soursop leaf and pumpkin pulp Diets Concerning Performance, nutrient utilizationand blood Blood constituentsProfileofgoatsGoatsfed different inclusion levels of soursopleaf powder in diets containingfluted pumpkin pulp

Abstract

The study wasWeconducted toassessed growth performance, nutrient utilization, and blood constituents ofgoats goats-fed diets containing fluted pumpkin pulp and different proportions of soursop leaf powder.Twenty We used twenty-four West African dwarf female goats of about 7 to 8 months old with an average initial body weight ofand 7.00 ± 0.15kg were used for the study. They were randomly allotted to four dietary treatments and each treatment waswith three replicatesdthree times withof two goats'per replicateeach in a completely randomized design. The compared diets contained; 6% dried fluted pumpkin pulp withoutsoursop leaf powder that served as the control group(Control, PPM_1), 6% dried fluted pumpkin pulp with 2% soursop leaf powder(SLP_2), 6% dried fluted pumpkin pulp with 2.5% soursop leaf powder(SLO_3), and 6% dried fluted pumpkin pulp with 3% soursop leaf powder (SLW_4). In all diets examined,The results showed that diet $PPM_1$was significantly ($P<0.05$) higher in feed conversion ratio, digestibility of ether extract, gross energy intake, total nitrogenand energy output, creatinine, urea, serum enzymes, total cholesterol, and low low-density lipoprotein.Goats in diet $SLOP_3$were revealed bettersignificantly ($P<0.05$) betterin final, total and &daily body weight gain,dry matter, crude protein and crudefibrefiberdigestibility, nitrogen retention, digestible and metabolizable energy, packed cell volume, haaemoglobin, red and white blood cells, serum total protein, albumin, glucose, and high high-density lipoprotein. However, fFeed and nitrogen intake, as well as triglycerides,indicated significant ($P<0.05$) higher values indiet SLW_4. No significant ($P>0.05$) difference was found in initial body weight, metabolizability, globulin, eosinophils, monocytes and basophils.It can therefore be concluded that uUsing 6% dried fluted pumpkin pulp with 2.5% or 3% soursop leaf powder in diets enhanced nutrient utilization for better performance and health status of goats.

Keywords: *blood, goats,* soursop leaf, *pumpkin-pulp,performance,pumpkin-pulp,* soursop leaf*blood,goats*.

Introduction

Goats have been identified to play a crucial role in nutritional security for supporting mankind in increasing animal protein availability for human sustainability. Theirbiological values and domestic demand as the choicest milk and meat for consumers have been ranked higher than sheep and cattle [1]Therefore, the need to increase goat productionis a consequence of its capacity to generate income and improve the living standardsof rural subsistence-farming communities [2]Thedegree to which goats survive to marketable age is one of the key indicators fortheir efficientproductivity. However, nutritional constraints remain a concern, because ~~it~~they limit~~s~~;animal digestion,and growth rate and weaken animals against parasitic and infectious diseases that bring about high mortality.Tropics experience seasonal dry periods thatdecrease~~d~~ the quantity and quality of available forages for ruminant livestock. Goats raised in thistropical region are predominantly faced with nutritional stress, due toa decrease in the quality of grazing pastures[3]Conventional feeds that supplement poor forages areexpensive as a result of high grain prices and less diversified animal feeds. One possible way to mitigate this incessant challenge ravaging ruminant livestock production is to explore alternate feed resources that are not consumed by man butcan be used as feeds for livestock.

Fluted pumpkin (*Telfairiaoccidentalis*) belongs to the genus *Cucurbita* and the family of *Cucurbitaceae*.The pulp is a by-product of the pumpkin seed which is relatively abundant,most especially inareas where they are produced. Thefluted pumpkin pulp is beneficial and economical as a feed resourcefor animals that provide considerable benefits to goat farmers [4]However, the inclusion of natural additives to poor quality feeds is currentlyused by most rural farmers to improve better sustainability of goat farming in Nigeria.They have valuable potentials that are profitable in theaspect of boosting the immune system, biodegradable and biocompatible[5]

Soursop *(Annona muricata)* belongs to the family of *Annonaceae.* It is aherbplant that hasgoodnatural multiple nutritive values with secondary metabolites that justify its application as phyto-additive[6]It also possesses great potential~~s~~as anti-microbial and anti-inflammationswith bioactive components that modulate rumen to regulate micro-flora for better digestion and inhibition of lipids[7]However, there is relatively little information regarding the effect of soursop leaf powdersupplementation on feed utilization and performance of goats. Thus, the study was designed to determine the effect of soursop leaf powder on growth, nutrient retention, and blood constituents of ~~goats~~ goats-fed diets containing dried fluted pumpkin pulp.

Materials and Methods

Location of study

The study was conducted at the Small Ruminant Unit of the Livestock Teaching and Research Farm of Ambrose Alli University, Ekpoma.The area lies on longitude 6.09^0E and latitude 6.42^0N within the humid climatic zone of Nigeria. The average annual rainfall and temperature of the region are about 1556mm and 31^0C respectively, whilethe relative humidity of the lactation is about 78%on average~~ly~~.

