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Archiva Zootechnica 26 :2, 36-51, 2023
DOI: 10.2478/azibna-2023-0013

Physiological responses of rabbit buck fed diets supplemented with varied levels of nutmeg seed meal, clove leaf meal, and their composite mix

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ABSTRACT

Fifty-six Hyla breeds of 12-week-old rabbit bucks were randomly distributed across 7 diet groups comprising the control, 0.25% nutmeg seed meal (NSM), 0.50%, 0.25% clove leaf meal (CLM), 0.50% CLM, 0.25% composite nutmeg and clove leaf meal mix (CNCM), and 0.50%CNCM. At the end of the 8 weeks of the experiment, 3 bucks per diet group were sacrificed. The growth performance, haematology, serum biochemical indices, and testicular morphometry of the buck were assessed. The different diet groups significantly increased ($P<0.05$) the feed intake, weight gained, and feed conversion ratio compared to the control. The highest weight gained and best feed conversion ratio were observed among bucks fed 0.25% CNCM. Dietary supplementation of NSM, CLM, and CLCM at 0.25 and 0.50% levels did not affect ($P>0.05$) the blood parameters, serum proteins, enzymes, and metabolites except for serum glutathione and catalase activity which revealed that the phytochemicals in NSM and CNCM could effectively combat free scavenging radicals. Testicular weight and densities were positively influenced ($P<0.05$) by dietary supplements which are indicative of better testicular functions compared to the control. Hence, the synergetic effect of NSM and CLM at 0.25% supplementation level could be incorporated into Bucks' diet for better productivity.

Keywords: spices, haematology, serum, testicular functions, performance

INTRODUCTION

The ban on antibiotic usage in animal feed by the European Union in 2006 has triggered the exploration of plants and their extracts as an alternative anti-microbial growth promoter for the improvement of livestock production. The use of herbs and spices started thousands of years ago (Greathead, 2003), utilized extensively in many Asian and African countries due to their medicinal properties (Diego et al., 2014) but there has been a paucity of scientific proof to validate their beneficial effects on the health and performance of livestock (Frankic et al., 2009).

Nutmeg (*Myristica fragrans*) is an evergreen, aromatic, perennial, tropical tree cultivated for the spices derived from its seed (nutmeg) and seed covering (mace) (Rashidian et al., 2022). Based on phytochemical studies, it contains volatile oil, a fixed oil, proteins, fats, starch, and mucilage (Periasamy et al., 2016). *M. fragrans* is rich in many bioactive substances; and exhibits antioxidant properties (Murcia et al., 2004; Olaleye et al., 2006), antidiarrheal properties (Parle et al., 2004), antitumor, and anti-inflammatory (Naeem et al., 2016), anti-bacterial and antioxidant activities (Matulyte et al., 2020). *M. fragrans* has been incorporated into diverse livestock diets as a feed additive. Rashidian et al. (2022) reported the utilization of dietary nutmeg up to 20 g/kg diet as a growth promotor and immunostimulant in common carp. Also, the dietary inclusion of nutmeg flesh extracts up to 1.5ml/kg diet did not only improve the performance of broiler chickens raised at a high stocking density of 16 chickens/m^2 but had no detrimental effect on the carcass characteristics of broiler chickens (Sapsuha et al., 2021). The utilization of different concentrations of *M. fragrans* extract (0.25%, 0.65%, 1.25%, 2.50%, and 5.00% (g/ml)) maintained the physio-chemical properties and lipid oxidative stability of raw beef stored at 18°C for 3 weeks compared with the control (Zakaria et al., 2015).

