Nutritional and Phytogenic Properties of Soursop (*Annona muricata*) Leaf Meal on the Productive and Physiological Performances of West African Dwarf Goats

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Abstract

The study aimed to examine the effect of soursop (*Annona muricata*) leaf meal (AMLM) diets on productive and physiological characteristics of West African dwarf (WAD) goats. Thirty six bucks were randomly divided into four experimental groups of nine animals each. Each group was assigned to one of the experimental diets formulated to contain AMLM at 0% (control), 15%, 30% and 45% for 82 days in a completely randomized design (CRD). The proximate composition of the experimental diets ranges from 87.32–89.19% dry matter (DM), 14.72–15.59% crude protein (CP), 27.18–29.30% crude fibre (CF), 9.48–13.62% ash, 2.00–2.31% ether extract (EE), 26.81–32.80% nitrogen free extract (NFE) and 3.56–3.73 MJ/kg gross energy (GE). The chemical analysis of the AMLM revealed 90.91% DM, 20.39% CP, 16.20% CF, 10.62% ash, 4.31% EE, 39.39% NFE and 3.93 MJ/kg GE. The results on intake and body weight changes showed significant ($P < 0.05$) improvement with the inclusion of AMLM in the diets for final body weight, daily weight gain, daily feed intake, forage dry matter intake, supplement dry matter intake, total dry matter intake and feed conversion ratio. AMLM at 45% inclusion produced the best ($P < 0.05$) packed cell volume and lymphocyte concentration in comparison to other treatments. AMLM at 15, 30 and 45% resulted to improved red blood cells, mean cell haemoglobin concentration, and white blood cells concentration when compared with the control. Sodium and chloride were however best ($P < 0.05$) at 15, 30 and 45% supplementations. The results indicated that AMLM enhanced body weight gain, dry matter intake, haemopoiesis and health status of the WAD goats and therefore should be incorporated into goat feeding programme to enhance better productivity.

Key words: body weight changes, dry matter intake, phytobiotics, blood profile, small ruminant

Introduction

Goat is one of the domestic livestock of high inestimable value in developed and developing countries. Its production has witnessed progressive growth in recent years. In most tropical countries, goats are non-seasonal breeders and the most prolific of all the domesticated ruminants under tropical and subtropical conditions, with high conception rate, early breeding age, high birth weight, high weaning weight, moderate kid survival rate, short gestation length, early maturity and moderate kidding interval. However, the West African dwarf (WAD) goat is the most adaptable breed of small ruminants found in rain forest and derived savanna zones where they are raised under smallholder management system. In eastern part of Nigeria, WAD goats are vital in marriages, religious rites, good medium of establishing friendship, common stake used as an object of fine for restoration of peace in communities and a ready source of family income.

Nevertheless, poor quality diets challenges WAD goats in expressing their full potential. This may be due to high cost of conventional concentrate, seasonal variations and little knowledge about efficient use of unconventional resources (Jiwuba and Ogbuewu, 2019) by goat farmers. Single possible means of improving the diets of goats is through formulation of supplemental diets with leaf meals from plants with phytogenic properties. One of such plants with reported (Coria-Téllez et al., 2016) phytogenic properties is soursop (*Annona muricata*). Jiwuba and Kadurumba (2019) attributed the recent attention on the utilization of phytogenic plant materials in animal nutrition to their growth promoting and medicinal properties. Soursop (*Annona muricata*), belongs to the genus *Annona,* family *Annonaceae* and order *Magnoliales* and known by diverse names like Graviola (Portuguese), Sawamsop (Igbos), Ebo (Yorubas) and Fasadarur (Hausas). *A. muricata* is a tropical plant usually cultivated for its nutritious and sour tasty fruit and serve as medicinal plant for the treatment of various ailments. The nutritional assay of *A. muricata* revealed high vitamin B and C, phosphorus, iron and calcium contents (Enweani et al., 2004). Earlier reports (Badrie and Schauss, 2009; Ezuruike and Prieto, 2014; Coria-Téllez, et al., 2016) enumerated the value of *A. muricata* leaves in the treatment of hypertension, diabetes, parasites, cancer, kidney disorders, cold, flu, asthma, malaria, digestive problems, microbial and worm infestation, inflammations, pains and respiratory disorders. Studies have shown that *A. muricata* leaves (Matsushige et al., 2011; Ragasa et al., 2012; Vijayameena et al., 2013) contain reasonable amount of alkaloid, acetogenins, phenols, vitamins and carotenoids. The popularity of *A. muricata* may be attributed to its selective cytotoxic activity, which tend to be more toxic to cancer and tumor cells than to normal cells (Dai et al., 2011). However, McLaughling (2008) reported that selective cytotoxicity of *A. muricata* may be attributed to the higher ATP demand of cancer cells with respect to normal cells. Notwithstanding, these properties, *A. muricata* leaf meal has not gained prominence as feedstuff for goats, especially as a component of WAD goat diet. The study was therefore, aimed at to evaluate the growth performance and blood profile of WAD goats fed graded levels of *A. muricata* leaf meal in their diets with a view of ascertaining its nutritional and phytogenic properties for enhanced goat production.

