Nigerian J. Anim, Sci. 2025, 27 (2): 198 - 211

Sustainable Use of Guava *(Psidium guajava)* Leaves to Enhance Growth Performance, Nutrient Digestibility and Blood Profile in West African Dwarf Goats

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Target audience: *Smallholder and Commercial Goat farmers, Feed industry professionals*

Abstract

Guava leaves are rich source of nutrients and bioactive compounds with a great potential as a sustainable and adaptable feed resource for ruminants. This study investigated the dietary effect of guava leaves (GL) on growth performance, nutrient digestibility and blood profile of West African dwarf (WAD) goats. Twenty (20) WAD goats with average body weight of 8.29±1.25kg were randomly assigned to four dietary treatments with graded levels (0, 15, 30 and 45%) of air-dried guava leaves for 70 days. The performance characteristics, nutrient digestibility and selected blood metabolites of animals were determined. The crude protein (CP), ether extract, tannins and flavonoids contents increased ($p < 0.05$) with increase in the inclusion of GL in the diets. Dry matter intake was higher in goats fed diets with 0% and 15%GLwhile the CP intake was higher in 30% and45% GL diets. Goats fed diets containing 0% and 30% GL recorded higher DM and NDF digestibility while those fed 15% and 30% GL had higher CP and ash digestibility. Inclusion of guava leaves in the diet reduced ($p < 0.05$) the serum aspartate aminotransferase, alkaline phosphatase and malonaldehyde levels of the animals. The study suggests that GL could form 30% of the diet of West African dwarf goats for improved nutrient digestibility, reduced oxidative stress and enhanced feed conversion ratio without deleterious effects on the blood profile of animals.

Keywords: Guava leaves, bioactive compounds, oxidative stress, ruminants

Description of Problem

Livestock production is an important sector in agriculture with capacity to boost economy of a nation. In West Africa, small ruminants such as the West African dwarf (WAD) goats and sheep contribute significantly to the livelihood of rural dweller chiefly as a source of income and protein (meat and milk). At least one ruminant animal is kept by more than a quarter of the world's 570 million farm holdings. This improves food security, families' livelihoods and nutritional outcome (1). The West African dwarf goats are hardy animals with high disease resistant potential and inherent adaptability. They often face with challenges of feed scarcity especially during the dry season; when the quality and quantity of forages decreased drastically. This limits their productivity potential, increased mortality and therefore results in economic losses for farmers. To address these nutritional challenges, there is growing interest in the use of non-conventional and sustainable feedstuffs that are locally available. Many browse and tree plants contribute a large amount of available forages as complementary source of feeds for livestock. Some tree species are under - utilized in Nigeria, despite their potential nutritional value as sources of protein, vitamin, minerals and bioactive compounds for livestock.

Guava (*Psidium guajava*) is one of the most important tropical trees cultivated for its fruits. It is a fast-growing evergreen shrub or small tree that can grow to a height of 3-10 m. It belongs to the family; Myrtaceae with more than 3800 species (2) and are readily available in many tropical regions including western Nigeria. Guava leaves composed of about 12 - 18% crude protein and 17% crude fibre (3, 4) The leaf is rich in vitamin C and minerals such as Calcium, Magnesium, Sodium and Manganese which makes it a suitable feed for both humans and animals to prevent nutrient deficiency (5). Additionally, guava leaves are rich in bioactive compounds such as tannins, phenolic compounds and flavonoids which exhibit anti-inflammatory, antioxidant and antimicrobial effects. These compounds can suppress pathogenic microbes and mitigate oxidative stress thereby promoting growth and physiological well-being in animals (6). Tannins had been revealed to reduce ruminal degradation of protein and nitrogen loss in the rumen (7) with reduction in urinary ammonia emission (8) and improved utilization of dietary protein (9). Phenolic compounds and flavonoids are known for their antioxidant activity. Recent studies have shown that dietary inclusion of guava leaves in diets reduced protozoa count and methane production *in vitro* (10). This is pointing to its potential as an eco-friendly and productive feed resource as enteric methane emission by ruminants is one the major components of greenhouse gases that contribute to global warming and it also represents a significant loss of feed energy for the animals (11).

