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Research Article

Blood Profiles of Rabbits Fed *Hyptis suaveolens* Leaf Meal Additive

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Abstract

A 10-week feeding trial was conducted to evaluate the hematology and serum biochemical response of rabbits fed graded levels of *Hyptis suaveolens* leaf meal. Forty-eight (48) rabbits aged 5–6 weeks were randomly assigned to four treatments in a completely randomized design, with twelve rabbits per treatment. The control group (T1) received a basal diet, while T2, T3, and T4 were supplemented with 1 g, 2 g, and 3 g *H. suaveolens* leaf meal per kg diet, respectively. Phytochemical analysis revealed appreciable levels of phenols (809.11 mg/100 g), flavonoids (406.34 mg/100 g), tannins (207.82 mg/100 g), alkaloids (177.60 mg/100 g), saponins (98.50 mg/100 g), glycosides (102.31 mg/100 g), and steroids (27.44 mg/100 g). Hematological indices significantly improved ($p<0.05$) with increasing inclusion levels of *Hyptis suavolens*: PCV (30.41–33.60%), Hb (8.42–10.11 g/dL), Red blood cell (5.07–7.80 $\times 10^{12}$/L), and White blood cell (13.40–16.91 $\times 10^{9}$/L). Serum proteins increased (total protein: 3.98–4.89 g/dL; globulin: 2.08–2.78 g/dL), while glucose (160.2–114.9 mg/dL) and cholesterol (97.33–70.10 mg/dL) decreased significantly ($p<0.05$). Activities of ALT, AST, and ALP were reduced in treated groups, indicating hepatoprotective potential. These findings demonstrate that *H. suaveolens* up to 3% dietary inclusion improves hematological and serum biochemical profiles, suggesting its potential as a safe phytogenic feed additive in rabbit nutrition.

Keywords: blood; haematology; liver function; rabbit; serum

Introduction

Hematological and serum biochemical parameters serve as reliable indicators of animal health, nutritional status, and physiological responses to dietary interventions [1]. In rabbits, these indices provide essential insights into erythropoiesis, immune status, liver and kidney function, and overall metabolic activity. Globally, one of the problems facing human growing population is shortage of protein supply which have been continuously combated by researchers, making efforts in animal production improvements. Rabbits being a fast growing and highly prolific animals has been encouraged in the recent years. However, feed cost remains a major constraint in rabbit production, accounting for up to 70% of total production costs [2,3]. Consequently, attention has shifted towards non-conventional feed resources and phytogenic additives that can improve health and productivity while reducing costs [4].

Hyptis suaveolens (L.) Poit., an aromatic shrub belonging to the Lamiaceae family, is widely distributed in tropical regions and is known for its antimicrobial, antioxidant, and anti-inflammatory properties [5,6]. Its leaves contain bioactive compounds such as flavonoids, tannins, saponins, alkaloids, and essential oils [7]. Despite its ethnoveterinary applications, limited information exists on its dietary inclusion in rabbit nutrition and its effect on hematological and serum biochemical parameters hence, this study.

Materials and Methods

Experimental Site

This study was conducted at the Teaching and Research Farm University of Abuja, Federal Capital Territory, Nigeria. It lies between latitude 8055′N and 900E and longitude 7000′E and 7005′E and, land mass of 655sqkm.

Samples Preparation

The preparations using standard practices and the phytochemicals analysis was carried out. Fresh samples of *Hyptis suaveolens* were obtained, cleaned and air-dried. After drying, it was grinded into powder form and authenticated at the laboratory.

Experimental Animal and Management

A total number of forty-eight (48) 5-6 weeks old were used for this experiment. The rabbits were allocated to four treatment groups (T1, T2, T3, and T4), with each group consisting of three replicates of four rabbits each. The rabbits were housed individually in a wired cage and allowed access to clean water and feed *ad libitum*.

Experimental Diets

The experimental diets were formulated to meet the nutritional requirements of growing rabbits as prescribed by the National Research Council [8].

The experimental groups are T1 (0g), T2 (1 g), T3 (2 g), and T4 (3 g) of *Hyptis suaveolens* leave meal per kg of feed.

Each treatment group consisted of 12 rabbits, randomly assigned in a completely randomized design.