Experimental diets

Green maturedsoursop leaf was obtained from their naturally growing plantwithin the Teaching and Research Farm environment. They were ~~air~~ air-driedunder a~~well~~ well-ventilated shed until the leaves were crispy to the touch~~,~~ while retaining their greenish coloration. Thereafter, they were milled to pass through a 0.15mm sieve to obtainsoursop leafy powder and stored inairtight bags at room temperature. Matured harvested fluted pumpkin fruits were cut open~~ed~~, and seeds and pulp were separately removed before pulp was ~~sun~~ sun-dried and crushed intoa fluted pumpkin pulp meal. However, soursop leaf powderand fluted pumpkin pulp meal with other feedingredients were used to prepare the supplementary diets as ~~showed~~ shown in Table, 1. Succulent elephant grass obtained within the farm was choppedto small lengths of about 4 to 5cm and served asa basal diet. The basal and supplementary diets were offered in a ratioof 60: 40 to the animals respectively. The prepared supplementary diets were composed as follows;PPM_1(6% dried fluted pumpkin pulp withoutsoursop leaf powder and served as the control group), SLP_2(6% dried fluted pumpkin pulp with 2% soursop leaf powder),SLO_3(6% dried fluted pumpkin pulp with 2.5% soursop leaf powder),andSLW_4(6% dried fluted pumpkin pulp with 3% soursop leafpowder) were the inclusion levels in differenttreatment diets

Table 1.Gross composition (%DM) of the supplementary diets

Ingredients	Treatment Diets			
	PPM_1	SLP_2	SLO_3	SLW_4
Wheat offal	47.00	44.00	41.00	38.00
Dried brewers grain	33.00	32.50	32.00	31.50
Rice bran	5.00	8.00	11.00	14.00
Dried flutedpumpkin pulp	6.00	6.00	6.00	6.00
Broken bean /husk	5.50	4.00	4.00	4.00
Soursop leaf powder	-	2.00	2.50	3.00

Bone meal	2.00	2.00	2.00	2.00
Vitamin premix	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00

Animal and management;

~~Twenty~~ Twenty-four West African dwarf female goats of about 7 to 8 months old~~with an averageinitial body weight of~~and 7.00 ± 0.15kg were used~~ for the study~~. On their arrival, they were confined for a preliminary period of fourteendays to allow them ~~adapted~~ to adaptto the environment and dewormed~~treated~~ against internal and external parasites. After the quarantine period, goats were randomly allocated to the four treatment diets giving six animals per treatment~~s~~. Thus, each treatment was replicated three times with two goats per replicate in a completely randomized design. They were housed in individual semi-open partitioned pens,equipped with feeders, water troughs, and sawdust that was changed twice weekly. Diets that were offered to each goat twice daily(8:00~~am~~ a.m.and 4:00~~pm~~p.m.) were calculated ~~on the basis of~~based on 5% dry matter of their body weight. The ratio of the basal diet of elephant grassto each of the supplementary diets was used to determine the proportion of each diet that was offered to the goat.The amount of diet supplied to each animal was adjusted daily based on the voluntary intake ofthe animal with an estimated leftover of 15%. They also had free access to drinking water and the duration of the experiment was 90 days exclusive of the 14 days ofacclamation.

Experimental procedures and measurements

Growth performance

The average daily feed intake was determined by the difference between the amount of feed offered and leftovers. ~~Initial~~ The initial body weight of goats ~~were~~ was weighed and recorded at the onset of the experiment. Subsequently, weekly weights using themeasuretech® hanging scale. Weeklyweights were taken ~~prior to~~before morning feeding to estimate change in body weight. Total body weight was obtained by the difference between the final and initial body weight. The average daily weight gain was calculated from the weekly weight ~~in~~ of individual goats over the entire period of the trial. However, daily feed intake with body weight gain was used to calculate the feed conversion ratio.

Nutrient digestibility, nitrogen retention, and energy metabolism

~~Growth~~ The growth study was preceded by a ~~14~~ 14-day metabolic trial to determine the apparent nutrient digestionof the diets. Three goats with similar body weights were randomly chosen from each treatment group and housed separately in individual metabolic cages designed for feeding, and watering with separate collections of f~~a~~eces and urine. Feed offered, leftover, voided f~~a~~eces, and urine were collected and recorded daily for~~the duration of~~ 14days, which includes 7 days of total collection after a 7-day~~of~~ adaption period. Thereafter, a sub-sample of about 10% of the total fe~~a~~cal output was bulked, properly mixed, and pooled for each animal beforebeing stored in a plastic container in the freezer (-20%) for later analysis. Urine from each animal was also collected in a plastic containercontaining 100 ml of 3.6 mol/L H_2SO_4.The collected urine was strained through a layer of grass wool to remove detached hair fragments and other solid contaminants. The volume was measured and then diluted to 5 L using tap water and a sample of 20 ml was collected~~,~~and pooled for each animal to prevent loss of nitrogen due to volatilization beforebeing stored at -20^{0}C for total nitrogen determination. Nutrient Digestibility(ND) of the diet was calculated for dry matter, crude protein, crude ~~fibre~~fiber, ether extract, ash, and ~~nitrogen~~ nitrogen-free extract from each treatment diet using the equation proposed by [8]

$$ND\ \% = \frac{\text{Total amount of nutrients in feed} - \text{Total amount of nutrients in f\sout{a}eces}}{\text{Total amount of nutrients in feeds}} \times 100$$

Nitrogen and energy retention were calculated by standard procedures outlined for direct estimation of animal digestion [8]Nitrogen balance was determined as the differences between nitrogen intake and nitrogen excreted from f~~a~~eces and urine. The nitrogen retention percentage was estimated from the nitrogen balance expressed as a percentage of nitrogen intake.

