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Influence of Ensiled Guinea Grass-Cassava Peels Enriched With Soybean Waste on Performance of West African Dwarf (WAd) Goats

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ABSTRACT

The study was conducted to investigate the effects of ensiled guinea grass (GG)- cassava peel (CSP) enriched with soybean cheese waste (SBCW) in varying proportions into 4 treatments: T1 (GG100%), T2 (GG80% + CSP10% + SBCW10%), T3 (GG60% + CSP30% + SBCW10%) and T4 (GG40% + CSP50% + SBCW10%) on West African Dwarf goats. Twenty WAd goats were allocated into four silages of five growing WAd goats each. Daily feed intake and weekly weight gain were measured for twelve weeks of the experiment. Digestibility study was carried out using Three animals per treatment for faeces and urine collection. Blood samples were collected via jugular vein for blood profile analysis using standard measures in a completely randomized design. The Crude protein (CP) concentrations of silage increased with the increasing level of cassava peels. Crude fiber levels of the silages also followed the same trend. The group of animals fed T4 had highest feed intake among the treatment groups. Daily weight gain of goats in T4 was better enhanced than other treatments. The apparent digestibility was significantly different ($P<0.05$) among the treatment groups**.** There were diet effects on the parameters measured for rumen liquor of the animals fed silages. The treatments had no effects on the haematology and total protein of goats fed diets. It is therefore indicated that agro-industrial by-products ensiled with guinea grass are potential means of feed sustainability during the dry season period for goats in Nigeria without any deleterious effects on goats' health and performance.

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Introduction

Given the estimated population of 34.5 million goats (Abdu et al., 2012), the importance and advantages of small ruminants cannot be over looked. It plays an important role both in the economy and in the food chain of the nation by increasing animal protein intake of Nigerian and other developing countries (Ogunbosoye et al., 2018). Goats are animals which can survive under inclement weather and low quality native pasture. They can be reared by low income small holder farmers for their sustainability and to create wealth. Nevertheless, the production and performance of these animals are still not encouraging and below their genetic potential. Their performance has been truncated by the inadequate availability of sustainable feed resources during the dry season and as those standing pasture were lignified. The animals were either left with crop residues, browse plants and probably some conventional feed resources, which may be too expensive for ruminant feeding. The low-quality feed results in reduced feed intake, poor digestibility, reduced production (growth, milk production, reproduction) and inability to resist the prevailing diseases among other things. The poor nutrition during pregnancy could also be responsible for low birth rate, high mortality percentage, abortion, longer weaning weight, with the resultant effect on long parturition interval in goats.

Feed is an essential aspect of livestock production, and has tremendously gained attention to enhance livestock productivity. In the past, efforts have been made to improve feed utilization through many methods (Abegunde et al., 2021). Insufficient amount of crude protein in the daily feed intake of ruminants could result into unhealthy functioning of micro-organisms in the rumen, thereby hindering the production of microbial protein for rumen maintenance and the overall growth of the animal (Dereje, 2012).

However, the poor native pasture could be enriched and preserved into silage with the cheap, noncompetitive agro-industrial wastes that are available all the year. Cassava peels

and soybean cheese waste are such non-toxic wastes to ruminants, generated at every period of the year in which their production is so much in that if not utilized may cause environmental hazard, making the surrounding unbearable to live and unhealthy to mankind. According to FAO (2019), world cassava production was at about 278 million, Nigeria being the largest producer in Africa. The tons in Nigeria increased from 10.2 million tonnes in 1970 to 59.2 million tonnes in 2019 growing at an average annual rate of 4.02%.

Soybean cheese waste is high in protein and other nutrients that when incorporated in the ruminant feed could improve the nutrient profile of the feed enhance, feed intake and will hence improve the overall performance of such animals. The feed scarcity being encountered during the lean period of the year will be alleviated, suggesting life improvement and more income to the low income small holder farmers and the animal wellbeing itself. The information on the silage made in combination with guinea grass, cassava peels and soybean cheese waste is not documented and therefore the focus of this research is the Performance of WAd goats fed guinea grass-cassava peels silage enriched with soybean cheese waste as means to mitigate feed shortage during the lean period of the season in Nigeria.