Syzygium aromaticum (Clove) is an aromatic herb that has been used for years due to its antioxidant and antimicrobial activities as food preservatives and as medicinal plants (Cortes-Rojas et al., 2014). *Syzygium aromaticum* is a major vegetal source of phenolic compounds such as flavonoids, hydroxybenzoic acids, hydroxycinnamic acids, and, hydroxyphenyl propens. The main bioactive compound present in the clove is eugenol which is found in concentrations ranging from 9 381.70 to 14 650.00 mg per 100 g of fresh plant material (Neveu et al., 2010). According to the USDA Food Data Central, clove contains 65.53g of carbohydrates, 5.97g of protein, 1145KJ of energy, and 33.9g of dietary fiber. It contains minerals such as potassium, calcium, sodium, magnesium, phosphorus, iron, and zinc. It also contains a good amount of vitamins: vitamin E, folate, niacin, vitamin C, thiamin, riboflavin, and vitamin K (Bhowmik et al., 2012). Numerous researchers have reported diverse use of clove in animal feed. Suliman et al. (2021) revealed

that the use of the dietary supplementation of clove seed in a broiler's diet of up to 1.91% could significantly promote the final body weight, carcass characteristics, quality, physical, and sensory attributes of broiler meat. Contrariwise, the supplementation of the high level of clove seed in the broiler diet at 6% increased the weight of internal organs (liver, gizzard, and heart). In ruminants, Saeed et al. (2021) stated the use of clove phytochemicals and extracts in manipulating rumen fermentation to inhibit methanogenesis and energy loss as well as ammonia–nitrogen waste. The combination of clove and nutmeg leaves at 5% level in goat ration had no effect on the pH, cooking shrinkage, water holding capacity, moisture content, protein content, and fat content of chevon. Likewise, Adu et al. (2020) stated that *Myristica fragrans* seed meal and *Syzygium aromaticum* supplementation at 0.25% enhanced the body weight gain, improved serum, and meat glutathione peroxidase and catalase but reduced cholesterol level and lipid oxidation in broiler's meat. Therefore, the objective of this study was to investigate the effects of *M. fragrans* seed meal and *S. aromaticum* leaf meal dietary supplementation on the performance, blood, and reproductive parameters of buck.

MATERIALS AND METHODS

Collection and Processing of Plant Samples

Myristica fragrans dry seed and *S. aramaticum* dry leaves were procured from the local market in southwestern Nigeria, ground to powder form to produce nutmeg seed meal (NSM) and clove leaf meal (CLM), respectively. Equal quantities (1:1) of NSM and CLM were mixed to achieve composite nutmeg and clove leaf meal mix (CNCM).

Animal Management and Experimental Design

Fifty-six growing Hyla bucks of 12 weeks of age with an average weight of 1360.00 ± 30.00g were acclimatized for 2 weeks after which they were assigned to the 7 diet groups. A basal diet was formulated for the bucks as shown in Table 1 according to requirement specified by NRC, (1994) while others were supplemented with NSM, CLM, and CNCM as follows: Diet 1 (control), Diet 2 (0.25% NSM), Diet 3 (0.50% NSM), Diet 4 (0.25% CLM), Diet 5 (0.50% CLM), Diet 6 (0.25% CNCM), and Diet 7 (0.50% CNCM).

Eight bucks were assigned to each diet group, that is, two bucks were replicated four times in each group, and housed in a metallic cage. The experiment lasted for 56 days (8 weeks).

Determination of the growth performance, haematological and serum biochemical indices, testicular and epididymis morphometric characteristics

Feed intake and body weight gained by buck were recorded weekly. The feed conversion ratio of the buck was calculated as the ratio of feed intake to the weight gained.

