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Performance Evaluation and HaematologicalParameters of West African Dwarf Goats Fed Diet Containing Graded Level of Raw and Fermented Malted Sorghum Sprout.

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Target Audience: Animal Scientists and Small Ruminant Farmers.

Abstract

Malted Sorghum Sprout (MSP) is a byproduct of sorghum malting process which has attracted great interest as an alternative feedstuff in the ruminant feeding. The study evaluated the performance characteristics of West African Dwarf (WAD) goats fed diets containing graded levels of raw and fermented MSP (RMSP and FMSP) incorporated into the concentrate diet at 0%, 25% and 50% respectively to formulate six experimental diets. A total of twenty four WAD goats were randomly allotted to six dietary treatments for 12 weeksusing 2×3 factorial layout in completely randomized design of four (4) buck per treatment. Data were collected on growth performance. Results showed that main effect of processing methods significantly ($p<0.05$) influenced the feed intake and feed conversion ratio (FCR). Significant ($p<0.05$) interaction effect were obtained in average daily weight gain (ADWG, g/day), metabolic weight gain (g/day $W^{0.75}$), total dry matter intake (g/day) and FCR. Animals fed diet containing 50% FMSP recorded the highest ADWG (30.51g/day) and the best FCR (7.89). The MSP inclusion levels significantly ($p<0.05$) influenced white blood cell count (WBC), lymphocytes, monocytes, basophil and mean corpuscular haemoglobin concentration across the dietary treatments. The monocytes and eosinophil counts were significantly ($p<0.05$) influenced by the processing methods. Animal fed FMSP based diet recorded higher monocytes (2.17%) and eosinophil (3.00%) compared to those on other diets. Interaction effect of the processing methods and MSP inclusion level significantly ($p<0.05$) influenced all the haematological parameters except the neutrophil and mean corpuscular haemoglobin. WBC increased significantly ($p<0.05$) across the dietary treatments (14.10-21.60×0^{3}/l) and were at normal levels expected of healthy goats. The study concluded that fermented malted sorghum sprout could be used up to 50% in WAD goats' diet without any adverse effect on the performance of the animals.

Keywords: Malted Sorghum Sprout, Fermentation, Performance and Haematology

Description of problems

Livestock provides one-third of humanity's protein intake and the demand for livestock products is expanding as a result of the growing populations and incomes along with changing preferences (1). Feeds, accounting for about 70% of the total production cost in livestock are a major threat to the expansion of the sector in Nigeria. This is because both cereals and legumes grains that serves as main source of energy and protein respectively in livestock diets are inadequate due to the stiff competition for their usage by man and industry. However, in an attempt to mitigate the feed production problem plaguing the goat industry in the country, there is need to diversify in the use of conventional feed stuffs as they may not be profitable due to the escalating cost of production and competition between man and livestock.

Malted sorghum sprout (MSP), a non-conventional feedstuff in the feed industry because it is a by-product of the sorghum malting process which has gained ground in Nigeria. Malted sorghum sprout has a lot of prospects as feeding stuff in the livestock industry. It is turned out in large quantities by breweries, food and allied industries(2). The separation of roots and shoots which are left after malt extraction from the young germinating sorghum seedling are collectively called sorghum sprout (3). Malted Sorghum sprout is rich in organic nitrogen (2) and contains (g/kg); 226 crude protein, 48 crude fibre, 33 ether extract, 16 ash, 522 nitrogen free extract and 16.26 MJ/kg DM gross energy. (4) reported that magnesium was the most abundant mineral while potassium was the least in MSP. However, among the trace minerals, zinc is the most abundant while copper is the least in MSP. The anti-nutritional factors in MSP are tannin and hydrogen cyanide. (5) reported that tannins affect the growth of animals in three main ways; they have astringent taste, which affects palatability; decrease feed intake; they form complexes with proteins and reduce its digestibility and they act as enzyme in activators. All these factors result from interaction of tannins and proteins to form soluble and insoluble complexes, an interaction that depends primarily on relative proportions of phenol and protein. More so, cyanide in MSP caused poisoning of the animal (6).Detoxification by means of processing might be a good means of reducing the level of anti-nutritional factors and increase the nutritive value of MSP. Fermentation of malted sorghum sprout has been reported to increase the relative value availability of limiting amino acid. (7) reported a 92% reduction of tannin content of a high tannin Sorghum cultivar as a result of fermentation while (8) reported 63% and 61% for two cultivars of sorghum at the end of 14 hoursfermentation period. This study therefore designed to investigate the performance and the haematological parameters of West African Dwarf goats fed diet containing graded level of raw and fermented malted sorghum sprout.