~~Gross~~ The gross energy (GE) of the diets, f~~a~~eces, and urine were measured using an adiabatic bomb calorimeter (C200, IKA Works Inc. Staufen, Germany). The GE intake was calculated as the GE of the feed in dry matter multiplied bythe dry matter (DM) of the feed intake, while f~~a~~ecal energy (FE) output was determined as the GE of the f~~a~~eces in DM multiplied by the quantity of the f~~a~~eces in DM. Urineenergy (UE) output was determined as the GE of the urine in DM multiplied by the quantity of the urine in DM. Digestible energy (DE) intake was calculatedas the difference between GE intake and FE output divided by GE intake expressed as a percentage.

Metabolizable energy (ME) was determined by 82% of DE intakes as reported by[9]Themetabolizability (qm) was calculated as ME/GE for each treatment diet [10]

Blood collection and analysis

After the metabolic trial, 10ml ofblood sample was collected from each goat the following day through jugular venipuncture, using disposable heparinised heparinized syringes into sterilized evacuated collection tubes before morning feeding. Sub-samples of 5ml were drawn into labelled sterilized universal bottles containing ethylene diamine tetra-acetic acid(EDTA)as an anti-coagulant to determine haematological traits. Packed cell volume (PCV) was determined with wintrobe's Wintrobe'smicro-haematocrit while red blood cell (RBC) and white blood cell (WBC) were determined with improved Neubauerhaemocytometer while differential counts of the WBC such as lymphocytes, eosinophils, neutrophils, monocytes, andbasophils were determined by making differential smear using wright stain and percentage. The haemoglobin concentration (Hb) was determined using the cyano-methaemoglobin method. The erythrocytic indices, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscularhaemoglobin concentration (MCHC) were computed as described by[11]

The other 5ml sub-samples were transferred into anti-coagulant coagulant-free plastic tubes andgently inverted a couple of times, kept in an ice box to allow coagulation at room temperature. They were later centrifuged for 15 minutes at 890xg at 4^0C and maintained for 8 hours in the refrigerator at 4^0C prior tobeforebiochemical analysis and separation of supernatantserum. The plasma was also transferred to a storage tube and labelled with the date and animal identification and stored at -20^0C until analysis.

The biochemical constituents of the serum samples estimated included total protein and albumin that were analyzed by using commercial kits (Biuret method, chemelexChemelex, SA Barcelona), but globulin was calculated by subtracting albumin from total protein serum. Ureain serum samples were wasestimated using the diacetylmonoxime method, creatinine was determined by the Jaffe reaction method while and blood glucose was obtained by enzymatic colorimetric test. All analyses followed the procedures described by[12] Serum glutamate oxaloacetate transaminase (SGOT), Serum glutamate pyruvate transaminase (SGPT), Alanine aminotransferase (ALT), Aspartate aminotransferase (AST),total cholesterol,high high-density lipoprotein (HDL) andtriglyceride concentrations were measured using procedures given by Green Cross MS in Korea as described by [13] Thelowlow-density lipoprotein (LDL) and very low low-density lipoprotein (VLDL) were calculated usingequations below as presented by [14]

$$LDL = \text{Total cholesterol} - (HDL + VLDL)$$

$$VLDL = \frac{\text{Triglycerides}}{5.}$$

Chemical analysis

Dry matter was determined by drying the fluted pumpkin pulp,soursop leaf, feed, orts, and f~~a~~ecal samples in an air-forced oven at 135^{0}C for 2 h [15]; crude ash content was measured by placing the samples into a muffle furnace at 550^{0}C for 24h. Nitrogen was determined using the Kjeldahl method, using selenium as a catalyst [15], and crude proteinwas calculated using the formula 6.25 x N. The ether extract was measured by calculating the weight loss of the dry matter on extraction with diethyl ether using the soxhlet extraction apparatus for 8 h [15] Crude~~fibre~~ fiberwas determined using Tecator Line (FT122 Fibertee TM). The concentra~~c~~tion of phytate was determined according to Fredlund *et al.* (1997). Total tannin was determined colorimetrically as described in [15]while total saponin and oxalates were also quantified using colorimetry [15].

Statistical analysis

Data generated from growth, digestibility, nitrogen, and energy retention as wellas blood constituents were subjected to analysis of variance using the general linear model (GLM) procedure ~~of~~[16] to determine the effects of the treatment diets on parameters. Where significant difference occurs, means were separated by Duncan's multiple range test[17]

Results

In the feed ingredients examined (Table 2), soursop leaf powder (SL) recorded a higher content of crude protein, ether extract, and ~~nitrogen~~ nitrogen-free extract but relatively lower~~in~~ash values as compared with dried flutedpumpkin pulp (FPP) and elephant grass(EG). However, FPP recorded higher values in dry matter and ash~~than values obtained in SL and EG~~, while EG had the highest crude ~~fibre~~ fibercontent than other feed ingredients. All treatment diets were variable according to types and varying levels of feed ingredients used. Treatment diets SLP_2, SLO_3,and SLW_4 had higher and similar values for dry matter, crude protein, ether extract, and ~~nitrogen~~ nitrogen-free extract than PPM_1. On the other hand, crude ~~fibre~~ fiberand ashwere relatively higher in dietPPM_1 ~~than diets SLP_2, SLO_3 and SLW_4~~. Above all, oxalate and phytate showed no remarkable difference among feed ingredients and treatment diets. However, diet PPM_1 had the lowest content ~~in~~ oftannin and saponin~~than other treatment diets, SLP_2, SLO_3 and SLW_4~~.

Table 2: Proximate and phytogenic composition(%DM) of dried fluted pumpkin pulp meal,souroup leaf powder, elephant grass,and treatment diets of goats.