Materials and Methods

Experimental Site

The experiment was conducted at the Small Ruminant Unit of the Teaching and Research Farm, Department of Animal production during December and March period, Fisheries and Aquaculture, Kwara State University, Malete Lat 8º71′N and Long 4º44′E (Ogunbosoye et al., 2015) Moro local government, Kwara State, Nigeria at the peak of the dry season.

Material collection and silage production

The experimental materials consisted of Guinea grass, cassava peels and soybean cheese waste. Fresh guinea grass was harvested manually with knives from existing pasture at the Teaching and Research Farm. Fresh cassava peels and soybean cheese waste were obtained from garri processing factory and soybean cheese processors in Shao, Kwara State.

Silage preparation

The harvested guinea grass was wilted overnight to reduce the moisture content and chopped to reduce the size for ease of compaction. Fresh cassava peels were also chopped immediately after collection. The soybean cheese waste SBCW) was squeezed with a cheese cloth immediately after collection to reduce the moisture content and to prevent spoilage. The grass, cassava peels and soybean cheese waste were weighed according to treatments (Table 1), mixed, and well compacted to be filled individually in a 120 liters capacity plastic used as storage silos. The storage silos were lined with white and black polythene. Silos were compacted and consolidated to exclude any air present in the silo. This is to secure an anaerobic condition. They were closed airtight and sand bags were placed on each silo (Ogunbosoye et al., 2016).

Management of experimental animals

The experiment lasted for twelve weeks. Prior to the arrival of the animals, the pens were cleaned and disinfected. The animals were acclimatized for two weeks in order to adjust to the environmental conditions prior to the commencement of the experiment. During this period, they were subjected to prophylactic treatment to get rid of any infection. At the end of the adaptation period, goats were randomly assigned to each of the four treatments and balanced by body weight. Each treatment was replicated five times with one goat per replicate in a Completely Randomized Design (CRD). Daily feed intake and weekly weight were the parameters measured during the growth study

Chemical analysis

Silages were analyzed for crude protein, crude fibre, ether extract, and ash, according to standard methods AOAC (2012). 200g were taken from each of the silos and oven-dried to a constant weight at 65°C. The dried samples were milled through a 1mm sieve and crude protein was determined with micro Kjeldhal distillation apparatus. Neutral detergent fibre (NDF), acid detergent, fibre (ADF), and acid detergent lignin (ADL) were determined according to the Van Soest (1995) method. Hemicellulose was calculated as NDF-ADF while Cellulose was calculated as subtraction of ADL from ADF.

Rumen liquor collection

At the end of growth study, the goats were denied of feed the previous night but water was served ad-libitum. 100ml rumen fluid was collected from the West African Dwarf (WAd) goats using stomach tube, sieved with a four layered muslin cloth into a beaker. The pH meter was placed in the beaker to estimate pH level. 2ml of 25% metaphosphoric acid was introduced into 10 ml of the liquor to inhibit further fermentation and frozen at -10º C. Another 10 ml of rumen liquor was measured to frozen to estimate rumen microbial population. Ammonia nitrogen concentration and volatile fatty acids (VFA) of the liquor were determined by adding 25 ml of metaphosphoric acid in equal, centrifuged at 4000g proportion to the rumen liquor. 0.5 ml supernatant was taken and added to 0.5 ml of 20 Mm valeric acid. VFA was determined according to the procedure of Ebrahim et al. (2017) while NH3-N was measured accordingly (Al Khalasi et al., 2010).

Table 1. Composition of four different silages made from guinea grass, SBCW and cassava peels (%) for the experiment

Composition	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Guinea grass (GG)	100	80	60	40
Cassava peel (CSP)	0	10	30	50
Soybean cheese waste (SBCW)	0	10	10	10
Total volume	100	100	100	100

Table 2. Chemical composition (%) of ensiled guinea grass-cassava peels enriched with Soybean cheese waste