Materials and Methods

Experimental site.

The experiment was conducted at the Teaching and Research Farm of the

Federal College of Animal Health and Production Technology, Moor Plantation, Ibadan in the South-western part of Nigeria. The area lies within the rain forest ecological zone, and falls within longitude and latitude $7^{0}\ 27^{1}$ and $3^{0}\ 25^{1}$ respectively at altitude 200- 300m above the sea level with an annual rainfall of about 1250mm. The temperature and relative humidity ranges from 30 – 35^{0}C and 76 – 84% respectively.

Experimental Animals and their Management.

A total of twenty four West African Dwarf (WAD) bucks aged 6 – 8 months with live weights between 7-9kg were used for this study. The animals were housed intensively in a well ventilated individual pens, disinfected with izal solution two weeks prior to the experiment. On arrival, the goats were quarantined for 30 days and during this period; they were given prophylactic treatments consisting of intra-muscular injection of oxytetracycline long acting (1ml/10kgBW) and vitamin B complex to ensure good condition of the animals. They were also routinely dewormed with 1ml/10kgBW of Albendanzole and injected with 0.5ml/10kgBW of ivermectin to eliminate both internal and external parasites respectively. Homologous *Pesti des petit ruminant* (PPR) vaccine was administered against PPR disease. The animals were adapted to pen environment for 14 days and data were collected for 84 days. Fresh cool clean water was also supplied *adlibitum*. After the adaptation period, the twenty four animals were balanced as closely as possible for body weight and randomly allotted to one of the six dietary treatments. The diets as contained in (Table 1) for each treatment was fed with a basal diet of *Panicum maximum*.

Table 1: Ingredient and composition of the experimental concentrates diet

Parameters **(%)**	RMSP			FMSP		
	0	25	50	0	25	50
Maize bran	40.00	40.00	40.00	40.00	40.00	40.00
Wheat offal	54.25	29.25	4.25	54.25	29.25	4.25
MSP	-	25.00	50.00	-	25.00	50.00
Premix	0.25	0.25	0.25	0.25	0.25	0.25
Limestone	5.00	5.00	5.00	5.00	5.00	5.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00	100.00
Determined Analysis						
Dry matter	88.20	90.08	91.86	88.20	90.69	92.65
Crude protein	15.78	17.06	17.21	15.78	16.22	16.93
NFE	54.26	54.47	55.81	54.26	55.43	55.83
EE	3.60	3.63	3.75	3.60	3.90	4.05
Ash	7.91	8.19	8.32	7.91	7.97	8.10
NDF	42.70	43.05	43.81	42.70	44.40	44.60
ADF	26.96	27.90	28.77	26.96	29.44	29.66
ADL	8.96	9.06	9.40	8.96	11.11	11.16
Hemicellulose	15.04	15.16	15.74	15.04	14.74	14.80
Cellulose	17.90	18.56	18.94	18.56	18.64	19.37

RMSP: Raw Malted Sorghum Sprout. FMSP: Fermented Malted Sorghum Sprout.

Fermentation of Malted Sorghum Sprout and Preparation of Experimental Diet.

