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Effect of Different Levels of Dried *Delonix regia* Seed Meal on the Performance, Hematology, Serum Biochemistry of Growing Grass Cutters

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Abstract

A feeding trial was conducted to investigate the effect of different levels of dried Delonix regia meal (DRM) on the performance, heamatology and serum biochemistry of growing grass cutters. Fifty, 8 weeks old grass cutters of mixed breed and sex were randomly divided into five treatment groups of diets containing 0, 2, 4, 6 and 8% DRM in a Completely Randomized Design (CRD) for a period of 49 days. The results of this experiment showed that there were significant differences ($P<0.05$) final weight gain and daily weight gain, however, no significant ($P>0.05$) differences were observed in feed intake, water intake and mortality rate. Diet containing 8% DRM had the highest weight gain of 1501g, while grass cutters fed 0% DRM had the lowest weight gain of 984.6g. There were no significant differences ($P>0.05$) in the haematological parameters and serum biochemical parameters across the dietary treatment. It was concluded based on the data from the final live weight, feed intake, total daily water intake, serum biochemistry and those from hematological indices that *Delonix regia* meal could be incorporated up to 8% level in weaner grass cutter ration.

Keywords: Grass cutters; *Delonix regia* meal; Hematology; Performance and serum biochemistry

Abbreviations: CRD: Completely Randomized Design; DRM: *Delonix regia* Meal; EDTA: Ethylene Diamine Tetra Acetate; PCV: Pack Cell Volume; RBC: Red Blood Cell; WBC: White Blood Cell; Hb: Haemoglobin; SGPT: Serum Glutamic Pyruvate Transaminase; SGOT: Serum Glutamic Pyruvate Transaminase; AAS: Absorption Spectrophotometer; MCV: Mean Corpuscular Volume; MCH: Mean Corpuscular Haemoglobin; MCHC: Mean Corpuscular Heamoglobin Concentration; ALP: Alkaline Phosphate

Introduction

Livestock production in Nigeria is faced with a lot of problems, one of which is high feed cost. According to Ekenyem [1], feed cost represents about 70-80% of the total cost of production. The increase in the prices of conventional feedstuffs like soya meal, fishmeal and maize which are highly used in the production of animal feed, flour milling, oil industries as well as human consumption is as a result of the competition between humans and animals for grains and upward increase in human population. Profit cannot be maximized unless birds are we fed well formulated diets at reasonable cost to meet up with their nutritional requirement therefore there is need to look for cheaper alternative sources of feed ingredients to feed livestock. For instance, *Delonix regia* seed is a non-conventional feedstuff of the family Caesalpiniaceae, the tree is commonly known as "flamboyant" or "flame tree". According to Andrea et al. [2], the tree is known to reach a height of approximately 12 metres and the flowers shows colours ranging from orange and red. Kumar et al. [3], reported the presence of alkaloids, flavonoids, phenols and cardiac glycosides during phytochemical screening of D. regia.

According to Esonu et al. [4], proximate components of *Delonix regia* seeds revealed 20.50%, 4.23% and 6.84% for crude protein, ether extract and crude fibre respectively. Grass cutter (*Thryonomys swinderianus*) also known as cane rat is a wild hystericomorphic rodent widely distributed in the African sub region and exploited in most of areas as a source of animal protein [5,6]. The colour of the fur is brownish, coarse and thin. Omole et al. [7], also reported that the protein content in the meat is about 20% which compares favorably with other sources of animal protein, the mineral content of the meat contains major minerals such as calcium, phosphorus and iron which are needed for metabolic activities in the body, strong bone formation, regulation of hormonal activities and utilization of other minerals. Grass cutters can utilize high fibrous and cellulose fraction of a feed more than poultry [8,9]. Martin [10], also reported that the animals can adapt to harsh environment and can utilize natural resources and digest most form of edible green stuff ranging from coarse grasses to roughages and household scraps.

Several research's has been carried out on the effect of supplementing *Delonix regia* meal in the diet of rabbits, for

instance Ishaya B Kaga [11]; Szendro et al. [12], reported a significant (P<0.05) difference in final live weight and feed conversion ratio of rabbits fed with D. regia meal. However, there is a dearth of information on the effect of D. regia meal on grass cutter's performance and blood profile when included in their diet. Therefore, this study was carried out to investigate the effect of partial replacement of dietary Soya meal with D. regia meal in grass cutter's diet.

