematological parameters were determined by conventional laboratory methods of (3). Serum biochemical indices were assayed using standard laboratory methods (12). All data were analyzed using the analysis of variance (ANOVA) procedure following a completely randomized model (16) and the levels of significance were determined using the Duncan's Multiple Range Test.

Table 3: Phytochemical composition of *Vitex doniana* leave meal

PHYTOCHEMICALS	QUALITATIVE	QUANTITATIVE (mg/100g)
Alkaloids	+	2.61
Saponins	++	6.48
Tannins	+	1.45
Flavonoids	++	20.82
Terponids	+	0.21
Phenols	+++	96.14
Steroids	+	2.02
Anthraquinones	+	0.04

KEY: + PRESENT; ++ MODERATELY PRESENT; +++ HIGHLY PRESENT

Results and discussion

Vitex doniana leaf meal was observed to be high in flavonoids and phenols which are necessary immunostimulants for defence against microbial invasion (13). Its inclusion in diets of West African Dwarf goat-bucks caused a significant increase ($p<0.05$) in red blood cells (RBC) with concurrent increase in *Vitex doniana* leaf meal. However, the haemoglobin (Hb) and packed cell volume (PCV) significantly reduce with increased addition of the leaf meal (Table 4). Other parameters though similar to the control was significantly different ($p<0.05$) from the treatment D, although it varies with increase in the leaf meal addition. Table 5 shows the effects of graded levels of *Vitex doniana* leaf meal on serum biochemistry of WAD goat-bucks. The total protein (TP), albumin (ALB), urea and glucose significantly increased with increase in *Vitex doniana* leaf meal. Alkaline phosphatase (ALP), Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST) was significantly influenced by the increase in *Vitex doniana* leaf meal inclusion. The ALT and AST were not significantly different ($p>0.05$) from the control in treatment D.

Table 4: Effects of graded levels of *Vitex doniana* leaf meal on haematology of West African dwarf bucks

Parameters	A	B	C	D	E	±SEM
Red blood cells×10^{12}/L	12.68^{d}	12.88^{c}	13.18^{b}	13.22^{b}	13.89^{a}	0.03
Haemoglobin (g/dl)	9.86^{b}	10.70^{a}	10.63^{a}	9.22^{c}	9.36^{c}	0.26
Packed cell Volume (%)	26.00^{b}	28.33^{a}	29.00^{a}	24.00^{c}	24.33^{c}	1.32
White blood cells×10^{9}/L	13.33^{a}	13.00^{ab}	13.00^{ab}	12.56^{b}	12.78^{ab}	1.81
Neutrophils (%)	21.67^{ab}	20.00^{b}	23.33^{a}	23.33^{a}	23.33^{a}	1.84
Lymphocyte (%)	83.70^{ab}	90.03^{a}	78.45^{b}	77.04^{b}	74.07^{b}	1.23
Monocytes (%)	2.33^{b}	3.00^{a}	1.33^{c}	1.33^{c}	1.33^{c}	0.37
Eosinophil (%)	0.00^{b}	1.00^{a}	0.00^{b}	0.00^{b}	0.00^{b}	0.87

a, b, c, d – means along the rows with different superscripts differ significantly ($p<0.05$); A (basal diet without *Vitex doniana* leaf meal), B (basal +5g *V. doniana*), C (basal +10g *V. doniana*), D (basal +15g *V. doniana*), E (basal + 20g *V. doniana*).