Hematological and Biochemical Analysis

At the end of the feeding trial, blood was collected from each rabbit's lateral saphenous vein using sterile 2ml syringes and 21-gauge needles. Samples for hematology were collected in to a tube containing ethylene diamine tetra-acetic acid (EDTA) as an anticoagulant, while serum samples were collected into plain bottles for biochemical analysis, which includes White blood cells (WBC), Packed cell volume (PCV), Lymphocytes (LYM), Red blood cells (RBC), Mean corpuscular volume (MCV), Mean corpuscular hemoglobin concentration (MCHC), Mean corpuscular hemoglobin (MCH), Eosinophil and Heterophils.

Serum biochemical analysis such as Alanine Aminotransferase (ALT), Aspartate Aminotransferase (AST), Alkaline Phosphate (ALP), kidney function indicators (Urea and Creatinine), lipid profiles (Cholesterol), globulin, glucose, Total protein and Albumin were also carried out [9,10].

Statistical Analysis

The data obtained was subjected to one-way Analysis of Variance (ANOVA) to establish significant differences which was separated using Duncan's multiple range test [11], both contained in Statistical Package for Social Science SPSS.

Results

Phytochemical Composition

Phytochemical analysis of *Hyptis suaveolens* confirmed the presence of bioactive compounds phenols (809.11 mg/100g), flavonoids (406.34 mg/100g), tannins (207.82 mg/100g), alkaloids (177.60 mg/100g), steroids (102.31 mg/100g), saponins (98.56 mg/100g), glycosides (27.44 mg/100g) in their order of availability.

Haematological parameters of rabbits fed diets containing *Hyptis suaveolens* leaf meal additive

The results of haematology of rabbit fed diets containing different levels of *Hyptis suaveolens* leaf meal additive is presented on table 2. The blood indices evaluated in this study were significantly ($p<0.05$) increased in all the treated groups. However, there was no significant ($p>0.05$) difference in the eosinophils. Serum biochemical parameters of rabbits fed diets containing Hyptis suaveolens leaf meal additive

Parameters	INCLUSION				
	T1 (0%)	T2 (1%)	T3 (2%)	T4 (3%)	SEM
Packed cell volume (%)	30.41^{b}	32.11^{a}	32.80^{a}	33.60^{a}	0.52
Haemoglobin (g/dL)	8.42^{b}	10.2^{a}	10.6^{a}	10.11^{a}	0.06
Red blood cell (x10^{12}/L)	5.07^{b}	6.98^{a}	7.02^{a}	7.80^{a}	0.03
MCH (pg)	37.96^{b}	44.65^{a}	45.80^{a}	46.22^{a}	0.77
MCV (fL)	40.22^{b}	51.36^{a}	52.03^{a}	52.21^{a}	0.51
MCHC (g/dL)	60.47^{b}	71.05^{a}	72.21^{a}	72.23^{a}	0.50
White blood cell (x10^{9}/L)	13.40^{b}	16.11^{a}	16.33^{a}	16.91^{a}	0.08
Heterophil (%)	33.87^{b}	29.50^{a}	28.57^{a}	28.50^{a}	0.04
Eosinophil (%)	0.92	0.87	0.85	0.88	0.01
Lymphocyte (%)	63.27^{b}	71.31^{a}	73.25^{a}	73.60^{a}	0.92
Superscripts (a,b) denote significant differences between groups (P<0.05), MCH= mean corpuscular haemoglobin MCV= mean corpuscular volume, MCHC= mean corpuscular haemoglobin concentration					

Table 2: Hematological Parameters of Rabbits Fed Different Dietary Level of Hyptis suaveolens LEAF MEAL ADDITIVE

The results of serum biochemical parameters of rabbit fed diets containing different levels of *Hyptis suaveolens* leaf meal additive is presented on table 3. The total protein was significantly increased ($p<0.05$) in the treated groups. The albumin: globulin ratio was within range for all the treated rabbit, however, its slightly lower in control group. The glucose and cholesterol were significantly ($p<0.05$) lowered in the treated groups compared with the control. The liver enzymes were reduced ($p<0.05$) in the treated group while no difference was observed in the uric acid and creatinine levels.