Feed ingredients	Treatment diets

	FPP	SL	EG	PPM_1	SLP_2	SLO_3	SLW_4
Dry matter	90.67	87.46	85.04	69.8	75.9	77.8	79.3
Crude protein	3.05	13.98	8.62	10.5	11.2	11.4	11.9
Ether extract	2.03	2.10	1.09	1.78	2.21	2.01	2.46
Crude fibre	19.49	7.53	31.04	33.0	31.9	32.4	30.1
Ash	9.36	5.79	7.41	6.98	5.59	5.19	4.92
Nitrogen free extract	54.74	58.06	35.88	48.1	49.3	48.9	50.1
Phytogenic components							
Tannin	0.68	0.82	0.76	0.87	1.32	1.71	1.56
Saponin	0.79	0.94	0.72	0.49	0.81	0.85	0.89
Oxalate	0.23	0.19	0.58	0.66	0.66	0.53	0.75
Phytate	0.19	0.30	0.51	0.54	0.59	0.67	0.73

FPP = Fluted pumpkin pulp, SL = Soursop leaf, EG = Elephant-grass

There were noticeable significant (p<0.05) differences in mean values for feed intake of goats on the treatment diets (Table 3). Diet SLW_4 appeared higher in value, followed by SLO_3 and SLP_2 compared to ~~thevalue obtained for~~PPM_1. However, an initial body weight ~~that ranged between 7.09 and 7.20kg in values for goats~~ did not show any significant differences~~(P>0.05)~~ among diets.~~Addition~~ The addition of 2.5~~%~~and 3%~~of~~soursop leaf powder in diets indicated highersignificant values (P<0.05) in the fin~~i~~al body weight of goats~~ than diet with2% soursop leaf powder and control diet~~. ~~Inclusion~~ The inclusion of test ingredients in diets consequently improvedthe total body weight gain of goats significantly (P<0.05), with the highest value recorded in SLO_3 and the lowest in ~~those on~~ PPM_1.Daily weight gain was significantly (P<0.05) increased witha progressive increase in levels of soursop leaf powder in the experimental diets, butthe feed conversion ratio showed fairly high values in goats onthe control diet as compared with diets with soursop leaf powder.

Dry matter digestibility was significantly (P<0.05) higher invaluesobservedfor goats on test diets (SLP_2, $SLOP_3$,and SLW_4) than the control diet (PPM_1). Goats placed on diets $SLOP_3$ and SLW_4 had higher crude protein digestibility as compared with those on diets $PPM_1$and SLP_2 ~~that~~which showed similar and lower significant (P<0.05) values~~ among treatment diets~~. Digestibility of crude fiber was ~~found to be~~significantly (P < 0.05)highest in ~~diet~~ SLO_3 followed by diets SLW_4 and SLP_2 compared to diet PPM_1 ~~that~~ whichrecorded the lowest value. The control diet hada higher significant (P<0.05) value in ether extract digestibility~~ than values obtained on other test diets~~. Digestibility of ash varied significantly (P< 0.05) in goats on different treatment diets, with test diets being higher in values~~ than value recorded for goats on control~~

group. However, nitrogen nitrogen-free extract values that ranged between 65.47 and 74.52% followed the same pattern of variation as noticed in the digestibility of ash.

Table 3: Effect of soursop leaf powder on growth and nutrient digestibility of goats fed diets Containing fluted pumpkin pulp meal

Parameters	Diets				SEM ±
	PPM_1	SLP_2	SLO_3	SLW_4	
Feed intake(g/day)	239.01[c]	252.64[b]	254.00[b]	265.02[a]	1.02
Initial body weight (kg)	7.20	7.14	7.09	7.18	0.09
Final body weight (kg)	9.14[b]	9.89[b]	10.11[a]	10.01[a]	0.15
Total weight gain (kg)	1.94[c]	2.75[b]	3.02[a]	2.83[b]	0.03
Daily weight gain (g/day)	27.71[c]	39.29[b]	43.14[a]	40.43[a]	0.58
Feed conversion ratio	8.63[a]	6.43[b]	5.89[c]	6.56[b]	0.07
Nutrient Digestibility (%)					
Dry matter	68.94[b]	71.82[a]	73.05[a]	72.28[a]	0.57
Crude protein	67.75[b]	70.93[a]	71.72[a]	70.96[a]	0.64
Crude fiber	60.97[c]	67.44[b]	70.03[a]	69.95[b]	0.59
Ether extract	63.58[a]	54.44[b]	51.43[b]	50.77[b]	0.48
Ash	55.22[c]	60.23[b]	67.56[a]	66.02[a]	0.61
Nitrogen free extract	65.47[c]	69.14[b]	74.52[a]	72.38[a]	0.79

[a,b,c] Means in the same row with varying superscripts differ significantly ($P < 0.05$).

The inclusion of soursop leaf powder toin diets affected nitrogen retention in goats (Table 4). Nitrogen intake was relatively higher in goats on test diets and significantly ($P< 0.05$) lower in the control diet. Nitrogen excreted in faaeces and urine (g/day) werewas significantly ($P< 0.05$) lowerin goats who that consumeddiets with soursop leaf powder as compared with those oncontrol diet. Total nitrogen output was highest significantly ($P< 0.05$) in diet PPM_1, followed by SLP_2, and lowest indiets SLO_3 and SLW_4. Furthermore, nitrogen balance (g/day) and retention (%) were found to be significantly ($P< 0.05$) higher in goats that consumed diets SLO_3 and SLW_4 than those fed on diets SLP_2 and PPM_1.