Treatment	DM	CP	CF	ASH	EE	NDF	ADF	ADL	HEM	CELL
T1	51.2^{a}	4.18^{d}	13.95^{a}	11.00^{a}	4.00^{c}	22.00^{c}	15.00^{b}	8.46^{a}	7.00^{c}	6.54^{d}
T2	42.4^{b}	6.01^{c}	13.16^{b}	11.00^{a}	5.00^{b}	25.00^{b}	17.00^{a}	8.48^{a}	9.00^{b}	8.52^{b}
T3	34.4^{c}	7.60^{b}	12.12^{c}	9.00^{b}	4.00^{c}	26.00^{a}	14.00^{c}	6.50^{b}	11.00^{a}	7.50^{c}
T4	32.8^{d}	7.70^{a}	12.12^{c}	8.00^{c}	6.00^{a}	18.00^{d}	15.00^{b}	5.00^{c}	3.00^{d}	10.00^{a}
SEM	3.33	2.37	3.33	0.33	0.33	0.33	0.33	0.17	0.33	0.17
P values	<0.0001	<0.0001	<0.0001	0.00043	0.008	<0.0001	0.0001	<0.0001	<0.0001	<0.001

GG- Guinea grass, CSP- Cassava peels, SBCW- Soybean cheese waste, DM- Dry matter, CP- Crude protein, CF- Crude fibre, EE- Ether extract, NDF- Neutral detergent fibre, ADF- Acid detergent fibre, ADL- Acid detergent lignin, HEM- Hemicellulose, CELL- Cellulose, T1 (GG100%), T2(GG80% + CSP10% + SBCW10%), T3(GG60% + CSP30% + SBCW10%), T4 (GG40% + CSP50% + SBCW10%). Letters with different superscripts along the same column are significantly difference (p<0.05), SEM standard error of means

Table 3. Growth performance parameters of West African Dwarf goats fed ensiled guinea grass-cassava Peels Enriched with Soybean cheese Waste

Parameters	T1	T2	T3	T4	S.E.M	P values
Initial weight (kg)	9.00	9.2	9	9.13	0.69	0.996
Final weight (kg)	10.39^{a}	11.06^{ab}	12.30^{ab}	13.13^{b}	0.86	0.162
Weight gain (kg)	1.39^{a}	1.86^{a}	3.3^{b}	4.00^{c}	0.20	<0.0001
Daily weight gained/day (g)	15.43^{a}	20.65^{a}	36.65^{b}	44.45^{c}	2.24	<0.0001
Silage intake, DMI (g)	271.75^{a}	282.25^{ab}	313.25^{ab}	340.50^{c}	20.52	0.129
Wheat bran intake (WI) (g)	209.0^{a}	216.75^{a}	254.50^{ab}	287.75^{b}	15.58	0.0133
Total feed intake(g/day)	480.75^{a}	499^{a}	567.75^{ab}	628.25^{b}	34.82	0.041
Feed conversion ratio	31.99^{c}	24.24^{b}	15.49^{a}	14.16^{a}	1.65	<0.0001

abc means on the same row with different superscripts are significantly different (P < 0.05) CSP = Cassava peels, GG= Guinea grass, SBCW- Soybean cheese waste. T1 (GG100%), T2 (GG80% + CSP10% + SBCW10%), T3 (GG60% + CSP30% + SBCW10%), T4 (GG40% + CSP50% + SBCW10%)

Digestibility and Nitrogen Balance

At the end of the feeding trial, twelve (12) goats from the twenty (20) used for the growth study were randomly selected for determination of digestibility of the diets. The experiment lasted for 14days, for collection for Separate faeces and urine. The animals were fed at 08:00hours daily. Feed was served 3% of the body weight of the animals. Three animals randomly selected from each treatment were individually housed in metabolic cages designed for separate collection for Separate faeces and urine. The animals were allowed 7 days adjustment period in the metabolic cages before the commencement of the data, which lasted for another 7 days. The daily urine collected was strained and 10% kept in the plastic containers containing two drops of sulfuric acid to inhibit microbial growth and prevent nitrogen loss by volatilization and stored in the refrigerator pending nitrogen determination. The total faecal output was also collected daily, weighed and sub sampled for chemical analysis. Apparent nutrient digestibility and nitrogen utilization were determined.