The malted sorghum sprout (MSP) was purchased in dried form from Taibod Nigeria Limited, a reputable agro allied industry at IjokoOtta in Ogun State, Nigeria. This was divided into two (2) equal parts; the first part was not treated (raw) while the second part was naturally fermented. Fermentation involved the use of water and polythene bag; water was mixed with the dried malted sorghum sprout at a ratio of 2:1 so that the entire sprout was moistened. The mixture was then transferred into an air-tight nylon and fermented under room temperature for 96 hours (4days). Thereafter, it was spread on concrete floor for sun drying (9). The raw and the fermented MSP prepared were mixed with concentrate at varying levels of 0, 25%, and 50% respectively to formulate six diets as indicated in Table 1. Other ingredients in the diets include limestone, maize bran, wheat offal, salt and premix.

Experimental Design.

A total of twenty four West African Dwarf goats aged 6-8 months were divided on weight equalization basis into six (6) treatment groups of four (4) buck each in a 2×3 factorial arrangement.

Data Collection

Feed intake and live weight changes.

The growth of the animals in response to the experimental diets was monitored by taking their pre-experimental body weights, followed by weighing on a weekly basis prior to feeding. Feed offered daily per animal was recorded and refusal was weighed and recorded to compute feed intake on daily basis.

Blood collection*:*3ml of blood sample was drawn from three randomly selected goats per treatment via the jugular vein into a sample bottle containing anticoagulant and the sample bottle was rocked gently to ensure easy mixing of the blood with the anticoagulant.

Chemical analysis

Subsamples of feed offered were analysed forcrude protein, ether extract and ash (10). Fibre fractions were determined as described by (11).

Statistical analysis

Data obtained was subjected to analysis of variance using 2×3 factorial arrangements in a completely randomized design. Duncan's multiple range tests was used to separate significantly different means (12).

Results

Chemical composition of RMSP and FMSP

The effect of processing on the chemical composition of MSP is shown in Table 2. Fermentation reduced the crude protein, ash and hemicelluloses while it increased the ether extract (EE), nitrogen free extract (NFE), crude fibre, neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) and cellulose of the MSP.

Table 2: Chemical Composition of RMSP and FMSP

Parameters (%)	RMSP	FMSP
Dry matter	88.79	90.11
Crude protein	26.38	22.67
Ether extract	2.35	2.44
NFE	51.06	54.16
Ash	5.21	4.56
NDF	49.57	51.28
ADF	31.25	39.67
ADL	3.92	5.86
Hemicellulose	18.32	11.61
Cellulose	27.33	33.81

Main Effect of Processing Methods and Malted Sorghum Sprout Inclusion Levels on the Performance Characteristics of West African Dwarf Goats

The main effect of processing methods and MSP inclusion level on the performance characteristics of West African dwarf goat is presented in Table 3. The result shows that processing of malted sorghum sprout did not reveal any significant (p>0.05) difference on the parameter of interest investigated except the forage dry matter intake (g/day), total dry matter intake (g/day) and feed conversion ratio. There was a significant (p<0.05) decrease in forage dry matter intake from 153.43g/day in the diet containing raw malted sorghum sprout (RMSP) to 123.21g/day in the diet containing fermented malted sorghum sprout (FMSP). The total dry matter intake and feed conversion ratio (FCR) were significantly (p<0.05) influenced by the processing methods. Animals fed RMSP recorded higher (p<0.05) value of 286.54g/day for the total dry matter intake while animals fed FMSP had lower value of 254.19g/day. More so, animals fed FMSP recorded better value (9.31) for FCR while those fed RMSP had higher value (12.28). The performance characteristics of West African dwarf goat observed in this study were not significantly (p>0.05) influenced by the MSP inclusion level irrespective of the processing methods adopted between the treatment groups.

Table 3: Main Effect of Processing Methods and Malted Sorghum Sprout Inclusion Levels on the Performance Characteristics of West African Dwarf Goats.