PARAMETERS	T1	T2	T3	T4	SEM
Total protein (g/dL)	3.98^{b}	4.72^{a}	4.85^{a}	4.89^{a}	0.18
Albumin (g/dL)	1.90^{b}	2.00^{a}	2.10^{a}	2.11^{a}	0.11
Globulin (g/dL)	2.08^{b}	2.72^{a}	2.75^{a}	2.78^{a}	0.13
Glucose (mg/dL)	160.2^{a}	110.6^{b}	112.8^{b}	114.9^{b}	1.48
Cholesterol (mg/dL)	97.33^{a}	80.02^{b}	70.16^{c}	70.10^{c}	0.82
Uric acid (mg/dL)	5.18	5.05	5.02	5.00	0.04

Creatinine (mg/dL)	0.67	0.62	0.66	0.61	0.02
ALT (U/L)	46.22^{a}	31.90^{b}	31.60^{b}	31.02^{b}	0.55
AST (U/L)	58.17^{a}	40.60^{b}	40.10^{b}	39.55^{b}	0.61
ALP (U/L)	81.51^{a}	60.87^{b}	59.81^{b}	59.55^{b}	0.68
Dactivity by disrupting microbial cell abc means same row with different superscript are significantly (P<0.05) different. AST: Aspartate transaminase, ALT: Alanine transaminase and ALP: Alanine phosphate					

Discussion

Phytochemical composition of *Hyptis suaveolens*

The results of the phytochemical analysis of *Hyptis suaveolens* leaf meal revealed that it is rich in many phyto compounds, with phenols (809.11 mg/100g), having the highest amount. Phenolics exhibit potent antioxidant activity through free radical scavenging, which plays a critical role in mitigating oxidative damage at the cellular level [12]. This antioxidative mechanism helps protect biological molecules from oxidative stress-related degradation. Flavonoids were present at 406.34 mg/100 g, indicating a significant contribution to the bioactive profile of *Hyptis suaveolens*. These compounds are widely recognized for their ability to scavenge free radicals, reduce oxidative stress, and protect cellular structures from damage. In addition, they exhibit antimicrobial membranes, while their anti-inflammatory effects support tissue repair and immune balance. Flavonoids also act as immunomodulators, influencing the activity of immune cells and enhancing overall physiological resilience [13,14]. Tannins, present at 207.82 mg/100 g, exhibit antimicrobial and antiparasitic properties relevant to gastrointestinal protection. Although high concentrations of tannins may reduce nutrient digestibility and absorption, moderate levels provide beneficial bioactivities by inhibiting pathogenic microorganisms and parasites [15].

Alkaloids (177.60 mg/100 g) contribute to pharmacological actions such as analgesic and antimicrobial effects. These nitrogen-containing compounds have been associated with modulating immune responses and inhibiting microbial growth [16]. Saponins, present at 98.56 mg/100 g, possess surfactant properties that enhance nutrient absorption, regulate cholesterol levels, and stimulate immune functions. These effects are attributed to the amphiphilic nature of saponins, which facilitates interaction with cell membranes and biological molecules [17].

Steroids, detected at 102.31 mg/100 g, are important bioactive constituents known to influence various physiological processes. They are implicated in modulating immune function by regulating the activity of immune cells and maintaining immune homeostasis. Additionally, steroids play a role in lipid metabolism, affecting cholesterol synthesis and transport, which is essential for cell membrane stability and hormone production. This dual role supports both metabolic health and immune resilience, adding to the therapeutic value of *Hyptis suaveolens* leaf meal [18].

Glycosides were the least abundant phytochemical detected (27.44 mg/100 g). Despite their low concentration, glycosides play important

roles in cardiotonic activity and other therapeutic effects, often exerting biological activity even at minimal doses [19].

Hematological Parameters of Rabbits fed *Hyptis suaveolens* leave meal

The inclusion of *Hyptis suaveolens* leaf meal as a dietary additive significantly affected the hematological parameters of rabbits compared to the control group. Packed Cell Volume (PCV) increased progressively from 30.41% in the control to 33.60% at 3% inclusion, indicating an improvement in blood's oxygen-carrying capacity. This observation aligns with previous findings that dietary phytogenic additives contribute to enhanced hematological status in animals [20,21]. Additionally, hemoglobin concentration and red blood cell (RBC) counts were significantly elevated in supplemented groups, further suggesting that *H. suaveolens* stimulates erythropoiesis and promotes hemoglobin synthesis, thereby facilitating improved oxygen transport in the bloodstream. Comparable enhancements in hematological parameters have been reported with other herbal feed additives, such as *Moringa oleifera, phyllathus amarus* and *Aloe vera*, which are known to benefit poultry and livestock health [20,22,23].

