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**Nutrient Digestibility Coefficient of West African Dwarf
Goat Fed Elephant Grass (*Pennisetum Purpureum*) Ensiled
with Varying Levels of Cassava Peel and Brewers Dried
Grain.**

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ABSTRACT

Purpose: This study was designed to investigate the digestibility of West African Dwarf (WAD) goats offered Elephant grass (*Pennisetum purpureum*) ensiled with varying levels of Cassava peel (CP) and Brewers dried grain (BDG).

Methodology: Eighteen West African Dwarf (WAD) goats were used for the study. The goats were randomly assigned to six dietary treatments namely; T1 (100% Elephant grass); T2 (60% Elephant grass + 0% CP + 40% BDG); T3 (60% Elephant grass + 10% CP + 30% BDG); T4 (60% Elephant grass + 20% CP + 20% BDG); T5 (60% Elephant grass + 30% CP + 10% BDG) and T6 (60% Elephant grass + 40% CP + 0% BDG) in a completely randomized design.

Findings: Data collected revealed significant difference ($p < 0.05$) in all the chemical composition parameters except for ether extract. The highest DM (51.80%), CP (18.20%), and EE (3.85%) were observed among animals exposed to T2 diet, NDF (64.25%) and ADF (32.33%) were observed among animals in diet T1. There was no significant differences ($p > 0.05$) in all the nutrient digestibility parameters except for the crude protein and acid detergent lignin. Animals fed T2 diet had the highest DM (70.76%) and CP digestibility (76.16%), while highest NDF (65.39%) and ADL (59.51%) were recorded in animals fed T1. There were significant difference ($p > 0.05$) among the nitrogen utilization variables observed except fecal and urinary nitrogen output. Goats fed T2 recorded the highest nitrogen retention (95.55%).

Recommendation: It can be recommended that Elephant grass ensiled with cassava peel and brewers dried grain can be used as potential sources of supplementing ruminant feeding most especially during the dry season as it enhanced nutrient digestibility and utilization

Keywords: Elephant grass, WAD goats, Cassava peel, Brewers Dried grain, Silage.

1.0 INTRODUCTION

The role of goats in the socio economic lives of many West African local populations cannot be overemphasized. African goat population represents 30% of Africa's ruminant livestock and produce about 17 and 12% of its meat and milk, respectively. Going by the data from the Food and Agriculture Organization of United Nation in 2014, West African goats' population was approximately 150 million heads accounting for 14.82% of goat population in the world. Nigeria (48.34%), Mali (12.76%), Niger (9.93%) and Burkina Faso (9.27%) host a large number of goats (Dehouegnon *et al*, 2017; FAO, 2017). During the dry season, the natural pastures and crops residues available for ruminants are highly fibrous and deficient of most essential nutrients required for increased rumen microbial fermentation and improved performance of the host animal therefore results in weight loss, low birth weights, lowered resistance to diseases and over all poor performance of the animal. According to Adegbola (2002), supplementation of livestock diets with protein rich conventional ingredients has resulted in improved performance of the host animal. However, these supplements are usually not fed due to scarcity and high cost associated to them.

Forage conservation bridges the gap between the feed requirement of the animals and the production of the forages. Hay and silage are the main methods of conserving the forage (Moran, 2005). Silage production is more relevant in the tropics than hay production because it is less dependent on weather conditions than hay (Wong, 2000). Silage feeding is an effective and easily adaptable technique despite its limited application in the tropical region (Babayemi, 2009). Elephant grass (*Pennisetum purpureum*) is a high yielding tropical grass with great potentials for making silage. It is a very versatile species that can be grown under a wide range of conditions and systems: dry or wet conditions, smallholder or larger scale agriculture. It is found in most parts of the humid tropics where it is usually rejected by ruminants while grazing but readily accepted when chopped and stall-fed. It is a valuable forage and very popular throughout the tropics, notably in cut-and-carry systems (FAO, 2015). Low levels of fermentable carbohydrates in elephant grass may, however, limit its use as a silage material, hence there is need to mix with highly fermentable carbohydrates to enhance its silage value. Quality of this grass can improve with addition of a readily fermentable carbohydrate like cassava peel which is cheap and available in large quantities in Nigeria. The high starch content in cassava peel (Onua & Okeke, 1999) will also improve energy concentration in the tropical grass silage. Ensiling Elephant grass with Cassava peels has been shown to improve its acceptability and feeding value to ruminants (Olorunnisomo, 2011).