In view of these promising findings, guava leaves (*Psidium guajava*) can successfully serve as a supplementary feed for ruminants during the dry season and may be capable of substituting high quality forage during this season due to its high profile of nutrients. According to (12) addition of guava leaves in the diet of ruminant has no negative effect on truly degraded dry matter and organic matter *in vitro* (12). Similarly, (10) reported minimal effect of guava leaves on nutrient digestibility *in vitro*. However, there is a need to establish the appropriate level of incorporating guava leaves in the diet of West African dwarf goats, evaluating the effect on the growth performance and blood profile of the animals especially when fed alongside *Megathrysus maximus* hay which is the most common grass available in the western part of Nigeria. This study is therefore, designed to investigate the dietary effect of guava leaf supplementation on nutrient digestibility, growth performance and blood profile in West African dwarf goats.

Materials and method

Study location

The study was carried out at the Small Ruminant Unit of the College of Animal Science and Livestock Production farm, Federal University of Agriculture, Abeokuta (FUNAAB), Nigeria. The site is situated in the rain forest zone of south western Nigeria at latitude 7°13'28" N and longitude 3°25'2" E (13). The site has an annual mean temperature of 34.7^{0}C and relative humidity range of between 63 to 96% during the raining season and 55 to 84% during the dry season (14)

Harvesting and processing of experimental feed materials

Guava leaves were freshly collected from orchards located in Odeda local government area of Ogun State, Nigeria. The leaves were harvested randomly and manually from various parts of the trees in order to obtain both young and mature leaves from each tree. The leaves were air-dried at room temperature for approximately 7days and stored in jute bags prior usage. *Megathyrsus maximus* (guinea grass) was harvested from an established pasture in FUNAAB after 12 weeks of regrowth. The grass was chopped into small pieces (2-4cm) and was sun dried for 7 days to form hay. The hay was later packed in bags and stored in a dry and ventilated shed.

Experimental treatments

The treatments consisted of concentrates diet and guinea grass hay (40:60) with guava leaves substituted for the grass hay at graded levels in accordance with the goat requirement (15). Therefore, the experimental treatments contained 0, 15, 30 and 45% guava leaf as shown:

MH – 0% guava leaf + 60% *Megathyrsus maximus* hay + 40% concentrate diet

$GL_{15}MH_{45}$ - 15% guava leaf + 45% *Megathyrsus maximus* hay + 40% concentrate diet

$GL_{30}MH_{30}$ - 30% guava leaf + 30% *Megathyrsus maximus* hay + 40% concentrate diet

$GL_{45}MH_{15}$ - 45% guava leaf + 15% *Megathyrsus maximus* hay + 40% concentrate diet

Experimental animals and management

Twenty (20) male West African dwarf goats with an initial average body weight of 8.29±1.25kg were used for the experiment. The animals were housed in well cleaned and disinfected individual pens. The animals were randomly divided into four treatment groups of five animals each. The experimental diets were offered at 8:00 am and 4:00 pm; water was provided *ad libitum*. The experiment was carried out in a Completely Randomized Design and it lasted for 70 days. The animals were weighed at the start of the experiment and on weekly basis before morning feeding to determine their weight changes. Daily intake was measured throughout the experimental periods by finding the difference between the amount of offered and rejected feed. Nutrient intake was also estimated based on the daily intake and the chemical composition of the diet.

Digestibility study

At the last week of the experiment, three animals per treatment were transferred into individual metabolic cages. The animals were fed their respective treatment for 21 days and fresh clean water was provided. Total collection of faeces and urine was done separately on daily basis in the last seven (7) days of the digestibility study. Urine was collected into bottles containing 2 mL of 10% concentrated Sulphuric acid to prevent escape of ammonia and was stored at -20°C prior subsequent analysis. Collected faeces was weighed, pooled and 10% aliquot was oven dried at 65°C until constant weight is attained to determine the dry matter. The feed samples were also taken and oven dried at the same temperature.