Materials and Methods

Location of experiment

The experiment was carried out at the University of Abuja Teaching and Research Farm, Animal Science Section, Main Campus, along Airport Road, Gwagwalada, Abuja-Nigeria. Gwagwalada is the headquarters of the Gwagwalada Area Council; located between latitude 80 57I and 80 55IN and longitude 70 05I and 70 06IE. The temperature of Gwagwalada ranges from 28 ˚C -33 ˚C in the day time and 22 ˚C-25 ˚C in the night.

Collection and processing of test materials

Matured pods of Delonix regia were collected from a tree within the premises of the University of Abuja, the seeds were removed from the pods, first washed with running tap water and then with distilled water, shade dried without any contamination for 10 days and passed through a hammer mill to produce D. regia meal (DRM). The sample was later kept in an air tight container for further analysis.

Experimental animals and their management

Fifty (50), 7 weeks old weaner grass cutters of mixed breed and sex with a weight range of 630 and 635grams were randomly assigned to five treatments of twelve (10) grass cutters per group, each treatment was replicated three times with each replicate having nine grass cutters in a completely randomized design. The hutches were cleaned and disinfected before the arrival of the animals. The grass cutters were allowed one-week adjustment period during which they were fed with control diet and given prophylactic treatment of Promectin against endo and ecto- parasites before they were placed on experimental diets. The animals were individually housed in cages measuring 30cm×45cm×50cm (width × length × height) and equipped with feeding and watering troughs. The rabbits were fed twice daily at 7.30h and 14.30H while water was provided ad-libitum.

Preparation of experimental diets

The test material (DRM) were mixed with other ingredients to form five experimental diets at levels of 0, 5, 10, 15 and 20% as presented in Table 1.

Table 1: Percentage composition (%) of experimental diets.

Ingredients	Treatments				
	1	2	3	4	5
Maize	30	29	28	27	26
Wheat Offal	20	18	17	15	12
Soya Meal	11.25	10.25	9.25	7.25	5.25
Fish Meal (72%)	5	5	5	5	5
Groundnut Cake	10	10	10	12	12
Palm Kernel Meal	20	20	20	25	30
Bone Meal	2	2	2	2	2
Limestone	1	1	1	1	1
1Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.5	0.5	0.5	0.5	0.5
DRM	0	2	4	6	8
	100	100	100	100	100
Determined Analysis					
Crude Protein (%)	18.25	18.19	18.14	18.08	18.04
Crude Fiber (%)	11.25	12.34	12.53	13.01	13.03
Ether Extract (%)	3.2	3.02	3.02	3.01	3
Ash (%)	5.05	6.33	6.36	6.4	6.43
Energy (ME kcal/kg)	2576.5	2569.1	2566.3	2552.6	2552.1

1P remix supplied per kg diet :- Vit A-10,000 I.U; Vit E-5mg; Vit D_3, 3000I.U, Vit K-3mg; Vit B_2-5.5mg; Niacin-25mg ; Vit B_{12}-16mg; Choline chloride-120mg; Mn-5.2mg; Zn-25mg; Cu-2.6g; Folic acid-2mg; Fe-5g; Pantothenic acid-10mg; Biotin-30.5g; Antioxidant-56mg

Data Collection

Growth performance parameters

Daily feed intake (g) was calculated by difference between feed offered and the left over, feed conversion ratio was determined as feed intake divided by body weight gain, water consumption and mortality were recorded daily throughout the experimental period which lasted for 7 weeks.

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Blood analysis

At the 7th week of the experiment, blood samples were collected from the veins of four randomly selected rabbits per group. The blood samples were analyzed for some hematological and serum biochemical parameters; blood samples for hematology were collected into bottles containing Ethylene Diamine Tetra Acetate (EDTA). The hematological parameters such as Pack cell volume (PCV), Red blood cell (RBC), White blood cell (WBC), Haemoglobin concentration (Hb) and absolute counts of neutrophils, lymphocytes, monocytes and eosinophils were computed according to the method of Jain [13].

Blood samples that were meant for serum chemistry were collected into bottles free of any anticoagulant. It was centrifuged at 1500 r. p. m for 10 minutes and the serum was separated and analyzed. Albumin, globulin and serum total protein were determined by Biuret reactions [14], and cholesterol [15]. Activities serum of serum glutamic pyruvate transaminase (SGPT), serum glutamic pyruvate transaminase (SGOT) were determined colorimetrically [16]. Activities of total glucose and cholesterol levels were determined as described by [17].