Materials and methods

The experiment was carried out at the Rabbit Unit, Federal College of Agriculture – Ishiagu, Ebonyi state, Nigeria. The College is located at about three kilometers (3km) away from Ishiagu main town. The College is situated at latitude 5.56 °N and longitude 7.31 °E, with an average rainfall of 1653 mm and a prevailing temperature condition of 28.50 °C and relative humidity of about 80%.

The experimental material *Annona muricata* leaves were sourced and harvested within Ishiagu environ and air dried for some days to a moisture content of about 10–15%. Other feed ingredients were procured from Farm associate – Enugu, Enugu State, Nigeria. Fresh, succulent, greenish non-over matured *Annona muricata* leaves were harvested to ensure lower value of lignin and higher nutrient availability. The leaves were air dried in batches before passing through a 10 mm hammer mill and further used in the formulation of the experimental diets. Four diets T_1, T_2, T_3, and T_4, were formulated. The *Annona muricata* leaf meal (AMLM) was included at the levels of 0%, 15%, 30% and 45% for T_1, T_2, T_3, and T_4, respectively as presented in Table 1.

Thirty-six (36) intact WAD bucks of about 8–10 months of age and averaging 7.96 kg in weight were selected from the College flock for this experiment. The goats were randomly divided

Table 1. Composition of the experimental diets

Ingredients	Dietary levels			
	T_1 (0%)	T_2 (15%)	T_3 (30%)	T_4 (45%)
Annona murica leaf meal	0.00	15.00	30.00	45.00
Cassava peel	36.00	36.00	36.00	36.00
Wheat offal	18.00	13.00	10.00	6.00
Brewer's dried grain	23.30	17.30	11.30	5.30
Palm kernel cake	20.00	16.00	10.00	5.00
Bone meal	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50
Premix	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00

into four groups of nine animals each. The groups were randomly assigned the four experimental diets (T_1, T_2, T_3, and T_4) in a completely randomized design (CRD) pattern. The animals were housed individually in a well-ventilated cement floored pens equipped with feeders and drinkers. Each animal received a designated treatment diet in the morning (8 am) for 82 days. Feed offered was based on 4.0% body weight per day; the animals were in addition fed 1 kg wilted chopped *Panicum maximum* later in the day (4 pm). Regular access to fresh drinking water was made available. Initial body weights of the animals were taken at the beginning of the feeding trial and weekly thereafter. Final live weight was obtained by weighing the goats at the end of the experiment. Daily weight gain, daily feed intake and feed conversion ratio were calculated accordingly.

Blood samples (10 ml) were drawn from each animal on the last day of the study. The WAD goats were bled through the jugular vein. The samples were separated into two lots and used for biochemical and haematological studies. An initial 5 ml was collected from each sample in labelled sterile universal bottle containing 1.0 mg/ml ethyldiamine tetracetic acid and used for haematological analysis. Another 5 ml was collected over anti-coagulant free bottle. The blood was allowed to clot at room temperature and serum separated by centrifuging within three hours of collection. Serum biochemistry (Total Protein, Creatinine, Aspartate aminotransferase, Alanine aminotransferase and Alkaline phosphatase) and haematological parameters (Packed cell volume, Haemoglobin, Red blood cell and White blood cell) were measured using Beckman Coulter Ac-T10 Laboratory Haematology Blood Analyzer and Bayer DCA 2000 + HbA1c analyzer, respectively. Mean cells haemoglobin (MCH), Mean cell volume (MCV) and mean cell haemoglobin concentrations (MCHC) were calculated. The standard flame photometry using Gallenkamp analysis were used to determine serum sodium (Na+) ion, Potassium (K+) ion, Chloride (ion-), Phosphorus, and HCO_3.