Blood collection and analysis

A 10ml of blood was collected from each animal before feeding in the morning via the jugular vein using hypodermic syringe. The blood was divided into two parts for the determination of haematological and serum indices (16). A part of this blood was dropped in tubes containing EDTA for the determination of Packed Cell Volume (PCV), Haemoglobin Concentration (Hb), White Blood Cell (WBC) and Red Blood Cell (RBC). The second part was dropped in tubes that are anti-coagulant free and was centrifuged at 4000 rpm for 20 minutes after which the blood serum was separated and preserved in clean and sterile plastic tubes at -18°C for the determination of serum total protein, glucose, albumin, creatinine and serum urea. Serum globulin was calculated by subtracting the albumin value from corresponding total serum protein value. Liver enzyme and malondialdehyde levels were also determined.

Chemical analysis

Both the feed and faecal samples were analyzed for crude protein, ether extract and ash according to AOAC (17) while the neutral detergent fibre, acid detergent fibre and acid detergent lignin contents were also determined (18). In addition, tannin (19), saponin (120), flavonoids (21), glycoside, total phenol (22) and alkaloids (23) contents in guava leaf were determined while the experimental diets were analyzed for tannin and flavonoids only. Apparent nutrient digestibility was calculated as the difference between the nutrient content in feed consumed and that of the faeces as the percentage of intake. Nitrogen content of the urine was also determined and subsequently nitrogen retention was calculated.

Statistical analysis

All data generated were subjected to one way analysis of variance in a Completely Randomized Design with the use of generalized linear model (24). The significant level, $P < 0.05$ was used and the model for the study is as follows:

$Y_{ij} = \mu + T_i + \sum_{ij}$

Where, Y_{ij} = observed values of dependent variables, μ = population mean, T_i =effect of different levels of guava leaves and Σ_{ij}=random residual error.

Results

The chemical composition of guava leaf, *Megathyrsus maximus* hay and concentrate diet used in the present study is presented in Table 1. Guava leaf contained 87.09% Dry Matter (DM), 14.14% Crude Protein (CP) and 66.50% Neutral Detergent fibre (NDF). Megathrysus hay contained 88.97% DM, 8.41% CP and 85% NDF while the concentrate diet contained 96.63% DM, 14.61% CP and 28.50% NDF. The phytochemical composition of the guava leaf includes tannins, total phenol, flavonoids, glycosides, alkaloids, and saponin. The mineral contents in guava leaf includes Calcium, Potassium, Manganese and Iron. Table 2 presents the chemical composition

Table 1: Chemical composi tion (%) of guava leaf, Megathyrsus hay and concentrate used for the study

Parameters	Guava leaf	Megathyrsus hay	Concentrate
Proximate and fibre composition			
Dry matter	87.09	88.97	96.63
Organic matter	92.75	87.00	95.73
Crude protein	14.14	8.41	14.61
Ether extract	3.27	1.27	3.27
Ash	7.25	13.00	4.27
Neutral detergent fibre	66.50	85.00	28.50
Acid detergent fibre	60.50	49.50	21.50
Phytochemical composition			
Tannin (mg/100g)	1151.788	ND	ND
Total Phenol (mg/100g)	1884.622	ND	ND
Flavonoids (mg/100g)	1523.051	ND	ND
Glycoside (mg/100g)	2.641	ND	ND
Alkaloid (%)	13.227	ND	ND
Saponin (%)	2.237	ND	ND
Mineral composition			
Calcium (mg/100g)	330.16	ND	ND
Potassium (mg/100g)	531.53	ND	ND
Manganese (mg/100g)	229.28	ND	ND
Iron (mg/100g)	38.74	ND	ND