Furthermore, mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV), and mean corpuscular hemoglobin concentration (MCHC) exhibited significant increases in the supplemented groups. These alterations indicate that red blood cells became larger and contained higher hemoglobin concentrations, thereby enhancing oxygen-carrying efficiency. Such effects align with findings that bioactive compounds in medicinal plants, including flavonoids and tannins, can stimulate hematopoiesis and improve erythrocyte indices [24,25].

Immune parameters were also positively influenced by *H. suaveolens* supplementation. White blood cell (WBC) counts increased significantly with higher inclusion levels, reflecting enhanced immune competence. In particular, lymphocyte percentages rose, indicating a stimulation of the adaptive immune response, while heterophil counts decreased, suggesting reduced physiological stress and improved systemic stability [26,27]. Meanwhile, eosinophil counts remained unchanged across all groups, signifying that allergic and parasitic responses were not affected by the supplementation, which also corroborates the absence of allergy and parasitic infestation in the animals during the study period as also reported in the work of [28].

Serum Biochemical Indices of Rabbits with Dietary Levels of *Hyptis suaveolens*

The results of serum biochemical indices of rabbit fed *Hyptis suaveolens* leaf meal are presented in table 4. The results were significantly influenced with the inclusions. Total serum protein increased progressively from 3.98 g/dL in the control group to 4.89 g/dL at 3% inclusion, indicating enhanced protein synthesis and improved hepatic synthetic capacity. This response is likely driven by bioactive phytochemicals such as phenols and flavonoids and steroids. While phenols and flavonoids are known for their hepatoprotective and anabolic effects, steroids contribute by modulating metabolic pathways involved in protein synthesis and immune function. These compounds facilitate improved nitrogen retention and protein metabolism, supporting overall growth and physiological resilience [29].

Similarly, serum albumin and globulin concentrations rose with increasing *H. suaveolens* supplementation. Albumin levels reflect the synthetic function of the liver, while increased globulin may signify enhanced immune protein production. The immunomodulatory effects of saponins and alkaloids present in the leaf meal are hypothesized to stimulate humoral immunity by promoting immunoglobulin synthesis and lymphocyte proliferation [21,30].

Serum glucose exhibited a significant dose-dependent decrease, from elevated baseline levels of 168.92 mg/dL to 114.99 mg/dL at 3% inclusion. This hypoglycemic effect is attributable to the flavonoids and steroids in *H. suaveolens*, which are documented to enhance insulin sensitivity, facilitate glucose uptake in peripheral tissues, and modulate carbohydrate metabolism [31,32].

Total cholesterol concentration declined substantially from 97.33 mg/dL in controls to 78.10 mg/dL in the highest treatment group. This lipid-lowering effect is explained by the high levels of saponins and tannins in the leaf meal, compounds known to inhibit intestinal cholesterol absorption and enhance bile acid excretion, thereby contributing to improved lipid metabolism and cardiovascular health markers [33,34].

Liver enzymes, specifically alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP), demonstrated significant reductions with dietary supplementation. For instance, ALT decreased from 46.22 U/L to 33.56 U/L, indicating reduced hepatocellular injury or stress. These reductions reflect the hepatoprotective and antioxidant properties of phenolic compounds found in *H. suaveolens*, which mitigate oxidative damage to hepatic tissues [35,36].

No statistically significant differences were observed in serum creatinine and uric acid levels among the treatment groups, suggesting that renal function was not adversely affected by the inclusion of *H. suaveolens* leaf meal. The presence of steroids in the leaf meal may contribute to this stability by exerting protective effects on renal tissues through their anti-inflammatory and immunomodulatory properties. This supports the overall safety profile of the plant for prolonged dietary use in rabbits [37]. Conclusively, the results from this study demonstrate that dietary inclusion of *Hyptis suaveolens* leaf meal at levels up to 3% significantly improves blood parameters in rabbits. The leave meals can be used up to 3% inclusion level in rabbit diets with better results. Furter study should be carried out to determine the optimal level of tolerance and productivity.

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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