Red blood cell (RBC) of $13.89\pm0.03\times10^{12}$/L obtained for bucks that received 20g *Vitex doniana* leaf meal in treatment E was significantly ($p<0.05$) higher than all other treatments. RBC values of $12.88\pm0.03\times10^{12}$/L in treatment A and $13.89\pm0.03\times10^{12}$/L in treatment E were in contrast with the report of (1) in Saanen goats but were within the range reported by (7) for West African Dwarf goat. It could be said that RBC value changes with breed. It therefore shows that *Vitex doniana* has no negative effect on the health status of the animal. Haemoglobin concentration (g/dl) and PCV (%) were significantly higher ($p<0.05$) in treatment B and C but lower in treatment C and D. The haemoglobin concentration and PCV were within the normal range reported by (7) and (17) for goats respectively. Increase in haemoglobin implies that the animals were able to transport oxygen

to tissues for oxidation of ingested food so as to release energy for the other body functions (14). The WBC counts were in contrast with the report of (1) in Saanen goat. This difference could be as a result of breed, environmental factor and age of the animal. Neutrophil, the most abundant of white blood cell type increases from treatment B to C but become constant with additional increase in *Vitex doniana* leaf meal. Lymphocytes are the largest type of white blood cell and it is a-granulocyte. It was significant ($p<0.05$) reduced with increase in the *Vitex doniana* leaf meal in the diet. Eosinophil was only significant in treatment B. Eosinophils are responsible for fighting infections of parasitic worms. These cells release toxins that kill the worms and are also involved in the inflammatory response when there is an allergic reaction. The value was within the normal range reported by (7) and (20).

Table 5: Effects of graded levels of *Vitex doniana* leaf meal on serum biochemistry of West African dwarf bucks

Parameters	A	B	C	D	E	±SEM
Total protein (g/L)	10.00^{b}	11.67^{a}	9.65^{ab}	9.15^{b}	11.33^{a}	1.19
Albumin (g/L)	3.67^{c}	3.77^{b}	3.67^{c}	3.00^{d}	4.44^{a}	0.35
Urea (mmol/L)	2.00^{d}	2.53^{c}	3.10^{b}	2.07^{d}	5.73^{a}	0.26
Creatinine (µmol/L)	0.24^{d}	0.39^{a}	0.24^{d}	0.27^{c}	0.31^{b}	1.04
Glucose (mmol/L)	0.57^{b}	0.87^{a}	0.33^{c}	0.30^{c}	0.83^{a}	0.05
ALP (IU/L)	86.00^{c}	68.67^{d}	98.00^{b}	108.33^{a}	108.33^{a}	2.83
ALT (IU/L)	27.67^{a}	26.00^{b}	21.67^{c}	28.00^{a}	17.67^{d}	1.19
Total cholesterol (mmol/L)	0.65^{ab}	0.45^{b}	0.70^{ab}	0.65^{ab}	1.20^{a}	0.14
Triglyceride (mmol/L)	0.10^{b}	0.15^{b}	0.45^{a}	0.10^{b}	0.15^{b}	0.02
Low-density lipoprotein (mmol/L)	0.30^{b}	0.30^{b}	0.45^{ab}	0.40^{b}	0.70^{a}	0.06
Luteinizing hormone (MIU/ml)	0.40^{a}	0.25^{b}	0.15^{bc}	0.10^{c}	0.10^{c}	0.03
Follicle-stimulating hormone (MIU/ml)	0.50^{b}	1.50^{b}	3.25^{a}	4.75^{a}	4.00^{a}	0.39
Testosterone (ng/dl)	5.50^{b}	2.20^{c}	0.30^{d}	7.10^{a}	0.40^{d}	0.34
Prolactin (µg/L)	0.50^{b}	0.25^{b}	0.50^{b}	0.90^{a}	0.60^{ab}	0.19

a, b, c, d – means along the rows with different superscripts differ significantly ($p<0.05$); A (basal diet without *Vitex doniana* leaf meal), B (basal +5g *V. doniana*), C (basal +10g *V. doniana*), D (basal +15g *V. doniana*), E (basal + 20g *V. doniana*), ALT- Alanine aminotransferase, ALP- Alkaline phosphatase and AST- Aspartate aminotransferase.