Energy utilization was also influenced by different proportions of soursop leaf powder in diets (Table,4). Differences were registered significantly ($P<0.05$) in gross energy intake in goats among treatment diets. Higher values were recorded for PPM_1, followed by SLP_2 before SLO_3 and SLW_4 that which had lower values. However, a remarkable differencewas also pronounced significantly ($P<0.05$) for faecal energy output in goats placed on diet PPM_1 than diets SLP_2, SLO_3 and SLW_4. Urinary energy was considerably lower in goats fed diets SLO_3

and SLW$_4$ as compared with those fed with diets PPM$_1$and SLP$_2$.Total energy output values that ranged between 798.97 and 1196.27(MJ/g/day/DM) followed the same trends as faecaland urinary energy, although their values were not strictly comparable. Digestible and metabolizable energy intake values appeared higher significantly (P<0.05)in goats on test diets (SLP$_2$, SLO$_3$, and SLW$_4$) than goats placed on control group (PPM$_1$) that had lower values. Metabolizability indicated no significant difference (P>0.05) betweenvalues (0.28-0.49 qm)registered in diets.

Table 4: Nitrogen retention and energyutilization of goats fed diets containing different inclusion levelsof soursopleafpowder.

Parameters	**Diets**				
	PPM$_1$	**SLP$_2$**	**SLO$_3$**	**SLW$_4$**	**SEM ±**
Nitrogen (N) intake (g/day	10.50^b	11.2^a	11.4^a	11.7^a	0.11
Faecal N-output (g/day)	3.00^a	2..35^b	2.01^b	2.24^b	0.03
Urinary N-output (g/day)	1.01^a	0.94^b	0.56^b	0.74^b	0.02
Total N-output (g/day)	4.01^a	3.29^b	2.57^c	2.98^c	0.04
N- balance (g/day)	6.49^c	7.91^b	8.83^a	8.72^a	0.06
N-retention of intake (%)	61.81^c	70.63^b	77.46^a	74.53^a	0.98
Energy ((MJ/g/day/DM)					
Gross energy	3948.25^a	3686.54^b	3299.79^c	3169.48^c	1.20
Faecal energy	979.84^a	799.92^b	696.42^c	701.55^{bc}	0.87
Urinary energy	216.43^a	168.49^b	102.55^c	134.22^c	1.05
Total energy output	1196.27^a	968.41^b	798.97^c	835.77^c	0.92
Digestible energy	1353.29^c	1566.03^b	1972.38^a	1790.91^a	1.73
Metabolizable energy	1109.70^c	1284.15^b	1617.35^a	1468.55^{ab}	0.99
Metabolizability (qm)	0.28	0.35	0.49	0.46	0.24

[a,b,c] Means in the same row with varying superscripts differ significantly (P < 0.05)

Haematological parameters of goats were significantly (P<0.05) influenced by treatment diets except foreosinophils, monocytes, basophils, and mean corpuscular volume that were not affected (P>0.05)as pointed out in Table 5. However,packed cellvolume (27.01-31.01%), haemoglobin,(5.01 -7.02 g/dl) and red blood cell(5.47-6.10x10^6/ml) values appeared to be higher in goats on test dietsSLP$_2$, SLO$_3$, and SLW$_4$ as compared with those on control dietPPM$_1$. Goats on diets SLP$_2$, SLO$_3$, and SLW$_4$ had higher values of white blood cellsthan the value recorded in goats on diet PPM$_1$.Lymphocyte and neutrophil values were highest in diets SLO_3 and SLW_4, followed by SLP_2 and PPM_1~~that~~ whichhad the lowest values. Mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration values were found to be improved in goats on diets with soursop leaf than those on diets without soursop leaf powder.

~~Remarkable s~~Significant($P<0.05$) differences were observedin all serum biochemical indices of goats except globulin~~that~~ whichwas unaffected ~~($P>0.05$)~~ by the treatment diets. Total protein and albumin values registered for goats on diets withsoursop leaf powder were significantly($P<0.05$) better~~than those on control group~~. Glucose and triglyceride values ~~that ranged from 62.49 to 72.01g/dl and 20.23 to 22.99 g/dl respectively~~were highest in animals placed on diets SLO_3 and SLW_4, followed by SLP_2 before PPM_1~~that~~ whichappeared to be the lowest. There were significant ($P<0.05$) variations in creatinine and urea among treatment diets, these variations were higher ~~in animals on~~ in the control group than those that were offered test diets.

Table 5: Mean values for haematological, serum biochemical, and lipid profile of goats fed experimental diets.

Parameters	Diets				
	PPM_1	**SLP_2**	**SLO_3**	**SLW_4**	**SEM ±**
Haematological indices					
Packed cell volume (%)	27.01[b]	29.45[a]	31.01[a]	30.98[a]	0.64
Haemoglobin (g/dl)	5.01[b]	6.79[a]	7.02[a]	6.95[a]	0.05
Red blood cell ($x10^6$/ml)	5.47[b]	6.04[a]	6.10[a]	6.08[a]	0.07
White blood cell ($x10^6$/ml	5.98[c]	7.98[b]	8.62[a]	8.43[a]	0.09
Lymphocytes (%)	43.67[c]	50.62[b]	54.96[a]	52.87[ab]	0.76
Eosinophils (%)	2.19	2.35	2.08	2.31	0.08
Neutrophils (%)	40.01[c]	45.96[b]	49.55[a]	47.02[a]	093
Monocytes (%)	0.25	0.42	0.61	0.58	0.03
Basophils (%)	0.30	0.37	0.41	0.45	0.02
MCV (fl)	34.01	34.58	34.95	34.70	0.67
MCH (pg)	7.99[c]	9.98[ab]	10.16[a]	10.07[a]	0.55
MCHC (%)	30.89[b]	31.95[a]	32.07[a]	32.01[a]	0.86
Serum biochemical indices					
Total protein (g/dl)	6.52[b]	6.89[ab]	7.39[a]	7.06[a]	0.05
Albumin (g/dll)	2.79[b]	3.45[a]	3.65[a]	3.40[a]	0.03
Globulin (g/dl)	3.55	3.44	3.74	3.66	0.04
Glucose (mg/dl)	62.49[c]	68.72[b]	72.01[a]	70.11[a]	0.79