All the sample of feed and test ingredients was analyzed for their chemical composition using the method of AOAC (2000). The following were determined and analyzed; Dry matter content (DM), Crude protein (CP), Crude fibre (CF), Ether extract (EE), Nitrogen free extract (NFE), Moisture content (MC), Ash, Neutral detergent fibre (NDF) and Acid detergent fibre (ADF), Hemi cellulose and Metabolizable energy. Gross energy was calculated using the formula $T = 5.72Z_1 + 9.50Z_2 + 4.79Z_3 + 4.03Z_4 \pm 0.9\%$; where T = Gross energy, Z_1 = Crude protein, Z_2 = Crude fat, Z_3 = Crude fibre, Z_4 = Nitrogen free extract.

The results were analyzed using the Statistical Package for Social Science Window 17.0. One-way analysis of variance (ANOVA) was employed to determine the means and standard error. Significant differences between the treatment means were separated using the Duncan Multiple New Range Test.

Results and discussion

The chemical composition of the experimental diets and *A. muricata* leaf meal is presented in Table 2. The experimental diets and AMLM were analyzed for dry matter (DM), crude protein (CP), crude fibre (CF), ash, ether extract (EE) and nitrogen free extract (NFE). The DM contents of the experimental diets did not follow a regular trend across the treatment groups. The DM for the diets ranged between 87.32 and 89.19%. The CP content of the diets increased progressively with an increasing levels of AMLM and the highest value of 15.59% recorded for T_4 with a corresponding lowest value of 14.72% recorded for T_1. The CF ranged from 27.18–29.70%, and failed to follow a specific tend. The ash values ranged between 9.48 and 13.62% and followed a specific trend across the treatment groups. The EE content ranged between 2.00 and 2.31% and followed a specific trend increasing with increasing levels of AMLM across the treatments. The NFE contents did not follow a regular trend and ranged from 26.81–32.80%. The gross energy however tended to decrease with increasing levels of AMLM, but ranged between 3.56 and 3.73 MJ/kg. The AMLM showed a high DM value of 90.91% with a corresponding higher CP value of 20.39% for leaf meals. It also showed a moderate CF value of 16.20% with a corresponding high ash content of 10.62%. NFE and EE content of 39.39 and 4.31% respectively were recorded for the AMLM. The energy value of 3.93 MJ/kg was obtained. The chemical composition of AMLM revealed a high dry matter value of 90.91% that was higher than 87.90%, 87.67% and 89.56% reported by Jiwuba et al. (2017 a), Jiwuba (2018) and Jiwuba et al. (2016) for *Moringa oleifera* leaf meal (MOLM), Pawpaw leaf meal (PLM) and *Gmelina arborea* leaf meal (GALM) respectively. The DM value reported in this study is perhaps lower than 95.70% and 92.74% reported by Jiwuba et al. (2018) and Abdu et al. (2012) for Siam weed leaf meal (SWLM) and GALM respectively. The differences in the DM may be attributed to the differences in the test ingredients, soil type and nutrient, age of the leaves, the level of dryness of the leaves and the processing methods used. The crude protein content of 20.39% obtained in this present study for AMLM is lower than 23.24% reported by Jiwuba et al. (2017 a) for MOLM but higher than 17.30% reported by Jiwuba and Kadurumba (2019) for PLM and compared favourably with 20.52% reported by Jiwuba et al. (2018) for SWLM. The relatively high CP obtained in this present study and earlier studies for leaf meals make it indispensable as dry season supplement in goat feeding system. The differences in the CP values may be attributed to the differences in the nitrogen com-

Table 2. Chemical composition of the experimental diets and *Annona muricata* leaf meal

	Dietary levels (%)				
Ingredients	T_1 (0%)	T_2 (15%)	T_3 (30%)	T_4 (45%)	AMLM
Dry matter (%)	87.75	88.37	89.19	87.32	90.91
Crude protein (%)	14.72	14.92	15.03	15.59	20.39
Crude fibre (%)	28.44	29.70	27.18	29.30	16.20
Ether extract (%)	2.31	2.30	2.24	2.00	4.31
Ash (%)	9.48	10.79	12.23	13.62	10.62
Nitrogen free extract (%)	32.80	30.66	32.51	26.81	39.39
Gross energy (MJ/Kg)	3.73	3.73	3.68	3.56	3.93