Parameters	Processing			Level of inclusion			
	RMSP	FMSP	SEM±	0%	25%	50%	SEM±
Initial Body Wt (kg)	5.78	5.69	0.24	5.61	5.81	5.78	0.30
Final Body Wt (kg)	7.86	8.04	0.31	7.83	8.16	7.88	0.38
Total Wt gain (kg)	2.08	2.36	0.12	2.22	2.35	2.09	0.15
Average daily wt gain(g/day)	24.78	28.04	1.48	26.40	27.92	24.91	1.81
Metabolic Wt (g/day $W^{0.75}$)	11.04	12.16	0.48	11.63	12.10	11.70	0.59
Concentrates DMI (g/day)	133.11	130.98	5.03	134.05	126.14	135.95	6.16
Forage DMI (g/day)	153.43^a	123.21^b	7.98	146.54	138.90	129.51	9.77
Total DMI (g/day)	286.54^a	254.19^b	8.86	280.59	265.04	265.46	10.85
FCR	12.28^a	9.31^b	0.61	10.74	9.76	11.89	0.74

^{ab}Means with different superscript along the same row are significantly different (P< 0.05)

Interactive Effect of Processing Methods and Malted Sorghum Sprout Inclusion Levels the Performance Characteristics of West African Dwarf Goats.

Table 4 shows the interactive effect between processing methods and MSP inclusion level on the performance characteristics of West African Dwarf goat. Significant difference ($p<0.05$) were observed in all the parameters investigated across the dietary treatments. Animals fed 25% RMSP and those fed 50% FMSP were statistically similar ($p>0.05$) in body weight gain but significantly ($p<0.05$) higher than those on other treatments while goat fed 50% RMSP had the least value. Similar pattern of variation was observed in average daily weight gain and metabolic weight gain. However animals that consumed 50% FMSP had the best value (7.89) for FCR while those that fed on 50% RMSP recorded the poorest value of 15.90.

Table 4: Interactive Effect of Processing Methods and Malted Sorghum Sprout InclusionLevel on the Performance Characteristics of West African Dwarf Goats

Parameters	RMSP			FMSP			
	0%	25%	50%	0%	25%	50%	SEM±
Initial Body Wt(Kg)	5.61	5.84	5.90	5.61	5.79	5.67	0.42
Final Body Wt (Kg)	7.83	8.24	7.52	7.83	8.07	8.23	0.54
Total Wt gain (Kg)	2.22^{ab}	2.41^{a}	1.62^{b}	2.22^{ab}	2.29^{ab}	2.56^{a}	0.22
Average daily Wt gain (g/day)	26.40^{ab}	28.68^{a}	19.32^{b}	26.40^{ab}	27.20^{ab}	30.51^{a}	2.56
Metabolic Wt (g/day$W^{0.75}$)	11.63^{ab}	12.28^{a}	9.20^{b}	11.63^{ab}	11.91^{a}	12.95^{a}	0.83
Concentrate DMI (g/day)	134.05	129.82	135.48	134.05	122.47	136.42	8.72
Forage DMI (g/day)	146.54^{a}	147.41^{a}	166.33^{a}	146.54^{a}	130.39^{ab}	92.69^{b}	13.82
Total DMI (g/day)	280.59^{a}	277.22^{a}	301.80^{a}	280.59^{a}	252.87^{ab}	229.11^{b}	15.34
FCR	10.74^{b}	10.21^{b}	15.90^{a}	10.74^{b}	9.31^{b}	7.89^{b}	1.05

^{ab} Means with different superscript along the same row are significantly different ($P< 0.05$)

Table 5 presents the main effect of processing and MSP inclusion level on the haematological parameters of WAD goats. The single effect of processing methods on the haematological parameters did not significantly ($p>0.05$) affected the parameters of interest investigated. All the parameters of interest observed in this study were not significantly ($P>0.05$) influenced by the MSP inclusion levels except the white blood cell (WBC), lymphocyte, basophil and Mean Corpuscular Haemoglobin concentration (MCHC). The WBC values obtained in the result varied significantly across the dietary treatments in which goats fed 25% MSP recorded the highest and while those fed 0% MSP had the lowest value. The lymphocyte values obtained in this study decreased as the MSP inclusion level increased across the dietary treatments. The basophil count observed in this study increased significantly across the treatment groups in which animals fed diet containing 25% MSP and 50% MSP were statistically similar (P>0.05) but they were however higher (P<0.05) than those fed diet containing 0% MSP.