ND – Not determined, Concentrate diet consisted of maize -12%; palm kernel cake -30%; wheat offer -25%; soyabean meal – 10%; rice bran – 20%, bone meal – 1.5%; salt – 1%

of the experimental diets. Diets containing 30% ($MH_{30}GL_{30}$) and 45% ($MH_{15}GL_{45}$) guava leaf had the higher ($p < 0.05$) dry matter content. The crude protein content increased with addition of guava leaves in the diet. The ash and the NDF contents of the diets reduced significantly ($p < 0.05$) with increase in guava leaves levels in the diets while the ether extract and the ADF contents were higher in diets containing guava leaf. There was a steady increase in the tannins and flavonoids contents of the diets as the levels of guava leaves increased.

The performance characteristics of West African dwarf goats fed the experimental diets is presented in Table 3. There were significant differences ($p < 0.05$) in the total weight gain,daily weight gain, dry matter intake and feed conversion ration of the animals. Addition of 45% guava leaf in the diet reduced the total and daily weight gain of animals while animals placed on 15% and 30% GL recorded the least feed conversion ratio.

The nutrient intake and apparent nutrient digestibility of West African dwarf goats fed guava leaf diets is shown in Table 4. The dry matter and NDF intakes of animals reduced while the crude protein intake increased as the levels of guava leaf in the diets increases. The dry matter and NDF digestibility were higher in goats fed 0% and 30%GLwhile the crude protein digestibility was higher ($p < 0.05$) in goats fed 15% and 30% guava leaves. Animals fed 45% GL had the least Acid detergent fibre digestibility.

Table 2: Chemical composition (%) of experimental diets

Parameters	Experimental diets				SEM	p-values
	$MH_{60}GL_0$	$MH_{45}GL_{15}$	$MH_{30}GL_{30}$	$MH_{15}GL_{45}$		
Dry matter	92.03^b	86.40^c	92.63^a	92.27^a	0.84	<0.001
Crude protein	10.91^d	11.73^c	12.57^b	13.46^a	0.29	<0.001
Ash	9.51^a	8.68^b	7.76^c	6.92^d	0.29	<0.001
Ether extract	2.06^d	2.37^c	2.66^b	2.96^a	0.10	<0.001
NDF	64.40^a	59.42^b	56.95^c	53.76^d	0.96	<0.001
ADF	38.30^b	46.07^a	46.70^a	47.60^a	1.29	0.008
Tannins (mg/100g)	127.791^d	772.408^c	1151.788^b	1372.002^a	128.33	<0.001
Flavonoids (mg/100g)	13.431^d	1316.400^c	1523.051^b	1721.094^a	172.90	<0.001

^{a,b,c}means with different superscript in same row are different significantly ($p < 0.05$). ***SEM*** *- Standard Error of Mean,* ***$MH_{60}GL_0$*** *-60%Megathyrsus hay + 40%concentrate diet;* ***$MH_{45}GL_{15}$*** *- 45%Megathyrsus hay + 15%guava leaf + 40%concentrate diet;* ***$MH_{30}GL_{30}$*** *- 30%Megathyrsus hay + 30%guava leaf + 40%concentrate diet;* ***$MH_{15}GL_{45}$*** *- 15%Megathyrsus hay + 45%guava leaf+40% concentrate diet;* ***NDF*** *– neutral detergent fibre;* ***ADF*** *– acid detergent fibre*

Table 3: Performance characteristics of West African Dwarf goats fed diets supplemented with varying levels of *Psidium guajava* leaves