AMLM = Annona muricata leaf meal

ponent of the leaves and stage of development of the leaves during harvest. The high ash content of AMLM obtained in this study may be attributed to high mineral content of Soursop leaves; a view corroborated with Enweani et al. (2004). The high CF and energy values of AMLM in this study is an indication for its suitability as a feed resource for ruminants. Adequate supply of dietary fibre (Jiwuba, 2018) stimulates rumen motility, equilibrium in rumen ecosystem and chyme chewing in goats. The energy value reported for AMLM in this study is in agreement with earlier reports by Jiwuba et al. (2017 a) and Jiwuba et al. (2018) for leaf meals. The chemical composition of the experimental diets in this study indicated that the protein, energy and mineral needs of the goats were met (ARC, 1980; NRC, 1981).

Table 3 shows the intake and body weight changes of WAD goats fed diets containing *Annona muricata* leaf meal. The diets had a positive influence body weight changes ($P < 0.05$) among the experimental groups, with T_3 and T_4 having the best ($P < 0.05$) weight gain ($Wkg^{0.75}$) and T_1 having the least. Average daily feed intake (ADFI) (g/d) differed significantly ($P < 0.05$) among the treatment groups with T_2 and T_4 having higher ($P < 0.05$) values than T_1 but T_3 showing similarities ($P > 0.05$) with T_1, T_2 and T_4. Supplement dry matter intake (SDMI), and total dry matter intake (TDMI) (g/day) and TDMI (g/day/$Wkg^{0.75}$) followed a particular trend with the treatment groups (T_2, T_3 and T_4) having ($P < 0.05$) better values than the control (T_1). Forage dry matter intake (FDMI) was best ($P < 0.05$) for T_3 and T_4 in comparison with T_1, while T_2 is similar ($P > 0.05$) to T_1, T_3 and T_4. The feed conversion ratio (FCR) differed ($P < 0.05$) among treatment groups, with T_3 and T_4 having the best ($P < 0.05$) values when compared with T_1 and T_2. The improved feed intake and total DMI in the AMLM diets might be attributed to high palatability and acceptability of the diets conferred by increased aroma, CP and essential nutrients of Annona muricata leaf meal. Jiwuba et al. (2017 b) noted that palatability is the degree of acceptability of a diet, which is a function of the diet and post-ingestive feedback. In addition, all the animals in the respective treatments had adequate total dry matter intake (DMI) that ranged from 368.48–409.32 g/day and metabolic weight of 84.40–91.00 g/day/$Wkg^{0.75}$. The values obtained in this study compared with 336.39–392.46 g/day for WAD goats fed *Moringa oleifera* leaf meal reported by Tona et al. (2014). Similarly, the goats met their daily minimum

Table 3. Intake and body weight changes of West African dwarf goat fed *Annona muricata* leaf meal

Parameters	Dietary levels (%)				SEM
	T_1 (0%)	T_2 (15%)	T_3 (30%)	T_4 (45%)	
Initial body weight (kg)	7.67	8.05	8.16	7.95	3.85
Final body weight (kg)	10.72^b	11.97^b	13.24^a	13.00^a	5.21
Average daily weight gain (g/d)	37.20^c	48.41^b	61.95^a	61.59^a	5.01
Av. daily weight gain ($Wkg^{0.75}$)	15.06^c	18.35^b	22.08^a	21.99^a	4.77
Average daily feed intake (g/d)	362.80^b	401.71^a	383.78^{ab}	412.32^a	12.77
Forage DMI (g/day)	202.93^b	208.45^a	215.00^{ab}	211.58^b	9.33
Supplement DMI (g/day)	265.55^b	287.46^a	294.32^a	289.81^a	10.02
Total DMI (g/day)	468.48^b	495.91^{ab}	509.32^a	501.39^{ab}	12.99
Total DMI (g/day/$Wkg^{0.75}$)	100.70^b	105.09^a	107.21^a	105.96^a	7.42
Feed conversion ratio	9.75^a	8.40^a	6.19^b	6.69^b	2.01