Brewery Dried Grain (BDG), which is the main waste product from beer production. The remaining product is a concentrate of proteins and fibre that is suitable for animal feeding particularly for ruminants (Crawshaw, 2004). Brewery Dried Grain has the potential to be used as source of nutrition for farm animals, in both its wet and dry forms. It is also a good source of high quality protein and its energy and fiber contents range from 21 to 33 %, on a dry matter basis (Mussatto *et al.*, 2006). Due to its high fiber content, brewer's grain is particularly useful as a supplement to the diet of ruminants (Westendorf & Wohlt, 2002). This study investigates the

nutrient intake and digestibility by West African Dwarf goat fed Elephant grass (*Pennisetum purpureum*) ensiled with varying levels of Cassava peel and Brewer's Dried Grain

2.0 MATERIALS AND METHOD Experimental Site

The research was carried out at the small ruminant unit of the Teaching and Research farm of Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Oyo State in the derived Savannah Zone of Nigeria. Ogbomoso lies at approximately 8°7' North of the equator and 4°15' East of the Greenwich Meridian. The natural vegetation is considered to be low land rainforest but under the influence of high agricultural activities comprising of a bush fallow system of farming, little high forest remains. Therefore, it is regarded as a derived savanna vegetation zone because grassy vegetation.

Silage Preparation and Quality Determination

Elephant grass (*Pennisetum purpureum*) was harvested from the arable section of the Teaching and Research farm, and wilted for 12 hours in order to reduce the moisture content. The wilted Elephant grass (*Pennisetum purpureum*) was crushed using a crusher for ease of compaction and consolidation of silages. Fresh Cassava peel was sourced from a garri processing unit around the university environs and crushed using a grinder. Brewers Dried Grain was sourced from a reputable feed mill in Ogbomoso town. The chopped grass material, crushed cassava peel and Brewers dried grain was thoroughly mixed as follows:

Treatment 1: 100% Elephant grass.

Treatment 2: 60% Elephant grass + 0% Cassava peel + 40% Brewers Dried grain.

Treatment 3: 60% Elephant grass + 10% Cassava peel + 30% Brewers Dried grain.

Treatment 4: 60% Elephant grass + 20% Cassava peel + 20% Brewers Dried grain.

Treatment 5: 60% Elephant grass + 30% Cassava peel + 10% Brewers Dried grain.

Treatment 6: 60% Elephant grass + 40% Cassava peel + 0% Brewers Dried grain.

Filling and compaction was done simultaneously to eliminate inherent air. The silage was prepared and packed in containers (plastic drums) already (lined with 20mm thick nylon sheets) in triplicate for each treatments, the final compaction was made after the container was sealed and compressed with piles of heavy sand bags in cement sacks. Fermentation was done for 56days.

After fermentation was terminated, the silage samples were opened for silage quality assessments. According to Ososanya and Olorunnisomo (2015), the assessed quality characteristics were colour, texture, aroma, temperature and pH are assessed. Immediately the silage was opened, a laboratory thermometer was inserted in order to determine the temperature. The pH of the silage was determined using a pH meter glass electrode. Colour chart was used for colour assessment using visual observation. Sub-samples from different points and depths was taken and mixed together for dry mater determination by oven drying at 65°C until a constant weight was achieved. The samples was later milled and stored in an air-tight container until it was ready for chemical analysis.

Experimental Animals and Their Management

A total number of twenty four (24) West African Dwarf goats were purchased from a reputable farm in Ogbomoso with a pre-trial body weight of 5.8-6.0 and they were housed intensively in an individual well ventilated pen. The pens were thoroughly washed and fumigated prior to the arrival of the animals. On arrival, the goats were quarantined for 30 days and during this period, they were given prophylactic treatments to ensure healthy condition of the animals. They were also treated against endo and ectoparasites and vaccinated against PPR (Pestis des petit ruminant).