Triglyceride (mg/dl)	20.23[b]	22.57[ab]	22.90[a]	22.99[a]	0.62
Creatinine (mg/dl)	1.07[a]	0.86[b]	0.73[b]	0.70[b]	0.01
Urea (mg/dl)	12.75[a]	8.62[b]	7.85[c]	7.09[c]	0.45

[a,b,c] Means in the same row with varying superscripts differ significantly (P < 0.05), MCV= Mean corpuscular volume, MCH = Mean corpuscular h~~a~~emoglobin, MCHC = Mean corpuscular h~~a~~emoglobin concentration.

As indicated in Table 6, are results for serum enzymes and lipid profile of goats feddiets containing soursop leaf powder and fluted pumpkin pulp.Animals placed on diets with test ingredientssystemically decreased significantly (P<0.05) in mean values for serumglutamate oxaloacetate transaminase (SGOT) and serum glutamate pyruvate transaminase (SGPT)~~-than those animals on control diet~~. ~~In this same view, a~~Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) ~~that ranged from 19.67 to 25.99 and 60.01 to 69.83(U/L)~~followed the same pattern of variation as observed for SGOT and SGPT.

Total cholesterol values recorded for goats in this study were significantly (P<0.05) varied by treatment effect, goats on diets with 2.50% (SLO_3) and 3.00% (SLW_4) soursop leaf powder inclusion were significantly (P< 0.05) lower than goats on diets without soursop leaf powder (PPM_1) and 2% inclusion of soursop leaf powder(SLP_2). However, ~~high~~high-density lipoprotein (HDL) was increased significantly (P< 0.05) across treatment diets as soursop leafy powder inclusion levels were increasing progressively in test diets. On the other hand, ~~low~~ low-density lipoprotein (LDL) values decreased significantly (P< 0.05) as the addition of soursop leafy powder ~~was increasing~~increased in the treatment diets of goats.~~It is worthy to note that, v~~Very ~~low~~ low-density lipoprotein (VLDL) values were not significantly ~~(P>0.05)~~ influenced by treatment diets in this study.

Table 6: Effect of soursop leaf powder inclusion onserum metabolites and lipid profiles of goats fed diets containing fluted pumpkin pulp~~.~~.

Parameters	Diets				
	PPM_1	**SLP_2**	**SLO_3**	**SLW_4**	**SEM ±**
Blood serum enzymes					
SGOT (U/L)	45.04[a]	32.83[b]	32.01[b]	31.03[b]	0.87
SGPT (U/L)	20.21[a]	16.32[b]	15.95[b]	15.28[b]	0.39
ALT (U/L)	25.99[a]	20.85[b]	19.93[b]	19.67[b]	0.46
AST (U/L)	69.83[a]	62.53[b]	60.47[c]	60.01[c]	0.74
Lipid profile					
Total cholesterol (mg/dl)	70.03[a]	65.27[b]	62.13[c]	61.99[c]	0.96
HDL (mg/dl)	30.96[c]	33.57[b]	35.72[a]	36.01[a]	0.85
LDL (mg/dl)	35.02[a]	27.21[b]	21.58[c]	21.32[c]	0.45
VLDL (mg/dl)	4.05	4.51	4.58	4.60	0.07

[a,b,c] Means in the same row with varying superscripts differ significantly ($P < 0.05$). SGOT = Serum glutamate oxaloacetate transaminase, SGPT = Serum glutamate pyruvate transaminase, ALT = Alanine aminotransferase, AST = Aspartate aminotransferase, HDL = ~~High~~ High-density lipoprotein, LDL = ~~Low~~ Low-density lipoprotein, VLDL = Very ~~low~~ low-density lipoprotein.

Discussion

Proximate composition and anti-nutritional factors of fluted pumpkin pulp, soursop leaf powder, and elephant grass were comparable with range values reported in literature by[4]; [7]; [18]respectively~~.~~. The phytogenic levels in these plant~~s~~species were considered low and safe with regards to phytogenic poisoning critical values of 7.3 – 9.0mg/g noted by [19]. Variationsobserved in the nutrient content of treatment diets could probably be due to the reflection of different feed components that supplied nutrients to diets. However, it was interesting to know that crude protein values recorded in dietswere above the 8% CP minimum value required for goat maintenance [20]

The test ingredient seems beneficial as it was able to reduce the level of ~~anti~~ anti-nutritional factors and possibly increase the ability of the animals to properly modify and improve feed efficiency for better nutrient supply, absorption, and utilization by animals. This resulted in higher significant final, total, and average daily weight gain in animals on thetest diets.This inference was ~~in~~ consisten~~cy~~t with the earlier report by [18] that efficient feed utilization by animals ~~supply~~ suppliesan adequate balance of nutrient~~s requirement~~ requirements at the site of metabolism for heavy weight gain. Daily weight gain values recorded in the work was comparable with the mean value(38.64g/day) reported by [21]The obvious variation in daily feed intake at similar growth stage of the animals could be related to the type as well as physical nature of diet components, length of time spent on diet and acceptability with other unknown contributing factors of the feeds. It is worth~~yto mention~~mentioning that the feed conversion ratio (FCR) ~~that~~ whichmeasures feed intake per unit weight gain was lowest in diet $SLOP_3$, indicating better feed efficiency. However, the higher weight gain and FCR recorded in diets with test ingredientsattest to the superiority of the diets.