Parameters	Experimental diets				SEM	P-values
	$MH_{60}GL_0$	$MH_{45}GL_{15}$	$MH_{30}GL_{30}$	$MH_{15}GL_{45}$		
Initial wt. (kg)	8.33	7.67	8.00	9.15	0.36	0.559
Final wt. (kg)	11.00	10.53	10.87	10.97	0.34	0.061
Total WG (kg)	2.67^a	2.86^a	2.87^a	1.82^b	0.15	<0.001
Daily WG(g/day)	47.67^b	51.07^a	51.25^a	32.50^c	2.67	<0.001
DM intake(g/day)	384.09^a	351.19^{ab}	336.64^{bc}	333.03^c	4.35	0.011
FCR	8.05^b	6.87^c	6.56^c	10.23^a	0.70	0.001

^{a,b,c}means with different superscript in same row are different significantly ($p < 0.05$). ***SEM*** *- Standard Error of Mean,* ***$MH_{60}GL_0$*** *– 60%MH + 40% Concentrate,* ***$MH_{45}GL_{15}$*** *–45%MH + 40% Concentrate,* ***$MH_{30}GL_{30}$*** *– 30%MH + 30%GL + 40% Concentrate,* ***$MH_{15}GL_{45}$*** *– 45%GL + 15%MH + 40% Concentrate , WG-weight gain, FCR- feed conversion ratio*

Effects of guava leaves supplemented diets on blood parameters of West African dwarf goats is presented in Table 5. Packed cell volume (PCV), haemoglobin (Hb) and red blood cell (RBC) of goats were significantly ($p < 0.05$) affected by the

Table 4: Nutrient intake and apparent nutrient digestibility of West African dwarf goats fed experimental diets

Parameters	Experimental diets				SEM	P-values
	$MH_{60}GL_0$	$MH_{45}GL_{15}$	$MH_{30}GL_{30}$	$MH_{15}GL_{45}$		
Nutrient intake (g/day)						
DM intake	364.09^a	351.19^{ab}	336.64^{bc}	333.03^c	4.35	0.011
CP intake	41.94^b	41.29^b	42.32^{ab}	44.83^a	2.13	0.053
NDF intake	239.67^a	208.68^b	191.17^c	179.04^d	0.88	<0.001
Apparent nutrient digestibility (%)						
DM	65.88^a	63.79^b	65.15^a	51.96^c	2.04	0.018
CP	66.46^b	71.92^a	71.74^a	57.50^c	2.22	0.023
ASH	60.99^b	65.18^{ab}	66.79^a	51.63^c	3.90	0.040
NDF	61.85^a	48.57^b	61.44^a	41.84^b	2.86	0.055
ADF	55.35^a	54.67^a	58.67^a	46.00^b	1.53	0.015

[a,b,c] means with different superscript in same row are different significantly (p < 0.05). ***SEM** - Standard Error of Mean,* ***$MH_{60}GL_0$**– 60%MH + 40% Concentrate,* ***$MH_{45}GL_{15}$** –45%MH + 40% Concentrate,* ***$MH_{30}GL_{30}$** – 30%MH + 30% GL + 40% Concentrate,* ***$MH_{15}GL_{45}$**– 45%GL + 15%MH + 40% Co ncentrate; DM-dry matter; CP-crude protein;* ***NDF**- neutral detergent fibre;* ***ADF**- acid detergent fibre;*

inclusion of the guava leaves in their diets. The PCV, Hb and RBC were higher in goat fed 0% and 30% GL while the white blood cell count and neutrophil level were unaffected (p > 0.05) by the diets.

Serum total protein, glucose and ALT reduced significantly (p < 0.05) in goats fed 30%and 45% GL while the serum AST and malonaldehyde levels reduced (p < 0.05) with addition of guava leaf in the diets of the animals.