Digestibility Study

In a completely randomized design using three replicates, the goats were allotted to different cages specially made for a separate collection of urine and faeces. Feed intake was determined on the following day by weighing the remnants and subtracting it from the feed served. Representative sample was obtained for dry matter and nutrient analysis. Fresh water was supplied *ad libitum* daily. Goats were adapted to the cages for 7 days and another 7 days were used for the collection of data. In the morning, before the animals were fed, the faecal output was evacuated and weighed. About 10% of each day's collection of faeces from each animal were oven dried at 65°C and was taken to the laboratory for dry matter determination. The oven-dried faeces were later bulked, milled and stored in an air-tight container pending the chemical analysis. The urine was collected in a plastic container under the cages, and 3 drops of concentrated sulphuric acid (H₂SO₄) was added to prevent the escape of the nitrogen (N) via ammonia gas. The volume of urine was weighed and recorded daily each morning. 10% of the urine collected from each animal was poured into a well-labeled urine bottle and stored in a refrigerator at about -5°C before they were taken to the laboratory for Nitrogen content analysis.

Chemical Analysis

The samples of the diets and faeces was analyzed for dry matter determination (DM%), crude fibre (CF%), ether extract (EE%), crude protein (CP%) which was calculated as Nx6.25 and ash (%) by the procedures of AOAC (2005). The fibre components including Neutral detergent fibre (NDF), Acid detergent fibre (ADF), Acid detergent lignin (ADL) was determined according to the procedure of Van Soest *et al.*, (1991).

Data Collection

Feed offered daily per animal were recorded and refusal were weighed and recorded to compute feed intake on daily basis.

Dry matter intake (g/d) = Feed intake weight basis x Dry matter of the feed/100

Nutrient intake (g/d) = Dry matter intake (g/d) x Nutrient in feed/100

Nutrient in feed was obtained from the proximate and fibre fractions analysis.

Digestibility Test and Nitrogen Utilization Study

As reported by McDonald *et al.* (2002), digestibility coefficient of nutrients were determined and calculated using the formula:

$$\frac{\text{Nutrient consumed (as feed)} - \text{Nutrient in faeces}}{\text{Nutrient consumed (as feed)}} \times 100$$

Daily urine samples from each goats were collected each morning before feeding. The urine sample collected was released into a sample bottle containing 10mls of 10% concentrated sulphuric acid to prevent the loss of Nitrogen and it was refrigerated until required for analysis. Nitrogen balance by goats was calculated as the difference between the Nitrogen intake and Nitrogen excreted from the faeces and urine while Nitrogen utilization was calculated as:

$$\text{Nitrogen utilization} = \frac{\text{Nutrient Retention}}{\text{Nutrient intake}} \times 100$$

Parameters Measured Digestibility Coefficient Calculation

Data from the chemical analysis of the feed and faeces were used for the calculation of digestibility of crude protein, crude fibre, ether extract, dry matter and ash. The figure was obtained on a dry matter basis. According to MAFF, (1993), the digestibility coefficients of the nutrients can be calculated as:

$$\text{Digestibility coefficient of the DM} = \frac{\text{Intake DM (g/d)} - \text{Faecal DM (g/d)}}{\text{Intake DM (g/d)}} \times 100$$

$$\text{Digestibility} = \frac{F_0 \times A_0 - (F_i \times A_i)}{F_0 \times A_0} \times 100$$

Where F_0 = weight of feed consumed

A_0 = % nutrient intake (i.e DM, CP, CF and EE)

F_i = weight of faeces collected

A_i = % nutrient in faeces (i.e DM, CP, CF and EE)

Using the same procedure (by replacing DM with CP, CF and EE), the digestibility coefficients of CP, CF and EE were calculated.

Statistical Analysis

Data generated from this experiment was analyzed by one way analysis of variance (ANOVA) using the procedure of SAS (SAS, 2002). The significant differences between the means was separated using the Duncan's Multiple range test of the same package at 5% probability level.