~~In accordance with~~Following the previous findings, digestibility in goats is governed by many factors that includethe nature and quality of feeds, level of feed intake, salivary secretion, manner of rumen fermentation, and flow rate in gastro-intestine [18] The improvement obtained in dry matter digestibility might be channe~~l~~led to unlimited nutrient from greater proportion of forage grass that was compensated with appreciable percentage of supplement diet. This nutrient availability could havepossibility possibly stimulated the activity of cellulolytic rumen floral for better feed ingested and digestibility. The higher crude protein digestibility in test diets showed that phytogenic bioactive components in the test ingredient did not cause harmful effects on the activities of rumen bacteria but improved digestibility. This is in harmony with a previous study of by[21]who observed that secondary components in diets suppress rumen degradation to enhance appreciable quantity of protein availability in post-rumen digestion. Likewise,fibre fiberdigestion in test diets thatcould be linked to the modulation effect that appeared to favourthe proper functioning of rumen ecology for high fermentable cell wall fractions and digestibility of fibrefiber. This was earlier observed by [20], who stated that easily digestible features in feeds increase the activity of rumen rumen-degrading microbes that break fibre fiberfeed constituents to provide energy for themselves and host animals.Interestingly, it was apparent that the addition of soursop leaf powder to diets was inversely proportional to the digestibility of ether extract. The reason for this inconsistency could presumably depend on the bioactive ingredients in the diets that could have disrupted the activity of enzymes reaction in the rumen by forming an indigestible complex for oil oil-degrading components..Notwithstanding, there were wasa considerable increasein the digestibility of ash and nitrogen nitrogen-free extract in goats on test diets. This observation further affirmed the positive interaction effect of the feed components that were found to enhance nutrient availability for effective digestion. The low digestion in almost all nutrients in the control diet could be traced to an inhibition of digestive enzymes activity by anti-nutritional factors in fluted pumpkin pulp and their interactions with fibre which adversely reduced cell wall carbohydrates as demonstrated in goats on diet with no soursop leaf powder.

The discrepancy noticed in values of nitrogen intake could mainly be attributed to the difference in contributory effects of the dietary components that tends to increase the protein content of test diets. However, the high numerical values of faecal, urinary, and total nitrogen excreted in the control group could be as a result of the rapid breakdown of dietary protein to ammonia which increased nitrogenous excretion[8].It is worth pointing out that all diets in the study had positive nitrogen balance, explaining treatment diets were tolerated with the provision of adequate protein requirement for the animals. The higher nitrogen retention noticed in diets with 2.5 and 3% soursop leaf powder inclusion, could be connected to the presence of optimum anti-microbial effects that delay rumen protein degradation by suppressing bacteria population and made makingdenatured protein absorbed and utilized in the intestine by animals for maintenance and production purposes [22]Nitrogen retention values obtained in this work were within the reference values reported by[23]

The observed increment in gross energy (GE) intake in the control diet could perhaps be linked with the ingestion of the feed components that hada measureable effect on energy concentration. This possibly ~~explained~~ explainsthe excessive amount of GE intake by the animal to meet ~~up~~ with energy requirements for their body's physiological activities. The higherfaecal, urinary, and total energy output noted inthe control diet, further buttressed the imbalanced level of energy catabolism that was associated with poor energy utilization in the diet. The improved digestible energy values in animals on test diets showed that the phytogenic components in the feeds were ~~activity~~ activeto make nutrients~~availably~~availablefor efficient feed utilization and reducedfaecal energy. Metabolizable energy (ME) is often used as a sensitive yardsticks for the determination of the overall energy intake of feed and measures the metabolic sum of the process of digestion, absorption,and utilization of feedin the energy unit [24]. Thus, the efficiency with which higher ME was retained and utilized for growth in animals on test diets was influenced by low energy loss as heat. This low heat increment was a function of nutrientadequacy in feeds that gave better ME which was expressed in higher weight gain. However,this depends on the interaction of two ~~principle~~ principalfactors; the nature of the chemical compounds in which ME was contained and the purpose for which these compounds were used by the animals. The similar values of metabolizability(qm) ~~has~~ havelaid credence to the work reported by [25]who noted that qm of complete feed is relatively constant and equivalent to about 0.96 MJ/g/day DM.