Blood collection

Samples of blood were collected from the animals at the end of the growth trial to analyze for haematological and biochemical components. Blood samples were taken before morning feeding via jugular vein puncture into two blood collection bottles. One containing an anticoagulant (Disodium salt of ethylene diamenetetracetic acid (EDTA)) and the other with no anticoagulant from which serum was harvested for biochemical analysis. Packed Cell Volume (PCV), Haemoglobin (Hb), red blood cell (RBC) and total white Blood Cells (WBC) were determined. Mean Corpuscular volume (MCV), Mean Corpuscular haemoglobin (MCH) and Mean Corpuscular haemoglobin concentration (MCHC) were calculated from PCV, Hb and RBC.

Serum biochemical parameters measured include: Glucose, Total protein, Albumin, Blood Urea Nitrogen (BUN), Aspartate Aminotransferase (AST) and Alanine Aminotransferase (ALT). These parameters were determined using the routine standard clinical chemistry procedures (Odhaib et al., 2018)

Statistical analysis

Data obtained for all determined parameters were subjected to one-way ANOVA and differences between treatment means were separated by least significance difference by using General Linear Model procedure of Statistical Analysis System (SAS, 2003).

Results and Discussion

Results

Chemical composition of the experimental feeds

There were significant (P<0.05) differences in all the measured parameters (Table 2). The crude protein (CP) of the silage increased while ADL decreased with increasing level of cassava peels.

Animal performance on the experimental feeds

The result shows that feed intake increased with the inclusion of CSP and SBCW (Table 3). The total feed intake ranged significantly (P<0.05) from 480.75- 628.25g in goats fed ensiled GG100% and ensiled 50%CSP + 10%SBCW respectively. The final body weight (kg) of WAd goats on the different silages were significantly different (P<0.05) from each other with the goats fed ensiled 50%CSP+ 10%SBCW having the highest value (13.13kg). Goats fed silage with 50%CSP+ 10%SBCW showed the best body weight gain (44.45g/day) while animals on silage with GG100% was the least (15.43g/day). Feed conversion ratio (FCR) was significantly (P<0.05) improved for goats fed ensiled 50%CSP+ 10%SBCW compared to other treatment group.

Digestibility of experimental feeds

The apparent digestibility (% DM) of the feeds indicated significant difference (P<0.05) in the dry matter digestibility with ensiled GG100% (77.23%) being the highest while GG40%+CSP50%+SBCW10% had the lowest 63.08% (Table 4). The CP digestibility also differed (P<0.05) significantly among treatments. The silage from GG100% had the least CP digestibility value while CSP30%+SBCW10% and CSP50%+SBCW10% silages had 48.23% and 61.41% respectively. Digestibility of NDF were significantly different (P<0.05) among the treatments, the value ranged from ensiled CSP50%+SBCW10% (36.87% lowest) to CSP30%+SBCW10% (49.8% highest). Digestibility of ADL varied from the least (26.09%) for CSP50 %+SBCW10 % to highest (46.95 %) in GG100 % silage.

In Table 5, the nitrogen utilization of WAd goats fed guinea grass cassava peel silage enriched with soybean cheese waste was reported. The mean values obtained varied significantly (P<0.05) among the treatments. Nitrogen intake increased progressively significantly from T1 (2.86 g/day) to T4 (6.12g/day). Nitrogen balance values observed to be significantly higher in T4 group than the other treatments.

Rumen liquor fermentation characteristics

There were significant diet effects on the parameters measured of the rumen liquor of the WAd goats fed ensiled guinea grass – cassava peels enriched with soybean cheese waste (Table 6). Goats fed diets T3 and T4 had higher (p < 0.05) ruminal pH value compared with other treatments although, group of animals in T4 produced highest pH concentration. The NH_3- N and total volatile fatty acids (TVFA) concentrations increased as the cassava peels inclusion increases but there was no significant difference in the concentration of TVFA between the goats fed T2 and T3. Goats fed diets T4 had the highest (p < 0.05)) value of acetic acid and butyric acids production among the treatments.