3.0 RESULTS AND DISCUSSION

The pH of Elephant Grass (*Pennisetum Purpureum*) Ensiled with Varying Levels of Cassava Peel and Brewers Dried Grain.

The pH of the silage (figure 1) was observed significantly ($p < 0.05$). The pH of the silage ranged from 3.95-5.27 with the highest (5.0) in T1 and lowest in T6 (3.95). The pH of silage were within the acceptable range of 3.5 -5.5 for good silage (Kung & Shaver, 2002; Obua, 2005; Menesses *et al.*, 2007). The acidity (pH) decreased from 3.95 to 5.27 as proportion of cassava peel in the silage mixture decreased, showing that cassava peel improved fermentation of elephant grass silage. This trend was also observed when cassava peel was ensiled with elephant grass and legume forages (Olorunnisomo, 2011; Olorunnisomo & Fayomi, 2012).

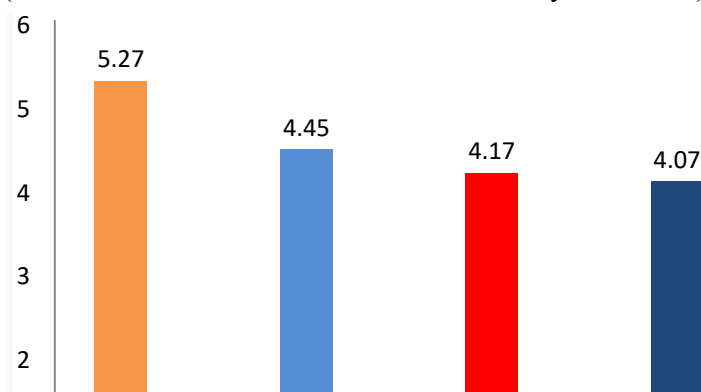


Figure 1: The pH of Elephant grass ensiled with varying levels of Cassava peel and Brewers dried grain.

T1: 100% Elephant grass.

T2: 60% Elephant grass + 0% Cassava peel + 40% Brewers Dried grain.

T3: 60% Elephant grass + 10% Cassava peel + 30% Brewers Dried grain.

T4: 60% Elephant grass + 20% Cassava peel + 20% Brewers Dried grain.

T5: 60% Elephant grass + 30% Cassava peel + 10% Brewers Dried grain.

T6: 60% Elephant grass + 40% Cassava peel + 0% Brewers Dried grain

Chemical Composition of Elephant Grass (*Pennisetum Purpureum*) Ensiled with Varying Levels of Cassava Peel and Brewer's Dried Grain

The chemical composition of Elephant grass (*Pennisetum purpureum*) ensiled with varying levels of Cassava peel and brewer's dried grain showed significant ($p < 0.05$) differences among different silages (table 1) except for ether extract and hemicellulose content. Dry matter (DM) content of the silage ranged from 25.30-51.80%, with T1 (25.30%) having the lowest DM content while T2 (51.80%) recorded the highest DM content. The dry matter (DM) (%) content of the silages increased with the inclusion of brewers dried grain in the silage mixtures. The crude protein (CP)

content of ranged between 9.95% and 18.20%. The highest CP was observed in T2 (18.20%) while the lowest CP was observed in T6 (9.95%). The CP values in the experimental treatments 1 to 6 fell within the limit of 9 to 14% recommended for growing sheep (Aduku, 2005). The CP values reported for silage diets in this study were higher than to the CP range of 8.46 to 10.72% reported by Binuomote *et al.* (2019) for elephant grass ensiled with cassava peels and poultry but lower than CP values of 23.63 and 31.46 g/kg for elephant grass ensiled with 10% wheat bran and 20% wheat bran, respectively as reported by Silva *et al.* (2014).