Table 1. Gross composition of rabbit buck experimental diet

Ingredients	% composition
Maize	18.40
Groundnut cake	8.70
Palm kernel cake	25.50
Soyabean meal	4.50
Wheat offal	6.90
Groundnut haulms	34.20
Vegetable oil	0.80
Lysine	0.10
Methionine	0.10
Limestione	0.40
Premix	0.20
Salt	0.20
Total	100
Calculated nutrients	
Dry matter (%)	90.15
Metabolizable energy (Kcal/kg)	2505.89
Crude protein (%)	15.92
Crude fiber (%)	15.64
Calcium (%)	0.94
Available phosphorus (%)	0.69
Lysine (%)	0.87
Methionine (%)	0.60
Analyzed composition	
Dry matter (%)	88.30
Crude protein (%)	16.38
Crude fiber (%)	15.62
Ash (%)	4.51
Ether Extract	6.32
Nitrogen-free extracts (%)	45.47

At the end of the 8 weeks feeding trial, the feed was withdrawn from the rabbits for a period of 12 hours. 3 rabbits were randomly selected from each diet group to determine the haematological and serum biochemical indices, testicular, and epididymal morphometric characteristics. The rabbits were stunned, bled, and blood was collected into well-labelled ethylenediamine tetraacetic acid (EDTA) bottles and plain bottles for the haematological and serum analyses respectively. The blood collected into the EDTA bottles was capped immediately and rocked gently for a few seconds to mix the blood with the anticoagulants for haematological studies while the sample in the plain

bottles was spined for proper decantation of the serum into another set of plain bottles and frozen at -20°C prior analysis. The serum antioxidant enzymes catalase, superoxide dismutase, and glutathione peroxidase were analyzed based on methods described by Aebi (1974), Misra and Fridovich (1972), and Rotruck et al. (1973) respectively. The procedure described by Roschlan et al. (1974) was used in the analysis of the total cholesterol in the serum and the serum enzyme concentration was analyzed using kits on a Reflectron ®Plus 8C79 (Roche diagnostic GombH Mannheim, Germany).

The left and right testes and epididymis of the selected slaughtered rabbits were removed immediately and trimmed of adhering tissues and weighed using a sensitive digital scale. Vernier caliper was used to measure the length and width of these reproductive organs while the testis volume was measured using the water displacement technique as described by Adu (2008).

Data Analysis

The statistical model: $T_{sm} = \mu + \alpha_s + \beta_{sm}$, was used for the experiment where T_{sm} is any of the response variables, s is the overall mean, α_s is the effect of the sth treatment (T= diets 1, 2,3, 4, 5,6, and 7); and β_{sm} is the experimental random error. The data were analysed using the one-way ANOVA, SPSS version 20, and the Duncan multiple range test was used to separate the mean.

RESULTS

Growth performance of rabbit buck fed diets supplemented with nutmeg seed meal, clove leaf meal and its composite mix

The performance characteristics of the rabbit bucks fed varied levels of dietary supplementation of nutmeg seed meal (NSM), clove leaf meal (CLM), and their composite mix (CNCM) presented in Table 2 revealed there was a significant influence ($P<0.05$) on the daily and total feed intake, daily and final weight gained as well as the feed conversion ratio of the buck.

The mean values of daily feed intake (DFI) were highest among bucks fed with diet 4 (34.00 ±0.01g), diet 5 (34.20±0.05g), and diet 6 (33.29 ±0.27g) while the least mean value was recorded among bucks fed with the control diet (30.00 ±0.00g) and diet 2 which contained 0.25% NSM (29.56 ±0.53g). A similar trend was observed in the total feed intake (TFI) of buck. The rabbit-fed diets 4, 6, and 7 had the highest daily weight gain (DWG) of 9.48±0.01g, 9.80 ±0.44g, and 10.24 ±0.01g respectively. The least value of DWG (6.15 ±0.81g) was observed among bucks fed with the control diet. Also, the same pattern was observed in the values recorded for the total weight gain (TWG), however, diets 4 and 6 fed to rabbit bucks resulted in the highest final weight gain (FWG) while the control group had the least value.