The interaction between the processing methods and MSP inclusion level on the haematological parameters of WAD goats is presented in Table 6. Haemoglobin (Hb), White Blood Cell (WBC), Lymphocyte, Monocytes, Eosinophil, Basophil and Mean Corpuscular Haemoglobin Concentration (MCHC) were significantly influenced (P< 0.05) by the interaction between the processing methods and MSP inclusion level.

Table 5: Main effect of Proce ssing methods and MSP Inclusion level on Haematological parameters of WAD goats

Parameters	Processing method			Level of MSP Inclusion			
	RMSP	FMSP	SEM±	0	25	50	SEM±
PCV (%)	29.00	26.78	1.55	27.00	27.92	28.75	1.89
Hb (g/dl)	9.35	8.34	0.39	8.68	8.26	9.60	0.48
RBC (10^{12}/L)	3.06	2.66	0.20	2.94	2.65	2.99	0.24
WBC (10^{3}/L)	17.90	16.70	1.00	14.10^{b}	21.00^{a}	16.80^{b}	1.20
Lymphocyte (%)	66.50	63.17	1.60	69.00^{a}	64.50^{ab}	61.00^{b}	1.95
Neutrophil (%)	34.28	31.89	3.05	28.67	31.67	38.92	3.73
Monocyte (%)	1.67	2.17	0.20	1.00^{b}	2.75^{a}	2.00^{a}	0.25
Eosinophil (%)	2.50	3.00	0.20	3.00	2.75	2.50	0.25
Basophil (%)	0.50	0.17	0.11	0.00^{b}	0.50^{a}	0.50^{a}	0.12
MCH (Pg)	30.03	31.94	2.31	29.79	21.83	25.84	3.25
MCV (FL)	81.37	96.43	7.79	80.32	84.30	102.09	9.54
MCHC (g/dl)	32.32	32.47	0.38	31.89^{b}	31.88^{b}	33.41^{a}	0.47

^{ab} Means with different superscript along the same row are significantly different (P< 0.05)

The haemoglobin (Hb) concentration values observed in this study varied significantly from 7.45-10.30g/dl across the dietary treatments. The lymph count obtained in this study decreased as the MSP inclusion level increased across the dietary treatments. However, the monocyte count showed significant (P<0.05) difference across the dietary treatment in which animals fed diet containing 25% FMSP recorded the highest values while the lowest value was noticed in goats fed diet containing 0% MSP. The eosinophil count obtained ranged from 1.50-4.00 %. The basophil count obtained increased significantly for the animals fed diet containing RMSP based diet but decreased significantly for those fed diet containing FMSP based diet.

Discussion

The dry matter content of MSP increased significantly after fermentation. The increase in dry matter content after fermentation process may probably be due to the soft and porous texture of the MSP after fermentation resulting in maximum moisture loss. The microorganisms must have utilized some moisture for metabolic activities thereby increasing the dry matter content. The ash content of MSP (5.21%) used in this study was higher than 16.0 g/kg but lower than 7.0% values reported by (4; 13) respectively.

Table 6: Interactive effect of Processing methods and Inclusion level of MSP on haematological parameters of WAD goats

Parameters	RMSP			FMSP			
	0	25	50	0	25	50	SEM±
PCV (%)	27.00	28.50	31.50	27.00	27.33	26.00	2.68
Hb (g/dl)	8.68^{ab}	9.07^{ab}	10.30^{a}	8.68^{ab}	7.45^{b}	8.90^{ab}	0.68
RBC (10^{12}/L)	2.94	2.67	3.57	2.94	2.63	2.41	0.34
WBC (10^{3}/L)	14.10^{c}	21.60^{a}	17.90^{abc}	14.10^{c}	20.40^{ab}	15.60^{bc}	1.70
Lymphocyte (%)	69.00^{a}	67.00^{ab}	63.50^{ab}	69.00^{a}	62.00^{ab}	58.50^{b}	2.76
Neutrophil (%)	28.67	32.83	41.33	28.67	30.50	36.50	5.28
Monocyte (%)	1.00^{c}	2.50^{ab}	1.50^{bc}	1.00^{c}	3.00^{a}	2.50^{ab}	0.35
Eosinophil (%)	3.00^{ab}	1.50^{c}	3.00^{ab}	3.00^{ab}	4.00^{a}	2.00^{bc}	0.35
Basophil (%)	0.00^{b}	0.50^{ab}	1.00^{a}	0.00^{b}	0.50^{ab}	0.14^{b}	0.17
MCH (Pg)	29.80	81.42	28.86	29.80	28.80	37.21	4.01
MCV(FL)	80.32	75.54	88.26	80.32	93.05	115.92	13.49
MCHC(g/dl)	31.89^{b}	32.79^{ab}	32.28^{b}	31.89^{b}	30.98^{b}	34.54^{a}	0.61