Crude protein in the study is above 7% CP recommended for rumen microbes of tropical livestock by Minson (1990) and Norton (2003) below which there will be a deficiency in performance. Ash content of the silage varied from 15.51-17.90%, highest in T3 (17.90%) while T4 was observed to be the lowest (15.51%). Ash content is useful in assessing the quality grading of leaves and also gives an idea of amount of mineral element present in the elephant grass. The ether extract ranged from 3.48-3.85% and were not affected significantly ($P < 0.05$) with the inclusion BDG and cassava peels. Lower values were observed compared to 7.1% and 8.0% for 4 weeks old Guinea grass and 12 weeks old Guinea grass reported by Babayemi (2009) while observed variations may be as a result of variation in grass used, additives and harvesting periods. According to the NRC (2007), the total amount of fat in the diet must not exceed 6 to 7% in the dry matter (DM), for it can bring reductions in the rumen fermentation at the fiber digestibility and its passage rate. Feedstuffs having a crude fat value of 1-2% have been found sufficient to maintain good health by reducing the risk of diseases and ageing caused by its excess consumption (Sodamade *et al.*, 2013).

The fiber contents (NDF, ADF and ADL) have impact on the digestibility of plants. The NDF is the chemical component of the feed that determines its rate of digestion. The higher the NDF, the lower the plant's digestible energy. Neutral Detergent Fibre (NDF) content of the silage ranged from 62.00-64.25%, T1 had the highest NDF content (64.25%) while T3 had the lowest NDF content (62.00%) which differ significantly across the treatments. It implies that T3 with the lowest NDF would be more digestible than T1 with the highest NDF values. ADF and ADL ranged from 29.00 to 32.33% and 12.75 to 13.60% respectively. Meissner *et al.* (1991) observed that NDF level of forage above 65% can limit feed intake. The values of the fibre fractions obtained in this study are lower than the values recorded by Oni *et al.*, (2010). The fibre fraction shows that the diets have the potentials to support intestinal movement and proper rumen function. This implies that the fibre fractions of the diet would enhance fermentation in the fore stomach of the animals. Fasae *et al.*, (2015) suggested that excess fibre fractions especially NDF reduces the rate of fermentation and reduce feed intake, but moderate fibre leads to rapid rumen fermentation and potential acidosis.

Table 1: Chemical composition (%) of Elephant grass (*Pennisetum purpureum*) ensiled with varying levels of Cassava peel and Brewers Dried grain.

PARAMETERS (%)	TREATMENTS						SEM
	T1	T2	T3	T4	T5	T6	
Dry Matter	25.30 ^d	51.80 ^a	43.10 ^b	40.00 ^{cb}	33.10 ^{cd}	29.00 ^d	2.45
Crude Protein	10.08 ^d	18.20 ^a	17.40 ^{ba}	15.40 ^b	12.65 ^c	9.95 ^d	0.72

Ash	16.90 ^{ba}	16.66 ^{ba}	17.90 ^a	15.51 ^c	15.90 ^b	16.49 ^{bc}	0.39
Ether Extract	3.50	3.85	3.55	3.48	3.65	3.60	0.17
Neutral Detergent Fibre	64.25 ^a	62.90 ^b	62.00 ^c	63.94 ^a	62.88 ^b	62.29 ^c	0.10
Acid Detergent Fibre	32.33 ^a	30.81 ^{ba}	29.00 ^c	31.70 ^{ba}	30.23 ^{bc}	30.79 ^{ba}	0.51
Acid Detergent Lignin	13.50 ^{ba}	13.35 ^{ba}	12.75 ^b	13.90 ^a	13.50 ^{ba}	13.60 ^{ba}	0.30

^{abcd} means with different superscripts along with the same row with different subscript along row differ significantly ($p < 0.05$). SEM: Standard error of the means.

T1: 100% Elephant grass.

T2: 60% Elephant grass + 0% Cassava peel + 40% Brewers Dried grain.

T3: 60% Elephant grass + 10% Cassava peel + 30% Brewers Dried grain.

T4: 60% Elephant grass + 20% Cassava peel + 20% Brewers Dried grain.

T5: 60% Elephant grass + 30% Cassava peel + 10% Brewers Dried grain.

