HAEMATOLOGICAL AND SERUM BIOCHEMICAL RESPONSES OF WEST AFRICAN DWARF GOATS FED DIETS SUPPLEMENTED WITH GINGER (*ZINGIBER OFFICINALE*) RHIZOME POWDER MEAL

Isaniyi, O. E., Fajemisin, A. N. and Osho, I. B.

Department of Animal Production and Health, Federal University of Technology, Akure, Ondo State, Nigeria.
Corresponding author: isaniyitoyin64@gmail.com

ABSTRACT

The use of phytogenic feed additives in livestock production is increasing, but their health impacts require further exploration. This study assessed the effects of ginger rhizome powder meal (GRPM) supplementation on proximate composition, haematological, and biochemical responses in West African Dwarf (WAD) goats. Five experimental diets, containing GRPM at 0, 200, 400, 600, and 800 g/100 kg basal diet (Diets A, B, C, D, and E), were fed to 20 WAD goats in a completely randomized design for 63 days. Results showed significant (P<0.05) variations in diet composition, except for nitrogen-free extract and ash content. Crude protein (16.56–17.68%), crude fiber (26.55–28.75%), and metabolizable energy (2,831.67–2,848.40 kcal/kg) increased with GRPM levels. Haematological and serum biochemical parameters were not significantly (P>0.05) different, except for white blood cell count (11.25 – 12.60 x 10^3/µl) haemoglobin (9.00 – 9.70 g/dL), neutrophil (40.50 – 46.00%), globulin (3.33 – 4.15 g/dL), and alkaline phosphatase (93.50 – 95.50 ul), which remained within healthy ranges. Hence, GRPM supplementation up to 600 g/100 kg basal diet could be adopted by goat farmers for improved health status of goat.

Keywords: Blood, Ginger, Health, Immunity, Ruminants

INTRODUCTION

Poor health and diseased conditions in livestock often result in the use of synthetic drugs which has raised concerns of possible residual and side effect, drug resistance in animals and humans, coupled with the high costs. These has prompted a shift toward nutraceuticals as a more sustainable alternative to treat and improve the health condition of livestock due to it little or no side effect (Ajanaku *et al*., 2022).

Ginger (*Zingiber officinale*) is a promising nutraceutical plant with rich composition of carbohydrates (60–70%), proteins (9%), lipids (3–6%), ash (8%), crude fiber (3–8%), and essential oils (2–3%) (Shaukat *et al*., 2023). Its nutraceutical properties could be attributed to bioactive compounds, both volatile compounds such as geraniol, zingiberol, and limonene, as well as non-volatile compounds like gingerols, shogaols, zingerone, and paradols, helping to elicit antioxidative, anti-inflammatory, immune boosting, nutrient utilization and metabolic functions (Singh *et al*., 2017, Moalamedi, 2023).

In addition, ginger has been reported to alleviate joint problems, muscle pain, osteoarthritis, enhancing bone health, blood production, and regulation of blood pressure, thereby promoting overall well-being in human (Singh *et al*., 2017). However, there is paucity of information of it impact on goat health. Thus, this study aims to evaluate the effects of dietary ginger supplementation on the chemical composition of diets, haematological indices, and serum biochemical profiles of West African Dwarf (WAD) goats.

MATERIALS AND METHODS

Experimental Site

The study was conducted at the Livestock section of the Teaching and Research Farm, Federal University of Technology, Akure, Nigeria. While the laboratory analysis was carried out in the Department of Animal Production and Health of the same institution.

Experimental Diets Formulation

Fresh ginger rhizomes were sourced from Akure township in Ondo State. They were cleaned, sliced, and air-dried before being milled into ginger rhizome powder meal (GRPM). The GRPM was then incorporated into the basal diet at 0, 200, 400, 600, and 800 g per 100 kg of the basal diet, designated as Diets A, B, C, D, and E, respectively. The basal diet was formulated to meet the nutritional requirements of growing goats.

Feeding and Management of Experimental Goat

Twenty WAD goats, aged 8–10 months, were randomly allocated to the five dietary treatments with four goats per treatment in a completely randomized design arrangement. Each goat was fed their respective diets at 3.5% of body weight and provided water *ad-libitum* during the 63-day feeding trial.

Chemical Composition

Proximate analysis of the diets was conducted following the method of AOAC (2011).

Haematological and Biochemical Analysis

Blood samples were collected via the jugular venipuncture of each experimental goat for haematological and serum biochemical indices according to Dacie and Lewis (1991) and Reitman and Frankel (1957) method respectively.