Blood profiles of the goats fed silages

The health status of animal performance was assessed through haematological and serum biochemistry analysis (Table 7). The animals under this study did not give any sign of illness all through the period of this experiment. The haematological parameters of West African Dwarf goats fed ensiled guinea grass- cassava peels enriched with soybean cheese waste showed no significant (P>0.05) differences in all the parameters measured. The glucose varied significantly among the treatment means (P<0.05). The glucose values ranged from lowest GG100 % (43.02 mg/dl) and highest (110.97 mg/dl). There was no significant difference among the total protein (P<0.05). The Blood Urea (BU) varied significantly among treatment means (P<0.05) with the value highest in T1(11.40mmol/l). The Albumin values ranged from GG100% (5.41 g/l) to 50%CSP+ 10%SBCW (7.69 g/l). The ALT values were significantly different and ranged from 30%CSP+ 10%SBCW (24.75 µ/l) to 10%CSP+ 10%SBCW (35.75). The AST values ranged from ensiled 30%CSP+ 10%SBCW (69.98) to T4 50%CSP+ 10%SBCW (77.45 µ/l).

Table 4. Apparent Digestibility (%) of West African Dwarf goats fed ensiled guinea grass-cassava peels silage enriched with soybean cheese waste.

Nutrients	T1	T2	T3	T4	S.E.M	P values
DDM	77.23^{c}	70.21^{b}	66.46^{ab}	63.08^{a}	2.30	0.0057
DCP	34.25^{a}	39.65^{b}	48.23^{c}	61.41^{d}	2.31	<0.0001
NDF	39.70^{a}	44.58^{b}	49.8^{c}	36.87^{a}	2.32	0.01
ADL	46.95^{c}	31.37^{b}	44.31^{c}	26.09^{a}	2.30	<0.0001
DEE	59.12^{b}	56.03^{b}	56.62^{b}	52.33^{a}	1.79	0.112
DASH	45.65^{c}	41.09^{b}	31.75^{a}	32.91^{a}	1.58	0.0001
DCF	40.27^{a}	42.29^{ab}	45.84^{b}	42.62^{ab}	2.06	0.334
ADF	50.54^{a}	36.60^{a}	38.43^{a}	36.80^{a}	2.39	0.0039
DHEM	39.62^{a}	47.50^{b}	55.92^{c}	37.05^{a}	1.99	<0.0001
DCELL	37.14^{a}	51.76^{b}	55.94^{b}	39.97^{a}	4.97	0.0564

a,b,c,d means with the similar superscript along the same row are not significantly different (p<0.05).DDM- Dry matter digestibility, DCP-Crude protein digestibility, NDF- Neutral detergent fibre, ADL- Acid detergent lignin, DEE- Ether extract digestibility, DASH- Ash digestibility, DCF- Crude fibre digestibility, ADF- Acid detergent fibre, DHEM- Hemicellulose digestibility , DCELL- Cellulose digestibility. CSP = Cassava peels, GG= Guinea grass, SBCW- Soybean cheese waste

Table 5. Nitrogen utilization (g/day) of West African Dwarf goats fed ensiled guinea grass-cassava peels enriched with soybean cheese waste.

Parameters	T1	T2	T3	T4	S.E.M	P values
Nitrogen Intake	2.86^{a}	3.49^{b}	4.03^{c}	6.12^{d}	0.25	<0.0001
Faecal Nitrogen	1.49^{a}	1.27^{a}	1.18^{a}	1.86^{b}	0.17	0.0688
Urinary Nitrogen	0.63^{a}	1.17^{b}	1.50^{c}	1.44^{c}	0.12	0.0009
Nitrogen Balance	1.17^{a}	1.16^{a}	1.44^{a}	3.24^{b}	0.19	<0.0001
Nitrogen Retained	0.74^{a}	1.05^{b}	1.35^{c}	2.82^{d}	8.79	<0.0001

Letters with the similar superscripts along the same row are not significantly different (P<0.05).T1 (GG100%), T2 (GG80% + CSP10% + SBCW10%), T3(GG60% + CSP30% + SBCW10%), T4 (GG40% + CSP50% + SBCW10%) CSP = Cassava peels, GG= Guinea grass, SBCW- Soybean cheese waste, SEM- standard error of means

Table 6. Rumen liquor fermentation characteristics of WAd goats fed ensiled guinea grass with cassava peels and soybean waste