Proximate analysis

The proximate components were determined by the AOAC [18]. Phytochemical screening was determined according to procedures outlined by Kumar et al. [3]. The mineral analysis was carried out using Atomic Absorption Spectrophotometer (AAS).

Statistical analysis

All data obtained from the study were subjected to analysis of variance (ANOVA) procedure of SAS [19], in a completely randomized design and significant means separated by Duncan multiple range test [20].

Results

Table 2: Proximate composition of DRM.

Nutrients	% DM
Crude Protein	19.48±0.02
Crude Fibre	15.31±0.12
Ether Extract	12.11±0.01
Ash	4.21±0.13
Minerals (mg/kg)	
Phosphorus	3.77±0.01
Magnesium	5.71±0.00
Calcium	2.10±0.01
Copper	5.41±0.11
Zinc	9.77±0.11
Manganese	6.21±0.00
Iron	3.61±0.02
Sodium	4.33±0.01
Selenium	4.12±0.00

Table 1 shows the percentage composition of experimental diet. The proximate component reveals that the composition of experimental diet ranges between 18.04% - 18.25% while those of energy is 2552.1 – 2576.5 ME kcal/kg. The proximate composition of components DRM used in this experiment are 19.48, 15.31, 12.11, 4.21 (%) for crude protein, crude fibre, ether extract and ash respectively while those of minerals are 3.77, 5.71, 2.10, 5.41, 9.77, 6.21, 3.61, 4.33 and 4.12 (mg/kg) for phosphorus, magnesium, calcium, copper, zinc, manganese, iron, sodium and selenium respectively all values fall within the range reported by Esonu et al. [4], as presented in Table 2.

Table 3: Phytochemical analysis of DRM.

Parameters	Quantity (%)
Saponin	3.09±0.00
Tannin	1.22±0.01
Phenols	0.22±0.02
Flavonoids	2.11±0.00
Alkaloids	1.06±0.01
Oxalate	2.15±0.01

Phytochemical values obtained are 3.09, 1.22, 0.22, 2.11, 1.06 and 2.15 (%) for saponin, tannin, phenols, flavonoids, alkaloids and oxalate. The growth performance parameters of grass cutters as influenced by the diets are expressed in Table 3. The grass cutters final live weight ranges between 984.6 and 1501.0g. There was a significant difference ($P<0.05$) among the treatments in terms of final live weight. The daily weight gain values obtained are 6.24, 13.33, 14.4, 14.67 and 15.53 (g) for treatments 1, 2, 3, 4 and 5 respectively while those of daily feed intake are 133.4, 130.6, 131.2, 130.9 and 131.0 (g) respectively. The values obtained for daily water intake (ml) are 1501.0, 1506.0, 1500.0, 1520.0 and 1502.0 for treatments 1, 2, 3, 4 and 5 respectively. The daily feed and water intake were not significantly ($P>0.05$) affected by the dietary inclusion of DRM. No mortality was recorded throughout the experimental period (Table 4).

Pack cell volume (PCV) values obtained are 38.02, 41.77, 43.21, 44.12 and 44.14 (%) for treatments 1, 2 3, 4 and 5 respectively while those of haemoglobin (Hb) are 9.11, 10.1, 13.2, 14.3 and 14.4 (g/dl) respectively. The values obtained for red blood cell (RBC) are 8.11, 8.26, 8.27, 8.41 and 8.43 (×106/mm3) for treatments 1, 2, 3, 4 and 5 respectively while those of white blood cell (WBC) are 9.11, 10.3, 12.1, 12.6 and 12.7 (×106/mm3) respectively. Mean corpuscular volume (MCV) values obtained are 71.11, 72.13, 72.61, 72.79 and 71.03 (f/l) for treatments 1, 2, 3, 4 and 5 respectively while those of mean corpuscular haemoglobin (MCH) are 20.3, 21.4, 22.4, 22.7 and 20.6 (pg) respectively. The values obtained for mean corpuscular heamoglobin concentration (MCHC) are 31.09, 32.21, 33.51, 33.01 and 32.06 (g/dl) for treatments 1, 2, 3, 4 and 5 respectively. The PCV, Hb and RBC values gradually increased from treatment 1 to 5 but were not significantly affected ($P>0.05$) by the dietary inclusion of DRM. Similarly, MCV, MCH and MCHC values increased from treatment 1 to 4 after which the value declined.