Statistical Analysis

Data obtained were analyzed using One-way Analysis of Variance (ANOVA) and means were separated using Duncan's Multiple Range Test (DMRT) with level of significance taken at $P < 0.05$ using the Statistical Package for Social Sciences (SPSS) version 26 software.

RESULTS AND DISCUSSION

Table 1 shows the proximate composition of basal diets supplemented with varying levels of GRPM. Crude protein (CP), crude fibre and metabolizable energy significantly ($P<0.05$) increased with higher GRPM supplementation, with values ranging between 16.49 to 17.68%, 26.55 to 28.75% and 2831.67 to 2848.40 kcal/kg respectively from diet A to D while the crude fat decrease across the diets.

The high dry matter (DM) content of the diets is likely due to the inherent characteristics of the feed ingredients. CP across the diets exceeded the critical threshold of 8.00 g/kg recommended by the NRC (2007) for optimal rumen functionality. This highlights the adequacy of these diets in meeting protein requirement of the goats. Similarly, the CF content increased as the GRPM supplementation increased and found to surpassed the 12 % minimum required for maintenance in goats (Omotoso, 2023). The increase in CF with GRPM supplementation supports findings that ginger can enhance fiber composition, promoting rumination, salivation, and improved rumen ecology (Okoruwa, 2020). There was no significant ($P>0.05$) or ordered pattern in the ash content, but high enough to support it critical roles in physiological functions like bone development, blood production and nerve coordination (Oso *et al*., 2024). Crude fat decreased as supplementation of GRPM increased, suggesting that while ginger contain oils, it may not be sufficient to help increase dietary fat content. However, the values exceeded the recommended 5-6 g/kg needed to support energy metabolism. Metabolizable energy, crucial for energy supply and microbial growth through fermentation into short-chain fatty acids was found to be high (Soltan and Patra, 2021).

Table 1: Proximate composition of diets supplemented with varying levels of GRPM fed to WAD goats

Parameters (%)	A	B	C	D	E	SEM	P-value
Dry matter	89.04^{c}	87.39^{e}	89.97^{a}	89.60^{b}	87.96^{d}	0.26	0.00
Crude protein	16.49^{c}	16.96^{bc}	16.56^{c}	17.68^{a}	17.73^{a}	0.18	0.02
Crude fiber	26.55^{c}	27.38^{b}	27.51^{b}	28.60^{a}	28.75^{a}	0.24	0.00
Nitrogen free extract	27.35	28.93	30.74	27.50	28.30	0.40	0.12
Ash	11.34	11.54	10.50	11.31	10.70	0.19	0.35
Crude fat	15.01^{a}	14.19^{b}	14.68^{b}	14.70^{b}	14.52^{b}	0.39	0.00
Metabolizable Energy (kcal/kg)	2831.67^{b}	2835.28^{ab}	2839.81^{ab}	2843.27^{a}	2848.40^{a}	2.05	0.02

^{abcd}: Means within the same row with different superscripts are significantly ($P<0.05$) different. SEM: Standard Error of Mean, A= Basal diet + 0.00g GRPM, B = Basal Diet + 200g GRPM, C = Basal Diet + 400g GRPM, D = Basal Diet + 600g GRPM, E = Basal Diet + 800g GRPM

Table 2 contains the haematological indices of WAD goats fed diets supplemented with varying levels of GRPM along with the standard range for goats. It was observed that only white blood cell (WBC) count, hemoglobin concentration, and neutrophil count were significantly ($P<0.05$) influenced by GRPM supplementation, with values ranging from 11.25 to 12.90 × 10^3/µL, 9.00 to 9.70 g/dL, and 40.50 to 46.00%, respectively. All parameters remained within the standard limits.

The packed cell volume values were within the recommended range of 22–38%, indicating sufficient dietary protein to support blood production (Oso *et al*., 2014). The red blood cell counts decreased with BPM supplementation but remained within the normal range, with no clinical signs of anemia observed. The WBC counts also fell within the normal range, with no evidence of pathological conditions, suggesting the animals were capable of combating foreign agents. Hemoglobin concentrations were within the normal range of 8–12 g/dL (MSD Veterinary Manual, 2022). Red blood cell indices, including mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration, remained within acceptable ranges, further supporting the ability of ginger to maintain blood profile suggesting the adequacy of the diets. Differential leukocyte counts, including neutrophils and lymphocytes, etc were within safe range indicating no allergic reactions or infections resulting from the supplementation of ginger rhizome powder meal, thus safe for use in ruminant nutrition (Oso *et al*., 2014).