Table 2. Growth performance of rabbits fed varied levels of nutmeg seed meal, clove leaf meal and their composite

Para-Meters	Diet 1 Control	Diet 2 0.25% NSM	Diet 3 0.5% NSM	Diet 4 0.25%CLM	Diet 5 0.5% CLM	Diet 6 0.25%CNCM	Diet 7 0.5%CNCM	P-value
IWT (g)	1360.00±26.46	1366.67±29.06	1355.67 ±27.97	1393.33±17.64	1370.00 ±20.00	1344.33±14.43	1360.00±26.46	0.85
FWT (g)	1704.67±48.34^{c}	1760.00±20.21^{c}	1788.33±35.52^{bc}	1924.00±17.01^{a}	1873.33±18.56^{ab}	1893.33±26.03^{a}	1933.67±26.34^{a}	0.01
TWG (g)	344.67±45.31^{d}	393.33 ±10.93^{c}	432.67 ±49.70^{bc}	530.67 ±0.67^{a}	503.33±3.33^{ab}	549.00 ±24.50^{a}	573.67 ±0.67^{a}	0.01
DWG (g)	6.15±0.81^{d}	7.02 ±0.19^{c}	7.73 ±0.89^{bc}	9.48 ±0.01^{a}	8.99 ±0.06^{ab}	9.80 ±0.44^{a}	10.24 ±0.01^{a}	0.01
TFI (g)	1680.0 ±0.00^{c}	1655.33±29.67^{c}	1753.00±75.51^{bc}	1904.33±0.33^{a}	1915.00±2.89^{a}	1864.33±15.34^{a}	1847.67±1.45^{ab}	0.01
DFI (g)	30.00 ±0.00^{c}	29.56 ±0.53^{c}	31.30 ±1.35^{bc}	34.00 ±0.01^{a}	34.20 ±0.05^{a}	33.29 ±0.27^{a}	32.99 ±0.03^{ab}	0.01
FCR	5.06 ±0.72^{a}	4.21 ±0.11^{ab}	4.11 ±0.27^{ab}	3.79 ±0.01^{b}	3.80 ±0.02^{b}	3.41 ±0.19^{a}	3.22 ±0.00^{a}	0.01

$^{a, b, ab, bc, c, d}$ = Means on the same row but with different superscripts are significant at P <0.05; NSM-Nutmeg Seed Meal; CLM-Clove Leaf Meal; CNCM-Composite nutmeg and clove leaf meal mix, IWT- Initial body weight, TWG-Total weight gain, DWG-Daily weight gain, TFI-Total feed intake, DFI-Daily feed intake, FCR-Feed conversion ratio.

The best feed conversion ratio (FCR) was observed among bucks fed with diets 6 & 7. Buck fed with the control diet had the highest FCR but the incorporation of NSM, CLM, and CNCM at their different levels resulted in a gradual reduction in the feed conversion ratio.

Haematological and serum biochemical indices of buck fed diets supplemented with nutmeg seed meal, clove leaf meal and their composite mix

Tables 3 revealed there was no significant differences (P>0.05) in all the haematological parameters: packed cell volume (PCV), red blood cell count (RBC), haemoglobin (Hb), mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV), white blood cells (WBC), monocytes, and lymphocyte analyzed.

Likewise, the different levels of NSM, CLM, and CNCM supplemented in the rabbit buck diet did not affect the serum proteins, metabolites, and cholesterol except for the antioxidant enzymes as presented in table 4.

Table 3. Blood parameters of rabbits fed varied levels of addition of nutmeg seed meal, clove leaf meal and their composite