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Table 4: Growth Performance of Growing grass cutters fed DRM.

Parameters	Treatments					
	1	2	3	4	5	S/L
Number of Animals	10	10	10	10	10	-
Initial Body Weight (g)	635.2±1.21	635.9±1.06	631.1±1.31	630.0±1.00	631.4±0.95	Ns
Final Body Weight (g)	984.6±0.11	1400.2±0.20	1423.1±0.13	1451.3±0.20	1501.0±0.14	**
Final Weight Gain (g)	349.4±1.23	764.3±0.08	792.0±0.21	821.3±0.67	869.6±0.32	**
Daily Weight Gain (g)	6.24±0.01	13.33±0.05	14.14±0.02	14.67±0.01	15.53±0.02	**
Daily Feed Intake (g)	133.4±0.20	130.6±0.24	131.2±0.13	130.9±0.27	130.2±0.34	Ns
Daily Water Intake (ml)	1501±0.03	1506±0.01	1500±0.01	1520±0.04	1502±0.06	Ns
Mortality	-	-	-	-	-	

NS: No significant difference (P>0.05); **: Significant difference (P<0.05).

Leucocytes values obtained are 30.67, 34.30, 36.40, 41.40 and 41.50 (%) for treatments 1, 2, 3, 4 and 5 respectively while those of monocytes are 1.87, 1.19, 1.78, 1.21 and 2.01 (%) respectively. The values obtained for eosinophils are 1.10, 1.06, 1.22, 1.12 and 1.03 (%) for treatments 1, 2, 3, 4 and 5 respectively. WBC, lymphocytes, monocytes and eosinophils were not significantly (P>0.05) different among the treatments in Table 5.

Table 5: Effect of feeding different levels of DRM on hematological parameters of Grass cutters.

Parameters	Treatments				
	1	2	3	4	5
Pack Cell Volume (%)	38.20 ± 5.02	41.77±4.11	43.21±1.22	44.12 ±2.13	44.14 ± 2.1
Hemoglobin (g/dl)	9.11±1.21	10.1 ± 1.41	13.2 ± 0.77	14.3 ± 0.21	14.4 ± 0.51
RBC (106/mm^3)	8.11 ± 0.02	8.26 ± 0.31	8.27± 0.08	8.41±0.41	8.43 ± 0.44
WBC (106/mm^3)	9.11± 0.56	10.3 ± 1.21	12.1 ±1.67	12.6 ± 1.03	12.7 ± 0.34
MCV (f/l)	71.11±0.67	72.13±0.87	72.61±2.11	72.79±3.14	71.03 ± 2.1
MCH (pg)	20.3±1.21	21.4 ± 0.55	22.4±0.33	22.7 ±0.28	20.6 ± 0.31
MCHC (g/dl)	31.09 ± 1.31	32.21± 0.45	33.51±1.71	33.01±0.67	32.06± 0.21
Lymphocytes (%)	30.67±0.21	34.30±0.09	36.40±0.12	41.40 ±0.98	41.50±1.21
Monocytes (%)	1.87±0.36	1.19±0.08	1.78±0.11	1.21±0.21	2.01±0.51
Eosinophils (%)	1.1±0.03	1.06±0.22	1.22±0.16	1.12±1.10	1.03±1.00
Basophils (%)	-	-	-	-	-

RBC: Red blood cell; WBC: White blood cell; MCV: Mean corpuscular volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentration

Table 6: Serum biochemical indices of Grass cutters fed different levels of DRM.