Table 2: Haematological indices of WAD goats fed diets supplemented with varying levels of GRPM

	Standard Range	A	B	C	D	E	SEM	P-Value
Packed cell volume (%)	22-38	26.00	26.50	26..50	26.50	26.40	2.10	0.50
White blood cell (10^3/µl)	4-13	12.60^{b}	11.25^{b}	11.50^{ab}	11.35^{b}	12.90^{a}	2.11	0.05
Red blood cell (x 10^6/µl)	8-12	15.10	14.20	14.00	13.75	14.20	0.24	0.54
Haemoglobin (g/dl)	8-12	9.70^{a}	9.70^{ab}	9.00^{b}	9.00^{b}	9.20^{b}	0.92	0.01
MCH (pg)	5.2-8	6.42	6.83	6.43	6.55	6.48	0.02	0.74
MCV (fl)	16-25	17.22	18.66	18.93	19.27	18.59	1.53	0.84
MCHC (g/dl)	30-36	35.38	36.60	33.96	34.22	34.89	0.20	0.50
Neutrophil (%)	30-48	42.50^{b}	43.50^{ab}	40.50^{ab}	46.00^{ab}	43.00^{a}	1.62	0.05
Lymphocyte (%)	50-70	51.00	50.50	49.50	47.00	44.00	1.77	0.19
Monocyte (%)	0-4	1.50	0.50	0.50	1.50	0.00	0.33	0.60
Eosinophil (%)	1-8	2.00	2.50	2.00	2.50	2.50	0.15	0.74
Basophil (%)	0-1	0.00	0.00	0.00	0.00	0.00	0.00	-

^{abcd}: Means within the same row with different superscripts are significantly (P<0.05) different. SEM: Standard Error of Mean, A=Basal diet + 0.00g GRPM, B= Basal Diet + 200g GRPM, C= Basal Diet + 400g GRPM, D= Basal Diet + 600g GRPM, E= Basal Diet + 800g GRPM

MCHC: Mean Corpuscular Haemoglobin Concentration, MCV: Mean Corpuscular Volume, MCH: Mean Corpuscular Haemoglobin. Standard Range sourced from MSD Veterinary Manual, 2022

Serum biochemical indices of WAD goats fed diets supplemented with varying levels of GRPM. Only globulin and alkaline phosphatase were found to be significantly (P<0.05) influence by GRPM supplementation with values ranging from 3.40 to 4.65 g/dL and 93.50 to 96.50 U/L respectively.

Serum biochemical analysis revealed that total protein levels increased with GRPM supplementation while albumin and globulin levels were also within their respective normal ranges, supporting effective transport functions and immune defense mechanisms (Rezende *et al*., 2017). Enzymatic activities of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were consistent with physiological ranges, indicating healthy liver and muscle function.

Table 3: Serum biochemical indices of WAD goats fed diets supplemented with varying levels of GRPM

	Standard Range	A	B	C	D	E	SEM	P-value
Total protein (g/dl)	6.4-7	6.60	7.55	8.05	7.30	8.10	0.31	0.81
Globulin (g/dl)	2.7-4.1	4.15^{a}	3.33^{b}	4.05^{ab}	3.40^{b}	4.10^{a}	0.16	0.03
Albumin (g/dl)	2.7-3.9	3.95	4..00	4.00	3.90	4.00	0.29	0.78
Total bilirubin (umol/L)	0-1.71	0.90	0.12	0.12	0.12	0.12	0.76	0.80
Alkaline phosphatase (u/l)	93-387	93.50^{b}	96.50^{a}	95.50^{a}	94.50^{ab}	93.50^{b}	1.63	0.03
Aspartate transaminase (u/l)	167-513	185.00	200.00	170.00	170.00	200.00	0.81	0.83
Alanine transaminase (u/l)	06-19	14.50	8.00	8.00	15.00	13.00	2.11	0.81

^{abcd}: Means within the same row with different superscripts are significantly (P<0.05) different. SEM: Standard Error of Mean, A=Basal diet + 0.00g GRPM, B= Basal Diet + 200g GRPM, C= Basal Diet + 400g GRPM, D= Basal Diet + 600g GRPM, E= Basal Diet + 800g GRPM. Standard Range sourced from MSD Veterinary Manual, 2022

CONCLUSION AND RECOMMENDATIONS

This study revealed that the supplementation of ginger root powder meal (GRPM) can significantly (P<0.05) enhance nutrient value particularly the crude protein and fibre content of the diet while helping to maintain stable hematological and serum biochemical parameters in the goats. The result revealed no adverse nor deleterious effects of GRPM, but able to boost the health and productivity of goats. Thus, supplementation of GRPM up to 600 g per 100 kg of diet is recommended for optimizing goat health.

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