T6: 60% Elephant grass + 40% Cassava peel + 0% Brewers Dried grain

Table 2 reveals the nutrients digestibility coefficient (%) of West African Dwarf goat fed Elephant grass (*Pennisetum purpureum*) ensiled with varying levels of Cassava peel and brewer's dried grain. The DM digestibility, Ash, Ether extract, NDF and ADF digestibility coefficient were similar as there were no significant ($p > 0.05$) differences across all the diets except for CP and ADL digestibility coefficient. The highest value for digestibility of DM has been observed in WAD goats fed T2 silage (70.76%), followed by WAD goat fed T3 (70.36%), T4 (69.23%), T5 (68.54%), T6 (67.86% and T1 silage (63.51%). The high DM digestibility indicates high palatability and acceptability of the diet. Higher values for digestibility of DM in T2 silage be attributed to the better fermentation of this diet as a result of the use of BGD and cassava peels. Cassava peels and BDG used in silage production are known to enhance nutrient digestibility, as reported by Olorunnisomo (2011) for Red Sokoto goats fed Napier grass ensiled with cassava peels

Crude protein digestibility was higher ($P < 0.05$) in T2 (76.16%) than T1 (48.91%) which may be attributed to 0% inclusion of brewers dried grain or cassava peels. Crude protein digestibility, which shows the extent to which microbial protein is made accessible to the animals daily (Kissada *et al.*, 2010), was significantly higher in T2 silage than in the others. This observation corroborates the findings of Jiang *et al.* (2015), who reported that the nutrient digestibility of diets increased with the increasing crude protein content. Low CP digestibility observed in T1 silage is probably due to the absence of additives during ensiling or low protein levels in the grass ensiled. Olorunnisomo (2011) reported the better digestibility of DM and CP in Red Sokoto goats fed elephant grass, and cassava peels silage compared to silage diets without cassava peels. The CP digestibility of the goats following the same values with DM digestibility which also was comparable with the value of 48.92 – 76.16% reported by Belewu and Fagbemi (2007) which is adequate to support the maintenance requirement, growth and performance of small ruminants but the observed lower value recorded for animals fed T6 in this study which could be attributed to

0% inclusion of brewer dried grain. CP digestibility coefficient in all the silages were all significantly higher ($P < 0.05$) than in the control. This is probably because BDG consists of more degradable components especially crude protein than elephant grass and thus could serve as supplement to the former in ruminant diets. The high level of CP digestibility recorded across the dietary treatments in the study indicates that Elephant grass ensiled with varying levels of Cassava peel and brewers dried grain in different forms could serve as potential protein supplements that will enhance the intake and utilization of low-quality grass and fibrous crop residues by ruminants.

The Ash digestibility coefficient ranged from 48.16-66.53%. The ether Extract (EE) digestibility coefficient 76.58- 81.81% of the goat were not in resonance with the range (46.15-80.00%) as observed in West African Dwarf goats fed soybean and dried poultry waste- based concentrates as supplements to ensiled *Panicum maximum* (Alikwe *et al.*, 2011) and higher than the experimented values of 52.78% obtained by Aye (2013) in West African Dwarf goats fed Elephant grass ensiled with cassava peel. This could be as a result of differences in forage used and animal factors.

Digestion in ruminant animals is highly influenced by the level of protein and fibre in the diet. A low protein concentration in the diet reduces the microbial synthesis and consequently, intake and digestibility of the diet is reduced (Olorunnisomo *et al.*, 2006; McDonald *et al.*, 2002). The quantity and nature of dietary fibre also influences microbial synthesis in the rumen. A good fibre mat must be maintained in the rumen to ensure adequate growth and activity of rumen microbes (Ishler *et al.*, 1996). NDF digestibility was higher in T1 (67.17%) than other treatment diets. Improvements in the digestibility values of DM and CP could be attributed to the positive influence of BDG and cassava peels on the rumen environment in the goats. Mixtures of brewers dried grains and cassava peels could have led to synchronized fermentability of individual chemical constituents leading to associative effects and improvements in DM intake and digestibility (Sinclair *et al.*, 1995; Rosales & Gill, 1997).