[ab] Means with different superscript along the same row are significantly different (P< 0.05)

This later decreased slightly after being fermented to 4.56% which was lower than the value (6.0%) reported by (13). The decrease in ash content of the MSP can be ascribed to possible leaching of soluble mineral elements into fermenting medium or due to general activities of the fermenting microorganisms whose enzymatic activity resulted in breakdown of the components into their absorbable forms. It is therefore confirmed that fermentation would drastically result to loss of important minerals. The result agrees with the result reported by (14) on a decrease in ash content (2.70-2.68%) in fermented millet. In contrast to this observation, (15) observed an increase in ash content of fermented maize cowpea blends. The slightly increased ether extract content of the MSP (2.35%) after being fermented (2.44%) could be as a result of extensive break down of large fat molecule to simpler fatty acid units due to the high activity of the lipolytic enzymes which could have resulted in fat increase. The increase in fat might be fat from dead microflora or the fermenting microflora did not use fat from these foods as source of energy (16). This observation agrees with that of (17). The crude protein content of the RMSP (26.38%) obtained in this study was found to be slightly higher than the value earlier reported by (4; 13) but lower than the value (35%) reported by (2). This later decreased after being fermented (22.67%). This observation is similar to result reported by (9). The decrease observed here in this study contradicted the observation of (18) in which protein content of millet increased 7.9 to 10% after fermentation. In addition to variations in method of processing and storage, a large proportion of the differences in chemical composition of the MSP used in this study compared to reported values of (4), can be attributed to the varieties of sorghum used.

The processing methods employed had significant effect on the performance characteristics of the West African Dwarf goat. For all the parameters measured, only the feed intake and feed conversion ratio (FCR) were significantly influenced by the processing methods. Feed intake is an important factor in ruminant livestock and is a critical determinant of energy and protein intake as well as performance in small ruminants (19). Although there were no significant difference on the daily concentrates dry matter intake but there was in daily forage dry matter intake which eventually reflected variation in the total dry matter intake. However animal fed diet containing RMSP recorded higher value in total DMI (g/day). This higher value obtained could be attributed to individual differences in animals and several reports indicated that supplementation with grass as basal diets could improve feed intake (20). The FCR of animals fed diet containing FMSP exhibited better value when compared to those fed diet containing RMSP based diet. It was evident from the results of this study that the processing method employed to reduce the anti-nutritional factors of MSP was effective and therefore resulted in the efficient utilization of the nutrient. Anti-nutritional factors have been reported to have detrimental effect on performance (21).