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	P-Value
	Control	0.25% NSM	0.5% NSM	0.25%CLM	0.5% CLM	0.25%CNCM	0.5%CNCM	
PCV (%)	37.00 ±2.00	36.67±1.67	35.67 ±0.88	35.33±2.03	35.67 ±4.41	34.33 ±0.83	34.17 ±0.83	0.500
RBC ($\times 10^6/mm^3$)	3.23 ±0.12	3.08 ±0.27	3.17 ±0.20	3.95 ±0.61	3.57 ±0.09	3.80 ±0.13	3.83 ±10.43	0.700
Hb (g/dL)	12.34 ±0.67	12.88±0.56	12.89 ±0.29	13.11±0.67	11.89 ±1.47	12.10 ±2.19	13.16 ±31.11	0.231
MCHC (g/dl)	33.33 ±0.00	33.33±0.00	33.33 ±0.00	33.33±0.00	33.33 ±0.00	33.33 ±0.00	34.47 ±11.26	0.701
MCV (fl)	126.40±7.05	127 ±5.88	122.77±5.17	121.17±9.32	120.62±14.76	123.30±0.00	123.19±10.14	0.500
MCH (pg)	30.13 ±2.35	32.36±1.96	31 .93±1.72	33.72 ±3.11	33.54 ±4.92	33.31 ±6.60	33.81 ±28.53	0.300
WBC ($\times 10^3/mm^3$)	5.10±0.71	4.63 ±2.09	4.40 ±0.95	3.73 ±0.30	4.60 ±1.71	4.66 ±0.33	4.51 ±10.54	0.053
Lymph (%)	45.67 ±5.61	43.00±7.57	41.57±2.19	42.00 ±7.51	42.00 ±2.31	42.35 ±0.12	43.99 ±12.02	0.400
Mono (%)	3.07 ±0.67	3.00±1.00	3.67 ±0.88	3.67 ±0.33	3.00 ±0.58	3.14 ±0.03	3.00 ±18.94	0.584

Means on the same row and with no superscripts are statistically non- significant at P >0.05; PCV- Packed cell volume, RBC- Red blood cell, Hb-Haemoglobin, MCHC: Mean corpuscular haemoglobin concentration, MCV: mean corpuscular volume, MCH: mean corpuscular haemoglobin, WBC- white blood cells, Lymph-lymphocytes, Mono-monocytes.

Table 4. Serum biochemistry of rabbit bucks fed diets with different levels of nutmeg seed meal, clove leaf meal and composite nutmeg and clove leaf meal mix

Parameters	Diet 1 Control	Diet 2 0.25% NSM	Diet 3 0.5% NSM	Diet 4 0.25%CLM	Diet 5 0.5% CLM	Diet 6 0.25% CNCM	Diet 7 0.5% CNCM	P value
Serum proteins (g/dl)								
TP	6.67 ±0.20	7.07 ±0.30	6.70 ±0.15	6.97 ±0.29	7.07 ±0.34	6.83 ±0.12	7.07 ±0.30	0.48
ALB	3.21 ±0.23	3.62 ±0.26	3.49 ±0.23	3.62 ±0.09	3.67 ±0.16	3.27 ±0.22	3.64 ±0.11	0.74
GLO	3.46 ±0.25	3.45 ±0.10	3.21 ±0.29	3.35 ±0.33	3.40 ±0.50	3.37 ±0.14	3.43 ±0.41	0.87
Serum Enzymes (U/L)								
ALT	52.93 ±1.18	52.10 ±1.53	52.83 ±1.64	54.23 ±1.68	50.97 ±0.62	51.23 ±0.43	54.17 ±2.35	0.14
AST	61.27 ±0.44	60.63 ±0.27	61.03 ±1.52	62.00 ±0.76	61.33 ±1.17	62.53 ±1.23	60.33 ±0.67	0.41
Serum Metabolites (mg/dl)								
Creatinine	0.96 ±0.19	0.89 ±0.20	0.96 ±0.19	0.89 ±0.20	1.07 ±0.07	0.73 ±0.19	1.12 ±0.06	0.61
Urea	15.17 ±1.70	13.78 ±2.41	13.47 ±1.37	11.90 ±0.38	13.58 ±2.51	13.40 ±1.40	11.63 ±0.30	0.59
Serum CHOL(mg/dl	27.20 ±2.63	31.97 ±5.23	30.73 ±5.19	31.27 ±3.58	27.97 ±2.04	35.80 ±3.53	31.27 ±5.29	0.92
Glucose (mg/dl)	118.00 ±4.16	114.67 ±7.42	118.00 ±4.16	114.67 ±7.42	113.33 ±3.33	110.00 ±5.77	122.67 ±1.33	0.41
Serum Antioxidants (mg/g)								
CAT	4.85 ±1.11^{c}	5.18 ±1.94^{c}	7.27 ±0.35^{ab}	8.88 ±1.09^{a}	9.50 ±0.93^{bc}	10.70±0.17^{ab}	10.76 ±0.12^{a}	0.003
GSH	80.59±37.55^{c}	145.84±6.67^{a}	119.68±7.39^{b}	157.01±0.43^{a}	157.76±0.25^{a}	156.16±0.21^{a}	156.68±0.51^{a}	0.016
SOD	61.00 ±6.11	63.00 ±17.01	47.67 ±4.67	45.67 ±13.38	67.67 ±3.33	63.00 ±1.00	63.67 ±2.91	0.501