^{a,c} means in the row with different superscripts are significantly different ($p < 0.05$)

dry matter intake of 3% of body weight recommended for small ruminants (NRC, 1985). The enhanced body weight gain observed with goats on T_2, T_3 and T_4 diets maybe attributed to higher intake and feed utilization; hence, voluntary feed intake is directly related to the body weight gain. *Annona muricata* leaves are high vitamins, carotenoids, minerals and other biologically active compounds (Enweani et al., 2004; Coria-Te´llez, et al., 2016) which may have enhanced nutrient digestion and nutrient utilization, which are essential for growth in WAD goats. AMLM have also been reported (Badrie and Schauss, 2009; Ezuruike and Prieto, 2014; Coria-Téllez, et al., 2016) to contain some natural substances that can promote health and reduce infection, thus resulting in positive effect on body weight gain in the goats. Better nutrient accord in T_3 and T_4 as earlier cited might be responsible for improved feed conversion ratio as this would have enhanced nutrient utilization among the experimental animals.

The haematological parameters of WAD bucks fed *Annona muricata* leaf meal in their diets are presented in Table 4. The packed cell volume (PCV) follow a particular trend, increasing ($p < 0.05$) with increasing levels of AMLM in the treatment diets. The haemoglobin (Hb), mean cell haemoglobin (MCH) and mean corpuscular volume (MCV) were not influenced ($P > 0.05$) by the treatment diets and failed to follow a particular trend across the treatment groups. The red blood cell (RBC) did not followed a specific pattern but showed significant ($P < 0.05$) difference across the treatments with T_3 and T_4 showing ($P < 0.05$) better values than T_1 and T_2. The mean corpuscular haemoglobin concentration (MCHC) was significantly ($P < 0.05$) influenced by the diets. However, T_1 was not significantly ($P > 0.05$) different from T_2, but was significantly ($P < 0.05$) different from T_3 and T_4, while T_2, T_3 and T_4 were similar ($P > 0.05$). The white blood cell (WBC) was significantly ($P < 0.05$) influenced by AMLM in the diets of the WAD goats. The WBC values followed a particular trend, increasing numerically with increasing levels of AMLM in the diets. T_1 was similar ($P > 0.05$) with T_2, but was significantly ($P < 0.05$) different from T_3 and T_4, while T_2, T_3 and T_4 were also similar ($P > 0.05$). Lymphocyte was significantly influenced ($P < 0.05$) by higher levels of AMLM with T_4 showing ($P < 0.05$) highest value of 61.21%, which was statistically ($P < 0.05$) higher than T_3, T_2 and T_1. T_1 was different ($P < 0.05$) from other treatments and had the lowest value of 52.59%, while T_2 and T_3 were similar ($P > 0.05$). Neutrophil followed a specific pattern and showed significant ($P < 0.05$) difference across the treatments with T_3 and T_4 showing ($P < 0.05$) higher values than T_1 and T_2. The PCV range of 25.10–33.12% obtained in this study is within 22–38% normal physiological for apparently healthy goats reported by Radostits et al. (2006) and compared well with 29.50–32.75% for WAD goats fed MOLM as reported by Jiwuba et al (2017 a). This indicated a balance in the physiological status and possible absence of toxic elements affecting blood homeostasis among the goats. The significant ($P > 0.05$) red blood cell obtained herein is in agreement with the findings of Okwori et al. (2016) for WAD goats fed guava leaf meal. The RBC values obtained are within the normal 8.0–18 x 10^{12}/L range reported Radostits et al. (2006) thus indicating that the that oxygen carrying capacity of red blood cells was not compromised and hence, absence of anaemia. The non significant ($P < 0.05$) results obtained for haemoglobin, mean cell haemoglobin and mean cell volume in this study is inconsonance with the results of Okwori et al. (2016) for similar animal. This demonstrated that the diets supported the health status of the animals. The within normal physiological range of 30–36% reported by Radostits et al. (2006) obtained in this study for mean corpuscular haemoglobin concentration gave a clear indication of the absence of anaemia among the goats. Jiwuba et al. (2017 b) stated that white blood cell function to fight infections, defend the body through phagocytosis against invasion by foreign organisms and to produce or transport antibodies in immune response. The normal physiological range of white blood cells reported herein suggested well developed immune system and hence the health of the animals were not compromised. However, the improved WBC, lymphocyte and

Table 4. Haematology of West African Dwarf goats fed *Annona muricata* leaf meal in their diets