The interaction between processing methods and MSP inclusion level revealed that body weight gain (kg) of the experimental animals increased as the inclusion level of RMSP and FMSP increased across the dietary treatment except those on 50% RMSP. The increase observed in this study corroborated with the earlier reports on an increasing trend in weight gain as a result of the effect of forage legume supplementation of crop residues in various species of ruminants (22). The reduction observed in goats on 50% RMSP might be as a result of the inability of goats to properly utilize the diet for body weight gain when compared with other dietary treatments. This is in agreement with the reports of (23) that an efficient utilization of nutrients that supply adequate energy and protein are required for optimum growth performance in small ruminants. The average daily weight gain (ADWG) obtained in this study were slightly higher than the range of values (23.33 to 28.57 g/day) reported by (24) for WAD goats fed forages of *Leucaena* and *Gliricidia*, but lower than the range of values (30-50g/day) obtained in the previous study of (25) who fed goats concentrates *ad libitum*. The variations in ADWG of the experimental animals could therefore be attributed to variation in nutrient supply from the diets (26). Availability of digestible protein and energy reflected by the relatively low fibre levels of the supplementary forages could have provided ready nutrients for the synthesis of body tissues in the lower gut. This could be responsible for the higher weight gains and efficiency of feed utilization of goats on FMSP based diet. The metabolic weight observed in this study was higher than the value (5.88-7.11 $kgW^{0.75}$) reported by (27) for sheep fed forages and concentrate. There was no significant effect of diet on the concentrates DMI (g) consumed per day across the dietary treatments but significant difference was noticed for forage DMI (g/day).The level of anti-nutritional factors in this experiment did not adversely affect voluntary intake in goats. (28) documented that goats can tolerate about 9% dietary tannin. Feed conversion ratio was influenced by dietary treatments. This depicted a reflection of the highest weight gain observed in animals on these treatments. Animals on diet containing 50% RMSP had the worst FCR, indicating that the feed was not efficiently converted by the animals.

Blood acts as a pathological indicator of the whole body and hence haematological parameters are important in diagnosing the functional status of an exposed animal to suspected toxicant. The haemoglobin values in this study fell within the range of 7–15 g/dl reported by (29) but higher than the values of 5– 6 g/dl obtained by (30) for goats fed fungi-treated *Jatropha curcas* kernel cake rations. With the relatively higher Hb concentration obtained in this study, the dietary treatments generally seemed to be capable of supporting high oxygen carrying capacity blood in the goats.

Similarly, increased level of MSP irrespective of the processing method adopted resulted in higher value of haemoglobin concentration. This is an indication that MSP might influence the production of Hb and therefore improve the health status of animals. This study contradicts the results obtained by (31) who observed reduction in Hb level when fore-stomach digesta was fed to lambs. Increase in WBC is normally due to immune response by animal as a result of the presence of an antigen (foreign body) in the body. The presence of traces of anti-nutritional factors in the MSP diets might have triggered off immune response by WBC which tended to rise as level of MSP increased in diets. However, WBC counts observed in this study were within the normal range of values ($6.8–20.1\times10^9$/l) reported by (29) and the range of values ($7.5–27.9$ mm^3) cited by (32) and (33) for WAD sheep. The WBC counts obtained in this study were significantly influenced by processing method adopted in which animal fed diet containing RMSP recorded higher value (17.90×10^3/L) compared to those on diet containing FMSP (16.70×10^3/L). The values obtained in this study fell within the broad range of 47–82% and 51.6% reported by (29) and (34) for lymphocytes and 17–52% and 36.4% for neutrophils reported by the same authors, respectively. These values are suggestive of a well developed immune system in the WAD goats with such number of immune cells to proffer good health (29). The higher level of neutrophil was generated by livestock in a bid to fight against foreign bodies and this may also have been responsible for the higher values of WBC recoded in these dietary treatments. Malted sorghum sprout has been confirmed to contain some anti-nutritional factors (35). The inclusion of fermented malted sorghum sprout in the diet could probably have caused superior haematological parameters compared with the raw malted sorghum sprout. Tannin and cyanide found in the malted sorghum sprout are known to cause erythrocyte haemolysis and reduction in blood (36). Improvement was observed in the haematological indices of goat fed

FMSP based diet relative to those fed RMSP based diet. This result was in accordance with the result reported by (37) that *Aspergillusniger* reduced the level of anti-nutritional factors.

Conclusion and Application

Based on the result of this study, it can be concluded that:

(1) Raw Malted Sorghum Sprout (MSP) can be used in the diet of West African Dwarf goats up to 25%.
(2) A dietary inclusion of 50% FMSP improved the performance of West African Dwarf goats in terms of feed conversion ratio.
(3) The inclusion of 50% FMSP in the diet of West African Dwarf (WAD) goats had no deleterious effect on their haematological parameters.

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