Parameters	Silage treatments					
	T1	T2	T3	T4	SEM	P values
pH	6.00^{c}	6.23^{b}	6.34^{ab}	6.41^{a}	5.57	0.17
NH_3-N mg/L	83.00^{d}	100.6^{c}	120.78^{b}	124.25^{a}	0.78	2.42
Total VFA mmol/L	73.71^{b}	70.2^{c}	75.6^{b}	80.77^{a}	0.66	2.03
Propionate	24.65^{a}	23.21^{b}	20.32^{c}	24.44^{a}	0.33	1.01
Acetate	49.65^{c}	45.44^{d}	54.11^{b}	57.76^{a}	5.60	2.07
Butyrate	1.78^{bc}	2.11^{ab}	1.43^{c}	2.32^{a}	0.16	0.51

Letters with the similar superscripts along the same row are not significantly different (P<0.05).T1 (GG100%), T2 (GG80% + CSP10% + SBCW10%), T3 (GG60% + CSP30% + SBCW10%), T4 (GG40% + CSP50% + SBCW10%) CSP = Cassava peels, GG= Guinea grass, SBCW- Soybean cheese waste. SEM- standard error of means

Table 7. Haematological and serum biochemistry indices of West African Dwarf goats fed ensiled guinea grass-cassava peels enriched with soybean cheese waste

Parameters	Treatments					
	T1	T2	T3	T4	SEM	P values
Haematological concentrations						
Packed cell volume (g/dl)	35.40	35.85	36.28	35.03	1.52	0.608
Hb (g/dl)	11.80	11.95	11.73	11.68	0.56	0.986
Red blood cell (x10^6µl)	2.15	1.52	2.33	2.22	0.28	0.215
White blood cell (x10^5 µl)	251.85	238.24	252.53	255.28	9.59	0.608
Lymphocytes (%)	96.95	97.48	97.13	97.65	0.46	0.705
Platelets	21.75	30.75	30.00	27.00	7.22	0.811
MCHC (g/dl)	26.38	27.45	26.38	29.38	1.12	0.133
Means Corpuscular volume (FI)	141.15	137.68	138.48	134.29	3.98	0.678
Mean corpuscular hemoglobin (g/dl)	37.22	37.7	36.95	39.3	1.12	0.476
Serum biochemistry indices						
Glucose (mg/dl)	43.02^{a}	83.38^{d}	91.14^{bc}	110.97^{c}	8.98	0.001
Total protein (g/dl)	11.82	9.86	9.92	10.00	0.94	0.421
Albumin (g/l)	5.41^{a}	6.24^{ab}	5.77^{a}	7.69^{b}	0.61	0.090
Blood urea (mmol/l)	11.40^{b}	4.42^{a}	4.58^{a}	4.59^{a}	1.13	0.002
Alanine aminotransferases (µl)	35.25^{ab}	35.75^{b}	24.75^{a}	35.25^{ab}	5.57	0.461
Aspartate aminotransferases (µl)	76.02	75.98	69.98	77.45	5.48	0.778

Letters with the similar superscripts along the same row are not significantly different (P<0.05).T1 (GG100%), T2 (GG80% + CSP10% + SBCW10%), T3 (GG60% + CSP30% + SBCW10%), T4 (GG40% + CSP50% + SBCW10%) CSP = Cassava peels, GG= Guinea grass, SBCW- Soybean cheese waste. SEM- standard error of means, NS- not significant

Discussion

Nutrients profile of silages

Treatment effect as observed in the CP and ADL may be the result of graded levels of cassava peels inclusion. The crude protein (CP) and Acid detergent lignin (ADL) of silages were affected by the inclusion levels of cassava peels. The improved CP in the treatment 4 will enhance multiplication of micro-organisms in the rumen thereby increase microbial protein for improved animal productivity (Al Khalasi et al., 2010).