The digestibility NDF and ADF were not affected by additives used for ensiling. Neutral Detergent Fibre (NDF) digestibility of West African dwarf goats ranged between 57.64 -67.17% goes in accordance with 48.60 -79.40% reported by Okpara *et al.*, (2014). The Acid Detergent fibre ADF digestibility (42.09 -53.55%) fell within 23.80 -88.52% obtained by Alikwe *et al.*, (2011) that fed soyabean and dried poultry waste-based concentrates as supplement to ensiled *Panicum maximum*. The ADL digestibility ranged between 35.01-59.51% which was higher than the estimated value of 10.68-47.69% reported by Olorunnisomo and Ososanya (2002) that fed maize offal and sorghum brewers' grain to West African dwarf goats.

The apparent digestibility of dietary DM, ASH, EE, NDF, ADF levels were not significantly different between the treatments. Generally, the higher DM and fiber digestibility observed for all the treatments was due to the fact that the growing animals have sufficient micro-flora for efficient degradation of fibre. McDonald *et al.* (2002) indicated that fibre fraction of a food as well as the species of animal has greater influence on digestibility.

Apparent digestibility results generally indicate that in ruminant nutrition, CP and fibre are important in enhancing microbial activities in the rumen (Abegunde and Akinsoyinu, 2010). This condition was achieved with the mixture of Elephant grass, BDG and cassava peels, which showed the improved digestibility of nutrients in this study. According to Gabriel *et al.*, (2018), high nutrient digestibility by goats indicated that the diets were palatable. The higher digestibility values obtained could be attributed to the crude protein content of the diet which in turn improved the digestibility of the diet (Abdu *et al.*, 2016). More so, the dietary fibre in the supplements could be said to have no hindering effect on nutrient intake or their utilization.

Table 2: Nutrient digestibility coefficient (%) of West African Dwarf goats fed Elephant grass (*Pennisetum purpureum*) ensiled with varying levels of cassava peel and brewer's dried grain.

Parameters (%)	T1	T2	T3	T4	T5	T6	SEM
Dry matter	63.51	70.76	70.36	69.23	68.54	67.86	3.10
Crude protein	48.92 ^c	76.16 ^a	67.99 ^{ab}	63.03 ^b	58.82 ^{bc}	57.83 ^{bc}	3.74
Ash	48.16	66.53	60.14	54.05	52.18	57.39	7.94
Ether extract	76.58	81.81	79.47	79.80	81.41	81.42	2.83
Neutral detergent fibre	67.17	65.39	65.13	63.25	62.66	57.64	3.60
Acid detergent fibre	53.55	51.22	46.15	47.78	45.36	42.09	4.78
Acid detergent lignin	53.47 ^a	59.51 ^{ba}	45.57 ^{ba}	47.64 ^a	42.95 ^{ba}	35.01 ^b	5.26

^{abc} means with different superscripts along with the same row with different subscript along row differ significantly ($p < 0.05$). SEM: Standard error of the means.

T1: 100% Elephant grass.

T2: 60% Elephant grass + 0% Cassava peel + 40% Brewers Dried grain.

T3: 60% Elephant grass + 10% Cassava peel + 30% Brewers Dried grain.

T4: 60% Elephant grass + 20% Cassava peel + 20% Brewers Dried grain.

T5: 60% Elephant grass + 30% Cassava peel + 10% Brewers Dried grain.

T6: 60% Elephant grass + 40% Cassava peel + 0% Brewers Dried grain

The nitrogen utilization, nitrogen balance and retention summary of West African dwarf goats fed elephant grass (*Pennisetum purpureum*) ensiled with varying levels of cassava peel and brewers dried grain are presented in Table 3. N-balance and N-retention which are functions of nitrogen ingested and digested (Okoruwa *et al.*, 2013) were positive in this study. The positive nitrogen balance observed in all treatment groups suggest that the nitrogen absorbed, which is the difference between nitrogen intake and faecal nitrogen was well tolerated and utilized by the goats. The Nitrogen intake (7.48g/d) of WAD goats fed T2 silage was higher ($p > 0.05$) than nitrogen intakes of goats fed T1, T3, T4, T5 AND T6 silage. N intake decreased progressively from treatment 2 to treatment 6 hence it has significant ($P < 0.05$) direct relationship with BDG level in the silage

resulting in decreased CP intake with decreasing level. The highest N – intake for T2 could probably due to the higher protein content of the diet compared to the protein content in others. This view is supported by Ahamefule *et al.* (2001) who earlier reported that higher protein content of diet has significant effect on N – intake of dwarf sheep. The values reported for nitrogen intake in this study are lower than those reported by Abegunde *et al.* (2021) for WAD goats fed ensiled *Guinea grass* (7.19–12.41 g/d) but were higher than those reported by Mako *et al.* (2012) for WAD goats fed guinea grass and varying levels of *Acroceras zizanioides* (AZ) (3.85 -6.95 g/d).