Table 5: Effects of guava leaf supplemented diet on blood parameters of West African dwarf goats

Parameters	Reference values	Experimental diets					
		$MH_{60}GL_0$	$MH_{45}GL_{15}$	$MH_{30}GL_{30}$	$MH_{15}GL_{45}$	SEM	p-values
Haematological parameters							
Packed cell volume (%)	21 - 35	32.50^a	24.50^b	31.50^a	24.00^b	1.43	0.025
Haemoglobin (g/dL)	7 – 15	11.27^a	8.65^b	10.50^a	9.00^b	0.35	0.002
Red blood cell ($x10^{12}$/L)	9.2 -13.5	11.50^a	10.10^b	11.25^a	9.90^b	0.25	0.016
White blood cell ($x10^9$/L))	6.8 - 20.1	7.05	5.85	6.00	6.75	0.05	0.130
Neutrophil (%)	17 – 52	35.00	40.83	35.50	37.00	0.94	0.088
Serum parameters							
Total protein (g/dL)	6.7 – 9	8.05^a	8.05^a	6.65^b	6.05^b	0.29	0.002
Glucose (mg/dL)	48.2 – 76	86.50^a	84.05^a	71.60^b	72.00^b	2.08	<0.001
AST (U/L)	60 – 280	115.00^a	109.00^b	104.00^b	105.00^b	1.34	<0.001
ALT (U/L)	15.3 -52.3	75.00^a	73.00^a	66.00^b	52.00^c	2.73	<0.001
ALP (U/L)	30-120.7	74.00^a	49.27^d	56.00^c	62.50^b	2.77	<0.001
MDA (U/L)	-	4.56^a	4.05^b	3.42^c	3.32^c	0.16	<0.001

[abcd] Means on the same column having different superscripts are significantly different, ***AST**- Aspartate aminotransferase,* ***ALT**- Alanine aminotransferase,* ***ALP**- Alkaline phosphatase,* ***MDA**- malonaldehyde*

Discussion

Several medicinal plants have been used as non-nutritive feed additive in the diet of ruminant to mitigate methane production and improve nutrient utilization (25, 26). However, little information is available on the use of some of these plants as nutrient source in diet of animals so that the nutritive and the medicinal values of the plants can be fully explored. Guava leaves as evaluated in this study contained appreciable levels of nutrients and plant secondary metabolites such as tannin, saponin, flavonoids, alkaloids and glycosides. The high organic matter and moderate crude protein content discovered in guava leaf was similar with values reported in previous studies (3, 4). The high fibre content of guava leaf as observed in this study shows its potential to improve rumen function and digestion. (27) established that guava leaf can be used as dietary source of protein, carbohydrate and fibre. Guava leaf is rich in essential minerals such as Calcium, Potassium, Iron and Manganese. This was in agreement with the previous study (28) who also reported higher concentration of these minerals in guava leaf. Minerals are critical for bone development, haemoglobin synthesis and immune functions in animals (29).

The use of guava leaf as a component of diets in this study improved the nutritional values of the diets as most of the nutrients increased with increased in the levels of guava leaves in the diets. Similar observation has been reported (12). Meanwhile, all the diets met the protein requirement (10-12%) for proper growth of sheep and goats (30). The high fibre content of the diets indicates adequate fibre necessary for proper rumen function. Tannin and flavonoids contents increased with increase in the proportion of guava leaf in the diet. This is because guava leaves are naturally rich in these compounds.

The performance of any livestock depends on the dry matter intake which could be influenced by nutrient composition of the diet and the extent of diet digestibility (31). The dry matter and neutral detergent fibre intakes of animals in this study reduced with increase in the level of guava leaves in the diet. This could be due to the bitter and astringent taste of guava leaves which may be as a result of anti-nutritional factors such as tannin and flavonoids it contained. This finding was in agreement with the observation by (32) when diet of goats was supplemented with leaves and whole plant of *Andrographis paniculata*. However, the range of dry matter intake observed in all animals across the treatments was similar to the range (325.81 – 432.79 g/day) reported by (33) when goats diet was supplemented with *Ficus infectoria* leaves. Meanwhile, the crude protein intake increased slightly as the proportion of guava leaves increased in the diet. High crude protein content of guava leaf may be responsible for this. The higher daily weight gain and the lower feed conversion ratio observed in animals fed 15% and 30% guava leaves may be due to higher crude protein and ash digestibility recorded in these animals which may be responsible for the efficient feed utilization by the animals on the treatments. High amount of phenolic compounds in the guava leaves with known antioxidant activity (34) may contribute to the positive growth response observed in the animals.