Parameters	Treatments					
	1	2	3	4	5	S/L
Albumin (g/dl)	2.45±0.07	2.67±0.12	2.71±0.05	2.46±0.13	2.44±0.13	N.S
Globulin (g/dl)	2.62 ±0.03	2.41±0.04	2.44±0.19	2.56±0.10	2.64±0.10	N.S
Total Protein (g/dl)	5.07±0.12	5.08±0.06	5.15±0.13	5.02±0.04	5.08±0.13	N.S
Cholesterol (mg/g)	189.1±3.03	191.1±4.21	193.4±3.41	193.7±4.05	194.2±4.11	N.S
Creatinine (mg/g)	1.14±0.07	1.23±0.04	1.22±0.10	1.20±0.03	1.27±0.10	N.S
ALP (U/l)	31.4±0.12	30.9±0.04	30.2±0.81	30.5±0.02	30.0±0.10	N.S
Na+ (mmol/l)	145.1±4.12	142.8±3.56	143.4±3.09	141.9±4.01	142.2±3.11	N.S
Cl- (mmol/l)	3.22±1.22	3.09±1.15	3.19±1.00	3.24±1.21	3.30±1.30	N.S
Urea (mg/dl)	22.12±2.05	21.88±2.18	21.43±1.97	22.03±2.51	22.41±2.06	N.S
SGOT (iu/l)	7.90±1.04	8.21±1.00	8.07± 0.91	8.13± 1.31	8.10±1.06	N.S
SGPT (iu/l	10.5±0.65	10.4±0.07	10.7±0.22	10.1±0.13	10.6±0.22	N.S

SGPT: Serum glutamic pyruvate transaminase; SGOT: Serum glutamic oxaloacetate transaminase; ALP: Alkaline Phosphate; NS: No significant difference (P>0.05); **: Significant difference (P<0.05)

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Table 6 shows the serum biochemical parameters of grass cutters fed different levels of DRM. Albumin values obtained are 2.45, 2.67, 2.71, 2.46 and 2.44 (g/dl) for treatments 1, 2, 3, 4 and 5 respectively while those of globulin are 2.62, 2.41, 2.44, 2.56 and 2.64 (g/dl). The values obtained for cholesterol are 189.1, 191.1, 193.4, 193.7 and 194.2 (mg/g) for treatments 1, 2, 3, 4 and 5 respectively while those of creatinine (mg/g) are 1.14, 1.23, 1.22, 1.20 and 1.27 respectively. Albumin, globulin, total protein, cholesterol and creatinine were not significantly (P>0.05) influenced by the different inclusion of DRM. The values obtained for alkaline phosphate (ALP) are 31.4, 30.9, 30.2, 30.5 and 30.0 (u/l) for treatments 1, 2, 3, 4 and 5 respectively while those of Sodium ion (Na+) obtained are 145.1, 142.8, 143.4, 141.9 and 142.2 (mmol/l) for treatments 1, 2, 3, 4 and 5 respectively. Cl- ion values obtained are 3.22, 3.09, 3.19, 3.24 and 3.30 (mmol/l) for treatments 1, 2, 3, 4 and 5 respectively. Na+, Cl-, glucose, Urea, SGPT and SGOT values were not significantly (P>0.05) different among the dietary treatments.

Discussion

Crude protein level in the experimental diet falls within the range recommended by Kusi et al. [21], for growing grass cutters. The grass cutter final live weight ranges between 984.6g and 1501g, there was a significant difference (P<0.05) among the treatments in terms of the final live weight. The best performance was observed in grass cutters fed 8% DRM (T5) they had the lowest feed consumption and daily weight gain those fed 0% DRM (T1) had the lowest weight gain of 6.24 g/grass cutter/day. This is a clear indication that the protein level in the experimental diet can adequately support the growth of the animals and the report agrees with the findings of Ishaya Kaga [11]; Alagbe et al. [22], but contrary to the reports of Saulawa et al. [23]; Salisu et al. [24]; Banjo et al. [25], when brewer's dry grain was replaced in the diet of weaner grass cutters. No mortality was recorded was recorded among the treatment different treatment groups throughout the experimental period. This could be due to the medicinal nature of Delonix regia seeds. According to Amata & Nwagu [26], D. regia seeds have multiple biological activities, including antiviral, anti-ulcer and antibacterial properties attributed mainly to their antioxidant activity. Proximate and phytochemical analysis reveals the presence of some bioactive compounds and minerals which are also in accordance with the findings of Roy et al. [27]; Kumar et al. [3]. Zinc had the highest mineral content of 9.77mg/kg followed by manganese with 6.21mg/kg, calcium had the lowest value of 2.17mg/kg. According to Gupta et al. [28]; Prasad [29], and Andrea et al. [2], zinc have been reported to perform anti-inflammatory and antioxidant activities. Magnesium, calcium and phosphorus are also proper red blood cell formation [30].