$^{a, b, ab, bc, c}$ = Means on the same row but with different superscripts are significant at P <0.05 ; TP- total protein, ALB- albumin, GLO-globulin, ALT-alanine transaminase, AST-aspartate transaminase, CHOL-cholesterol, CAT- Catalase, GSH- glutathione peroxidase, SOD- superoxide dismutase

The concentration of the serum catalase was appreciably highest (P<0.05) in bucks fed diets 6 and 7 when compared with the other treatment groups and the control. The supplementation of the buck's diet with different levels of CLM and CNCM increased the serum glutathione level when compared with those fed with the control diet and diets containing 0.25% (diet 2), and 0.50% NSM (diet 3). However, the serum superoxide dismutase of the bucks was unaffected by the different diet groups.

Testicular morphometric characteristics of bucks fed varied levels of nutmeg seed meal, clove leaf meal and their composite mix

The testicular weights, volumes, and densities of the rabbits fed varied levels of nutmeg seed meal, clove leaf meal and their composite mix are shown in Table 5. Rabbit buck fed with 0.25% CNCM (diet 6) had the highest mean values for the weight of the right testis (1.73±0.05g), left testicular (1.94±0.05g) and the paired testes (3.68±0.08g) while those fed the control diet recorded the least significant mean values for these parameters. The testicular volume of the rabbit bucks was not influenced (P>0.05) by the different supplemented diet groups when compared with the control. However, similar trend as the testicular weight was observed in the testicular densities whereby bucks fed with diet supplemented with 0.25% CNCM (diet 6) had the highest mean values for the left testis (2.89±0.17g/ml), right testis (2.71±0.12g/ml) and paired testes (5.54±0.25g/ml).

DISCUSSION

Plant-based supplements have been currently used in livestock production to improve growth performance (Abdelnour et al., 2018). Hence, its incorporation into rabbit feed enhances nutrient absorption and utilization (Földešiová et al., 2015). The increased daily and total feed intake of rabbit buck fed diets containing 0.25% CLM, 0.50% CLM, and 0.25% CNCM concomitantly resulted in the rise in bucks' weight when compared to others. This could be contributed by the bioactive constituents of the clove leaf meal on the digestibility process (Mandey et al., 2019; Suliman et al., 2021). The improvement in feed intake observed particularly in rabbit bucks fed diets containing clove dietary supplement could also be attributed to the enhanced appetite, increased pancreatic and digestive enzymes secretion, and improved intestinal digestibility (Arif et al., 2022). Clove is a herb which acts as growth promoter and reduce the degradation of amino acids thereby causing improved weight gain due to availability of more amino acids (Mohammed et al., 2022). Likewise, the synergetic actions of the phytochemicals (favoniods, phenols, and saponins) present in nutmeg potentiates its antibacterial, antiparasitic, antifungal, anti-coccidiosis, and hepatoprotective properties