Total protein value was significantly high ($p<0.05$) in most of the treatments compared with the control. *Vitex doniana* leaf seems to improve the total protein which serves as buffer in the maintenance of Acid-base balance and a carrier of essential blood constituents such as hormone, vitamins and certain minerals. Plasma protein helps to transport calcium, phosphorus and other substances in the blood by attachment to the albumin (6; 13). Albumin which is most abundant serum total protein was highest in treatment E which had the highest inclusion of *Vernonia doniana*. This implies that *Vitex doniana* leaf meal at 20g improve Albumin level. Urea and creatinine are waste products of protein metabolism and waste generated from creatine respectively. High level of urea is toxic to the body likewise the high value of creatinine shows a renal dysfunction. Though, urea was significantly high in treatment E and C, but was within the normal range reported by (7). Hence, the leaf meal has no deleterious effect on bucks. Glucose level was significantly high at treatments B and E but low in treatment C and D. When glucose is lower than the normal range, it is an indication of hypoglycaemia while higher levels are indication of hyperglycaemia (13). Alkaline phosphatase (ALP) increased with increase in level of the leaf meal inclusion while Alanine aminotransferase (ALT) was within the normal range reported by (1) in Saanen goats. There was an increase in Aspartate aminotransferase (AST) level with increase in leaf meal inclusion but it was still within the normal range (12). These enzymes are tests of liver and organ functions of the animal and any elevation above or below the normal range would have indicated organ dysfunction.

The total cholesterol was highest in treatment E but low in the other treatments with treatment B having the lowest. This may be due to the fact that the body also compensates for any absorption of additional cholesterol by reducing cholesterol synthesis as reported by (10). For these reasons, seven to ten hours after ingestion of cholesterol, blood levels will show little if any effect on total body cholesterol content or concentrations of cholesterol in the blood. However, during the first seven hours after ingestion of cholesterol, the levels significantly increase (13). The observed increased in total cholesterol, triglycerides and low-density lipoprotein could be attributed to its health and medicinal effects of three groups of active phytochemicals (tannins, saponins, alkaloids). Saponin (in excess) causes hypocholestrolaemia because it binds cholesterol making it unavailable for absorption (15).

There were significant differences ($p<0.05$) in luteinizing hormone (LH) value and these ranges from 0.10 ± 0.03 in treatment D and E to 0.40 ± 0.03 in the control, A. LH has been reported to stimulate testosterone output in a variety of *in-vitro* systems including perfused testes, incubations of testicular slices, minces or homogenates, incubations of entire decapsulated testes and in suspensions of purified Leydig cells (5).

Follicle stimulating hormones (FSH) significantly increase with increased level of *Vitex doniana* leaf meal. This support the work of (8) that increase in serum estradiol levels cause a decrease in FSH production by inhibiting gonadotrophin releasing hormone (GnRH) production in the hypothalamus. A decrease in serum FSH level would cause the smaller follicles in the ovary to undergo atresia as they lack sufficient sensitivity to FSH to survive (18). The significantly high levels of testosterone in treatment D (7.10 ± 0.34 ng/dl) could be as a result of increased *Vitex doniana* leaf meal on FSH/LH secreting organ. Testosterone is essential for muscle lay-down, health and well-being as well as the prevention of osteoporosis (19). Prolactin level was significantly high with increase in *Vitex*

doniana leaf meal with the highest in treatment D (15g inclusion level). Prolactin has been reported to enhance spermatogenesis by augmenting the effect of endogenous or exogenous LH on testicular steroidogenesis rather than potentiating the effect of androgens on the seminiferous epithelium (4).

Conclusion and Application

In conclusion,

1. *Vitex doniana* leaf meal has a valuable non-conventional feedstuff potential; Livestock farmers can use it as a feed supplement in the diet of West African Dwarf bucks with up to 20g/kg concentrate feed, without fear of compromising haematopoietic processes and blood chemistry.
2. Optimum performance in terms of moderating cholesterol and reproductive function can be achieved with a 15g inclusion of *Vitex doniana* leaf meal in concentrate diets.
3. Further studies should be done on the mechanism for effecting the changes on the animal and the residual effect on the animal product.

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