Blood examination is a scientific way of screening and assessing thenutritional and health status of an animal. Thus, haematology providesan opportunity to clinically investigate the presence of several metabolic needs and other constituents in the body of animals [26]Packed cell volume (PCV) is an indicator of blood volume or blood dilution that may result from the toxic substance, while haemoglobin (Hb) and red blood cell (RBC) measure the ability to withstand some levels of respiratory stress and oxygen carrying capacity. The positive comparative values of these indices showed that animals were in normal healthy condition and not anaemic. Mean corpuscular volume,mean corpuscular haemoglobin, and mean corpuscular haemoglobin concentration values that explainthe bone marrow capacity for blood cells production and diagnosis of anaemia were correlated with PCV, Hb, and RBC obtained in this study. This further explains the quality of the balancedfeeds that had no adverse effect on blood and health status. White blood cell (WBC) improvesthe immune system,antibodies antibodyproduction, and disease disease-fighting ability of the animal. The immune response of animals in this studywere wasnot negatively affected by test feeds as showed in their values that tallies with average value ($7.68x10^3/m^3$) for goats as reported by[26]Theresults of neutrophils and lymphocytes for white blood differential counts imply that goats on these diets had the tendency oftended not being susceptible to microbial infection or disease condition. While lLow values of monocytes, eosinophils, and basophils were indications that their immune system were not challengedwithbytoxic substances present in the test feeds. However, their values showed good resistance to diseases and did not portend any danger, since they fell within the normal range values of 10-50% neutrophils, 40-75% lymphocytes, 1-5% monocytes, 1-8% eosinophils and 0-3% basophils [11]

The higher serum total protein and albumin concentration obtained in animals on diets with soursop leafpowder could be traceable to low content of secondary compounds and availability of better nutrient utilization that were able to supply an adequate digestible amount of protein needed to make nitrogen available for rumen microbes. Consequently,this increased protein absorption in the intestine that whichis responsible for maintaining normal serum protein levels in animals. However, total protein and albumin values obtained in this study, were in line with average range values of 7.02 and 3.18 g/dlrespectively,earlier noted by[23]Thisindicates that antianti-nutritional factors in test diets could not reduce nutrient absorption but proposed intact health hepatic cellular functions. The constant globulin values observed, could probably be due to the goats' adaptation to stress thatwhichmade themdisease disease-free and causedan excessive production of antibodies through gamma globulin production[12]It might be logical to say that the favourable role of test feeds gave way to increased soluble carbohydrate for metabolic efficiency in the stomach which modulated nutritional metabolism. This might probablybe translatedto the improvement in serum glucose and triglyceride that was linked tothe increment in body weight gain of the animals. The low creatinine levels in serum, suggests no muscle or tissue wastage and animals did not survive at the expense of their body reserves. This is proportional to the low urea levels with positive nitrogen balance observed in animals on test diets, reflecting the superiority of the dietary protein that was efficiently utilized and did not cause excessive protein catabolism that is associated with protein deficiency. [27] noted in the literaturethat urea tests measure the amount of nitrogen in the serum and high serum urea level is an indication of kidneydysfunction because protein intake and kidney functioning are affected by the quantityof blood urea nitrogen.

Serum enzymes are found in practically every tissue of the animalbody, inducing red blood cellsthat are highly concentrated in cardiac muscle and liver intermediate in skeletal muscle and kidney but much lower concentration in other tissues [28]Theirmeasurements are helpful for diagnosis and following cases of myocardial malfunction, hepatocellular disease and skeletal muscle disorders. They are excellent markers of hepatic liver damage caused by exposure to toxic substances [22]The reference values of SGOT (14.0 to 123 U/L), SGPT (15 to 44 U/L), ALT (10.3 to 53.3 U/L) and AST (43 to 230 U/L) reported by Adebayo*et al* (2019); Chen *et al*. (2015) for goats were within the recorded values obtained in this study. These normal physiological serum enzymeslevels imply that the phytogenic bioactive components in the test diets had no debilitating effect on the liver of the animals. Kim *et al*. .(2012), asserted that the clinically significant risk of serum enzymes activities above normal range is an aberration and indication that animals may suffer from liver diseases. Moreover, the clear low values of serum enzymes, creatinine, and cholesterol in conjunction with urea observed in this study could be conventionally used as tools to show that the test ingredients did not interfere with renal and hepatic functions, explaining the absence of damage in the liver and myocardial.

The residual effect of tannin and saponin in the test diets could be responsible for the scavenging effect of free radicals in the blood that suppressed serum as expressed in low cholesterol. Okoruwa (2021), observed that a cholesterol level of 180mg/dl and below may not result in arteriosclerosis, hence the values registered in this work suggestthat a safe concentration for good animal health. The increased levels of highhigh-density lipoprotein cholesterol noted in animals on test diets further attest to the good effect of the feeds that could prevent peripheral artery disease and arteriosclerosis. Ugochukwu *et al.* (2003) found that low and very low low-density lipoproteins are considered as bad cholesterol because theretheirhigh levels can cause a build build-up of cholesterol in arteries. However, the reduction of their concentration levels in the test diets could be attributed to high dietaryfibrefiberutilization and the presence of secondary metabolites which could possibly depress hepatic activities of lipoemic and cholesterol enzymes.

Conclusion

The study discovered that feeding dried flutedpumpkin pulp with different proportions of soursop leaf powder asa dietary supplement to goats can serve as a potential alternative feed that will provide a more practical approach in totheir feeding regime. Thus, it is expected that this alternative feedcan go a long way in making animal protein available at affordable prices to an average Nigerian and also reduce competition between man and ruminant livestock for feeds, most especially during the dry season.

~~It can therefore be concluded that,~~The efficacy of processing fluted pumpkin pulp and soursop leaf powder in the study diets reduced~~anti-~~ anti-nutritional factors and provided phytogenic components. This increases nutrient utilization as demonstrated in greater feed ingestion capacity with nutrient digestibility that consequently improved health status and body tissue build-upas seen in growth performance without any negative effect in goats. However, the response in terms of goat~~s~~ improvement ~~were~~ wasmore pronounced in diets that contained 6% dried flutedpumpkin pulp with 2.5~~%~~ or 3% soursop leaf powder (SLO_3 and SLW_4)

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