The results obtained agreed with the report of (35) who observed improved body weight of West African dwarf goats fed guava leaves mixed with corn offal. Similarly, (36) also confirmed improved milk yield and immune response when grazing Damascus goats were fed dry guava leaves as supplement.

The dry matter digestibility of animals placed on 30% and 45% guava leaf diets was reduced compared to the control. This may be ascribed to the effect of the phytochemical in GL which might have affected the population of microorganisms involve in feed degradation. Meanwhile, higher crude protein digestibility recorded in animals fed 15% and 30% GL may be as a result of moderate tannin content at this level of inclusion which might have protected the protein from being degraded in the rumen and hence improved its utilization in the true stomach. (37), discovered better digestibility of dry matter and crude protein when guava leaves were included in the diet of dairy cattle compared to jack fruit leaves.

Assessing the blood haematology and serum biochemistry are important parameters to evaluate the use of non-conventional feed ingredients and their effects on health status of animals. The haematological parameters (packed cell volume, white blood cells, red blood cells and haemoglobin) measured in this study were within the normal range recommended by (38) for healthy West African dwarf goats. This indicates a healthy blood profile suggesting that the guava leaf supplementation is not negatively impacting these key haematological parameters related to oxygen transport. It also means that the goats did not develop anaemia or having issues with red blood cells production or function. Serum levels of proteins and albumin are valuable in reflecting the health of hepatic cells. Serum protein, albumin and globulin values of the goats fed the control and GL supplemented diets were within the normal range indicating no detrimental effect of the plant metabolites. Similar globulin levels obtained across the treatments indicated that the animals were not affected by a disease that would cause an excessive production of antibodies through gamma globulin production (39) as gamma globulin form a major component of antibodies. The lower glucose level obtained in goats fed 30% and 45% guava leaves diets was in order as guava leaves have beneficial health effects related to the modulation of blood sugar level (40). Studies have shown that guava leaf extract can enhance glucose tolerance by influencing various metabolic pathways (41). Addition of guava leaves in the diet of WAD goats reduced aspartate aminotransferase, alanine aminotransferase, and alkaline phosphate in the blood; this showed that guava leaves promote proper functioning of the liver and kidney due to their antioxidant and anti-inflammatory properties which help protect the organs from being damaged. According to (42), phenols have capacity to hinder specific enzymes that cause inflammation and to prevent diseases. (43) established the potential of guava leaves as vital materials in food and health industries due to its remarkable antioxidant, antidiabetic, anti-inflammatory and hepato-protective effects. The decrease in the Malondialdehyde (MDA) content with increase in GL inclusion may be due to high phenolic content and antioxidant activity of guava leaves (43) compared to Panicum hay. High level of Malondialdehyde in the blood is a sign of oxidative stress because it is a by-product of lipid peroxidation; a process that produces free radicals that can damage cell membranes.

Conclusion and Applications

1. Guava leaves contained appreciable amount of nutrients and bioactive compounds with total phenol and flavonoids being the most abundant
2. Inclusion of guava leaves in the diets improved the nutrient composition of the diets
3. Goats fed diets containing 15% and 30% guava leaves had the best daily weight gain and feed conversion ratio
4. Inclusion of 15% and 30% guava leaves in the diet improved the crude protein and ash digestibility in West African dwarf goats
5. Guava leaves reduced the levels of liver enzymes (aspartate aminotransferase, alanine aminotransferase, and alkaline phosphate) and malonaldehyde in West African dwarf goats
6. It is therefore recommended that guava leaves can form up to 30% of the diet of West African dwarf goats to reduce oxidative stress and improve performance.

Acknowledgement

The authors are grateful to Tertiary Education Trust Fund for its financial support.

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