Intake and growth rate

Animal production is largely dependent on daily rate of feed intake. The findings of this study on total feed intake significantly increased with increased CSP and SBCW is similar to other reports (Ajayi and Omotoso, 2018; Akinwande et al., 2019) for cassava peel silage. The higher intake of the silages by goats could be due to the palatability, succulent nature, improved microbial degradation and the moderate CP concentration of the silage couple with high fermentable carbohydrate (CSP and SBCW). The total feed intake was higher than 223.08-325.62g reported for goats fed silage-based diets (Okoruwa and Edoror, 2019). The low intake in GG100% could be due to low fibre degradability in the rumen. The silage and supplement intakes were higher than 264.29- 302.38 and 110.12- 165.87g reported by Olawoye et al. (2020) for WAd goats fed grass silage. The highest weight gain (44.45 g/day) of ensiled 50% CSP+ 10% SBCW suggests the availability of energy in cassava peel. The result was higher than 12.22- 21.19 g reported by Olawoye et al. (2020) for WAd goats fed grass silage. The higher weight gain obtained for group treatments in T3 and T4 could be corroborated to rapid by pass protein from the rumen and subsequent digestion and absorption in the lower gastro intestinal tracts (Akinwande et al., 2019). This was, however, notably lower than the daily weight gain (131.97-142.01 g/d reported by Dorper lamp fed Nigella seeds and Rosmarinus leaves (Odhaib et al, 2018).

Digestibility of nutrients and ruminal fermentation characteristics

Nutrient digestibility is one of the crucial tools in the assessment of nutrients that are available for ruminant nutrition. Dry matter digestibility (DMD) in the present study was however, markedly lower than 89.01- 93.95% reported by Akinwande et al. (2019) for WAd goats fed grass silage. The differences could be attributed to stage of maturity, harvesting period, preservation method of grass and the additive included in the silage. Junior Magalhaes et

al. (2016) reported that factors that can affect digestibility of DM are the type of raw material used, preparation of the diet and the studied species. Bode et al. (2019) reported that digestibility is an indication that a particular diet was palatable and digestible. The CP digestibility values were within 61.04% reported by Idowu et al. (2018) for WAd goats fed unripe plantain peels. Sayed (2009) reported that an increase in the dietary protein intake level may cause changes in the process of rumen fermentation and allow more protein digestibility. Mc Donald (2011) indicated that fibre fraction of a feed as well as the species of animal have greatest influence on digestibility. The higher apparent digestibility of all measured parameters obtained in ensiled CSP50%+SBCW10% may be an indication of better feed utilization.

Nitrogen balance and retention are methods of determining the amount of nitrogen ingested and utilized by animals (Akinwande et al., 2019). These differences were probably due to the crude protein content of the test ingredients. The values obtained in this study could be compared with 5.04-7.98% obtained by Aye (2015) for Yankasa rams fed *Moringa oleifera*, *Gliricidia sepium* and *Leucaena leucocephala* ensiled with molasses as additive. The variations in the values obtained in different studies might be due to the inclusion levels of cassava peels and soybean cheese waste. Nitrogen retained was significantly different among the treatment means. The values obtained were, however, comparable to (1.97 to 8.05) reported by Olorunnisomo (2011) for Red Sokoto goats fed elephant grass ensiled with cassava peels. Gabriel et al. (2018) in his findings stated that increased nitrogen retention is attributed to increased N available in the rumen for microbial activities. This observation could also be due to the residual anti nutrient which might be present in the feed that aided in trapping down the bypass protein

Ruminal fermentation variables obtained in this experiment showed that the diets were well utilized by the animals. There was no indication of rumen acidity because the pH concentrations of the animals in the group treatments were within the range of 6. Ruminal NH_3-N concentrations of the study were high enough to support rumen microbes for enhanced carbohydrate fermentation. This may be linked with the high percentage of fermentable carbhydrate inherent in cassava peels of the silage. It could be the reason for the high digestibility coefficient of the diet T4. The NH3-N values in this study were greater than the recommended for the optimal level for microbial protein synthesis (Wahyuni et al., 2012). The higher total volatile fatty acids production in the rumen, which is the source of energy supply to animals enhanced uptake of NH_3-N by the microbes.