	Dietary levels (%)				
Parameters	T_1 (0%)	T_2 (15%)	T_3 (30%)	T_4 (45%)	SEM
Packed cell volume (%)	25.10[d]	27.80[c]	30.00[b]	33.12[a]	0.26
Haemoglobin (g/dl)	10.05	9.97	10.15	10.12	0.10
Red blood cell (× 10^{12}/l)	10.53[b]	10.46[b]	13.79[a]	12.91[a]	0.12
Mean cell haemoglobin (pg)	5.14	5.62	6.00	5.77	0.18
Mean cell haemoglobin conc. (%)	30.82[b]	32.17[ab]	34.64[a]	34.92[a]	0.23
Mean cell volume (fl)	16.07	17.76	16.41	17.02	0.13
White blood cell (× 10^9/l)	5.30[b]	7.85[ab]	9.55[a]	10.00[a]	0.15
Lymphocyte (%)	52.59[c]	57.46[b]	58.94[b]	61.21[a]	0.47
Neutrophil (%)	29.52[b]	32.11[b]	35.61[a]	37.55[a]	0.24

[a-d] Means within a row with different superscript differ significantly (P < 0.05) from one another.

Table 5. Serum biochemistry of West African Dwarf goats fed *Annona muricata* leaf meal

	Treatments				
Parameters	T_1 (0%)	T_2 (15%)	T_3 (30%)	T_4 (45%)	SEM
Total Protein (g/dl)	6.26	6.31	6.77	6.81	0.41
Creatinine (mg/dl)	1.14	1.37	1.51	1.72	0.11
AST (μ/l)	29.50	37.50	30.00	35.87	2.10
ALP (μ/l)	91.00	92.50	93.50	92.94	0.98
ALT (μ/l)	29.50	34.5	29.50	32.59	0.21
Sodium (mmol/l)	144.06[b]	149.97[a]	146.43[ab]	151.04[a]	1.74
Potassium (mmol/l)	3.92	3.95	3.66	3.93	0.05
Chloride (mmol/l)	100.02[b]	105.51[a]	107.27[a]	106.49[a]	1.64
Phosphorus (mmol/l)	2.31	2.44	2.29	2.36	0.15
Bicarbonate (mmol/l)	27.87	24.89	25.67	26.27	1.22

[a,b] means in the row with different superscripts are significantly different (p < 0.05)

neutrophil observed in the treatment groups over the control explained the ethno-veterinary properties of soursop leaves; a view corroborated by Coria-Téllez et al. (2016).

The blood chemistry of WAD goats fed *Annona muricata* leaf meal in their diets is presented in Table 5. The total protein and creatinine were not significantly (P > 0.05) affected by the treatment diets, but numerically tended to increase with incremental levels of AMLM. Aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), potassium (K), phosphorus (P) and bicarbonate (HCO_3^-) were not influenced (P > 0.05) by the treatment diets and failed to follow a particular pattern with incremental levels of AMLM. Sodium (Na) was significantly (P < 0.05) affected with T_1 being similar (P > 0.05) with T_3, but was significantly (P < 0.05) different from T_2 and T_4, while T_2, T_3 and T_4 were also similar (P > 0.05).

Chloride (Cl^-) was significantly ($P < 0.05$) influenced with T_1 showing ($P < 0.05$) lower value than other treatments. The lack of significant difference in most of the serum biochemical parameters evaluated (all which remained within the normal value for the goats) is an indication of high quality of the test diets. However, the significant difference for sodium and chloride in this study is in agreement with the results of Uwagie-Ero et al. (2016) and fall with the normal physiological of 142–155 (mmol/l) and 99–110.3 (mmol/l) respectively as reported Kaneko et al. (1997) for goats. The within normal range and better values for sodium reported for treatment diets is an indication the diets supported a balance of water in the cells, ensured stable blood pressure and ensure better functioning of the muscles and nerves. In addition, the significantly higher chloride in the treatment diets indicated that the AMLM supported good acid-base balance, metabolism and proper functioning of the kidneys.

Conclusion

Inclusion of soursop leaf meal in the diets of WAD goats produced enhanced body weight gain, dry matter intake and feed conversion ratio. The blood profiles of goats in all the treatment groups were within normal range for goats; an indication that the test ingredient enhanced feed quality and inadvertently the nutritional and health status of the experimental animals; hence recommended for enhanced goat production.

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