Watts [31]; Gupta et al. [28], also reported that minerals are very important for proper enzymatic activities in the body and can be grouped into macro and micro minerals. Insufficient amount of minerals in the body can lead to deficiency. For instance, copper deficiency could lead to osteoporosis, calcium and phosphorus deficiency can affect the structure of the bone.

Phytochemical screening revealed the presence of tannins, phenols, saponin, flavonoids, alkaloids and oxalate confirming the findings of Parekh et al. [32]; Kavitha et al. [33], and Naveen Prasad [34], but contrary to the Oyediji et al. [35], who reported that tannin, oxalate and saponin contains 1.28, 2.57 and 2.89 respectively, this could be due to differences in the environmental conditions where the plant is found. According to Kennedy et al. [36], phytochemical parameters can be altered during period of extreme stress and weather conditions. High level of anti-nutrients (phytochemicals) can prevents the absorption of minerals which are necessary for body metabolism [37]. Anti-nutrients present in DRM did not have any adverse effect on the performance of the grass cutters.

The hematological parameters were not significantly influenced (P>0.05) with the inclusion of DRM in the diets, this could be attributed to nutritional adequacy and safety level of DRM. The values for all parameters fall within the normal range established for grass cutters by Okpara et al. [38]; Byanet et al. [39]. According to Iheukwumere & Herbert [40]; Kurtoglu et al. [41]; Afolabi et al. [42]; Nse Abasi et al. [43]; Etim et al. [44], hematological parameters are useful tools to determine stress due to nutrition, health and physiological state of animals. Bamishaiye et al. [45], posited that hematological parameters are related to blood and blood forming organs.

Red blood cell (RBC) is responsible in carrying oxygen and carbon dioxide in the body [46], it also contains a red pigment known as hemoglobin. Soetan et al. [47], reported that a reduction in RBC value implies a reduction in the level of oxygen that would be carried to the tissues as well as the level of carbon (IV) oxide returned in the lungs. The values of Hb, PCV, RBC, MCV, MCH and MCHC could be a clear indication that the animals were well nourished, and possibility that DRM was able to supply all the essential nutrients necessary for the proper functioning of the animal's body. According to Issac et al. [46]; Ugwuene [48]; pack cell volume (PCV) is involved in the transportation of absorbed nutrients. Hb and MCH are major indices for the diagnosis of anemia.

The WBC values slightly increased as the level of DRM increased though not at a significant level, high values of white blood cell count and its differentials is a sign of resistance to disease, WBC counts suggests a greater challenge to the immune system. According to Eheba et al. [49], a decrease in the WBC count reflects a fall in the production of defensive mechanism to combat infection. Animals with low WBC are exposed to high risk of disease infection, while those of high counts are capable of generating antibodies and have a high degree of resistance to diseases Soetan et al. [47]; Gotoh et al. [50]. Eosinophils and basophils are effector cells in allergy and host defense responses particularly against parasitic infections [51].

The total protein, albumin, globulin, urea, creatinine and alkaline phosphatase of the grass cutters used in this experiment were not affected (P>0.05) by DRM inclusion, this is a clear

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indication that the protein and minerals contained in the diet is enough to support the normal protein reserves across the treatments. The values obtained fall within the normal range reported by Okpara et al. [38], on hematology and plasma biochemistry of the wild adult grass cutters, the total protein did not follow any specific pattern, this agrees with the findings of Alagbe et al. [22], when dried shear butter leaf – neem meal mixture were fed to broilers but contrary to the reports of Obikaonu et al. [52]. High uric acid and creatinine are measure of amino acid degradation [41], blood proteins are usually affected by level of nutrition [53].

The non-significant ($P<0.05$) difference in the values obtained for Na+ and Cl- across the treatment group is a clear indication that the kidney was not damaged or negatively affected. SGPT and SGOT values did not show serious consistency, ALP values also reduced as the inclusion of DRM increased. According to Obikaonu et al. [52]; Iyayi [54], ALP, SGPT and SGOT values are usually affected when a test material fed to an animal contains some toxic substance which could damage some vital organs like the liver, intestine and kidney [55,56].

Conclusion

The results obtained from this study clearly demonstrated that DRM could be efficiently utilized and tolerated by grass cutters up to 8.0% inclusion level without any deleterious effect on performance and health status of the animals.

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