Blood variables

Haematological components have been useful indicators in monitoring level of feed toxicity as it affects the blood as well as the health of animals (Ogunbade et al., 2017). When PCV value falls below normal range, it's an indication of poor quality of protein diets and results in anaemia. The PCV value obtained in the present study is within the range 22.00- 37.00% and also the value obtained elsewhere for Dorper lambs fed Nigelia and Rosmarinus leaves (Odhaib et al., 2018). It could imply that the protein content of the treatments was adequate since the PCV values were within normal range for WAd goats. The Hb values obtained are within the normal range of (9-11.70g/dl) recorded for clinically healthy WAd goats for clinically healthy WAd goats (Ikyume et al. (2018). Haemoglobin (Hb) is a blood pigment that carries oxygen. The haemoglobin concentration in the goats implies that the animals had sufficient blood pigment for proper transportation of oxygen thus, healthy living and low level is an indication of disease infection and poor nutrition. WBC counts were within the range (193.33-257.0) for WAd goats fed Cassava peels with Urea Molasses Multi nutrient Block supplements (Gabriel et al., 2018). White blood cell count is an indication of immune response to toxic substances in organism and an increase in count suggests a pathogenic infection (Olorunnisomo et al., 2012). Lymphocytes values was within the range of 96.95-97.65%. The Variations observed in MCV and MCHC between diets may not be detrimental since MCH, MCV and MCHC are referred to as RBC indices (Wada et al., 2014). It is an indication of better nutritional adequacy and safety of the ingredients in the treatments.

Serum biochemical analysis is a generalized method used to determine liver damage as well as to evaluate protein quality and amino acid requirement in animals. The values obtained for glucose were within the normal range (43-100 mg/dl) as reported by Mitruka and Rawnsley (1977) but lower than 109.00- 132.00mg/dl reported by (Adebisi et al., 2019). Nonetheless, Olorunnisomo et al. (2012) observed that serum glucose is an indication of carbohydrate metabolism in diets with high energy value and when it's lower or higher than the normal range results in hypoglycaemia and hyperglycaemia respectively. It is a metabolite used in measuring the energy status of an animal. The increased glucose value for the treatment GG60%+CsP30%+SBCW10% and GG40%+CP50%+SBCW10% may be due to the higher inclusion of cassava peels in the diet which signified that enough energy was made available for the goats for growth and they were not surviving at the expense of body tissue (Olafadehan, 2011). Serum total protein reflects the level of dietary protein and the state of health of the animal. The total protein values (9.86-11.82g/dl) examined in the goats for all dietary treatments were higher than the value 59.93-60.38mg/dl (Ogunbosoye et al., 2018) for WAd goats However, the total protein values observed were within the normal range values (5.70- 9.10g/dl) (Mitruka and Rawnsley, 1977) for goats generally. The normal level of total protein observed suggested to be related to sufficient protein in the treatments. Okukpe et al., (2015) stated that a decrease in TP may be caused by loss of protein in urine, reduced synthesis in liver and low protein intake. The Albumin value (5.41- 7.69g/dl) observed was slightly higher than normal range reported (2.70- 4.55g/dl) by Mitruka and Rawnsley (1977). Additionally, Mitruka and Rawnsley (1977) stated that the higher the value of albumin, the higher the clotting ability of blood, thus, prevents hemorrhage. The observed mean values were higher than 2.70- 3.30g/dl reported by Adebisi et al. (2019) for rams fed *Panicum maximum* supplemented with differently processed pigeon pea leaves. The concentrations of serum transaminases (ALT and AST) in the blood are reliable for liver damage tests as reported by Ogunbosoye et al. (2018). The increase in ALT and AST activity of the WAd goats fed all the treatments diets was

significant and could be adduced to improvement in liver function. The ALT is involved in the conversion of an existing keto acid into an amino acid. This takes place in the liver, red blood cells and skeletal muscle tissues. An increase in ALT indicates acute hepatocellular damage while low level may be as a result of malnutrition or liver disease (Okukpe et al., 2015).

Conclusion

From the results obtained in this study, guinea grass could be ensiled with cassava peels and soybean cheese waste and use as dry season feed for enhanced performance and sustainability of West African Dwarf (WAd) goats in the tropics without poising any health hazard on the animals, although goats fed ensiled GG40% + CSP50% + SBCW10%) performed best.

Conflict of interest

The authors hereby declared that there is no conflict of interest with any financial, personal, or other relationships with other people or organization related to the material used in the manuscript.

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