(Olaleye et al., 2006; Panggabean et al., 2019). Therefore, the presence of clove leaf meal and its composite mix with nutmeg thereby deactivate the growth of pathogenic bacteria, enhance the multiplication of beneficial bacteria, and accelerate nutrient metabolism and absorption in the digestive tract which in turn improved the body weight of rabbit bucks (Dhama et al 2015; Sapsuha et al., 2021). Likewise, the best FCR observed among bucks fed CNCM at 0.25% and 0.50% indicated that that the feeds were better utilized due to the enhanced production of endogenous enzymes, pancreatic juices, and bile salt triggered by the synergetic effects of the bioactive components of the composite mix when compared to others (Adu et al., 2020; Sapsuha et al., 2021).

Herbs and spices have been studied to act as immunomodulators which does not only improve the immune system but also enhance disease resistance (Dawood et al., 2021; Faheem et al., 2022). The results in Table 3 revealed there was no significant differences in the PCV, RBC, HB, MCHC, MCV, WBC, monocyte and lymphocyte of bucks distributed across the different diet group. This observation validated the nutritional adequacy and safety of the clove leaf meal and nutmeg seed meal as it has no deleterious effects on the normal haemapoietic processes of the rabbit buck (Oloruntola et al., 2019; Adu et al., 2020). As most medicinal herbs, plants, or spices usually have similar effects on the blood and serum biochemical parameters of livestock, table 4 revealed that the serum proteins (albumin, globulin, and total protein) of the bucks unaffected by CLM, NSM, and CNCM supplementation agreed with the findings of Chowdhury et al. (2018) who did not report a significant change on the serum total proteins in broiler chickens fed dietary clove oil at 0.6%. Likewise, the result agreed with the investigation of Tariq et al., 2014 who stated that 0.5% clove powder did not affect total serum protein, albumin, and globulin levels of birds. The non-significant effect of the CLM, NSM, and CNCM on the serum enzymes (ALP, AST, and ALP) activity also agreed with the findings of Kazi et al. (2017), Hosseni et al. (2011), Vijayasteltar et al. (2016) who examined different levels of clove powder on different species of livestock. Also, the creatinine values were insignificant across the different dietary group. The values fell within the normal physiological range for rabbits which is indicative of the normal functioning of the kidney of the bucks irrespective of the varying supplementation levels of the nutmeg seed meal and clove leaf meal. On the contrary, significant differences was observed in the serum glutathione and catalase activity of the bucks compared to the control which implied that NSM, CLM, and its mix (CNCM) triggered the production of more endogenous antioxidant enzymes which are essential to protect the cell molecules against peroxide toxicity (Oloruntola et al., 2018; Adu et al., 2020) when compared to the control particularly at 0.25% supplementation level.

Testicular biometric parameters are very important for establishing reproductive patterns (Caldeira et al., 2010) as a positive correlation exist

between the testicular weight and sperm production (Mascarenhas et al., 2006). Hence, the result in table 5 revealed that the supplementation of the spices (NSM, CLM, and CNCM) act as sexual invigorators and had no reducing effect on the testicular weight and density compared to the control. Rather, dietary CNCM at 0.25% supplementation level increased the weight and density of the left testis, right testis and paired testes. Consequently, the increased testicular size at 0.25% CNCM supplementation level is indicative of better testicular growth and spermatozoa production in the bucks fed with these diet group compared to others. The mean testicular weight values of the paired testes (2.74g±0.10 to 3.68g±0.08) obtained in this study fell in range with the values of 2.61g±0.50 to 3.57g±0.37 reported by Ahemen et al. (2016) who investigated the testicular morphometry of rabbits administered aqueous extract of Gmelina arborea leaves but contradicted the findings of Ismail and Ayoub (2007) and Meera et al. (2009).

CONCLUSION

The study established that the supplementation of nutmeg seed meal, clove leaf meal, and particularly the composite mix of the two spices at 0.25% level enhanced growth performance and increased testicular size without any negative impact on the health status of the buck.

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