Nitrogen voided through faeces and urine in the goats was not significantly ($P>0.05$) different among the six experimental silage. The total N loss (g/d) in goats fed T5, T2, T3, T6, T4 and T1 was 0.61,0.63; 0.64;0.74 0.90 and 1.00g/d, respectively. The total N loss (g/d) were significantly ($P<0.05$) different among the WAD goats fed different experimental rations. The loss being highest in goats fed ration T1 and lowest in goats fed T2 probably due to variation in N intake in goats fed different experimental silage. The nitrogen retention was observed from 1.44-6.84g/d. The highest nitrogen retention (6.84g/d) was observed in goats fed T2 while the lowest nitrogen retention (1.44g/d) was observed in goats fed T1. The nitrogen absorbed varied from 1.857.00g/d. The highest nitrogen absorbed (7.00g/d) was observed in T2 while the lowest was observed in goats fed T1 (1.85g/d) and was significantly different. The percentage nitrogen absorbed ranged from 75.64-93.58%. The highest % nitrogen absorbed (93.58%) was observed in T2 while the lowest was observed in T1 (75.64%). It was observed that animals exposed to T2 diets had the highest values of nitrogen intake, nitrogen retained, nitrogen absorbed, percentage nitrogen retention and percentage absorbed contents, while the least value of were observed among animals fed T1.

Nitrogen balance (g/d) was significantly ($P<0.01$) different among the six experimental silage being significantly higher in diet T2,T3,T4 and T5 and lower in diet T6 and T1 silage. Higher nitrogen retention in T2, T3, T4 and T5 than other silage fed animals in the present study might be due to more nitrogen intake from respective diet. Nitrogen retention is the major indicator used to access the protein nutritional status of ruminant livestock (Abdu *et al.*, 2012; Hassan *et al.*, 2016). Percent nitrogen retention of animals in treatment 2 (95.55%) tends to be higher than per cent nitrogen retention of animals in treatment 1 (58.09 %). Nitrogen retention is the proportion of nitrogen utilized by farm animals from the total nitrogen intake for the body process, hence, the more the nitrogen consumed and digested, the more the nitrogen retained and vice versa as reported by Okeniyi *et al.*, (2010). The highest percentage nitrogen retention was recorded in T2 while goats fed T1 recorded the lowest value which suggested that nitrogen retention depends on good digestibility of nutrients and/or utilization. Also, nitrogen excreted in the faeces and urine is related to the digestion and absorption of nitrogen. High excretion of urinary nitrogen is associated with high rumen nitrogen degradability (Mc Donald *et. al.*, (2002). Nitrogen retention is now well established to depend on the intake of nitrogen and the level of fermentable carbohydrates in the feed (Hamchara *et al.*, 2018).

Table 3: Nitrogen utilization of West African dwarf goats fed Elephant grass (*Pennisetum purpureum*) ensiled with varying levels of Cassava peel and Brewers dried grain.

Parameters (%)	T1	T2	T3	T4	T5	T6	SEM
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Nitrogen Intake	2.44 ^c	7.48 ^a	6.20 ^{ba}	5.03 ^{bac}	4.97 ^{bac}	3.87 ^{bc}	0.90
Faecal Nitrogen	0.58	0.48	0.51	0.59	0.48	0.53	0.04
Urinary-N-Output	0.41	0.16	0.13	0.31	0.12	0.21	0.08
Nitrogen Voided	1.00 ^a	0.63 ^b	0.64 ^b	0.90 ^{ba}	0.61 ^b	0.74 ^{ba}	0.09
Nitrogen Retained	1.44 ^c	6.84 ^a	5.56 ^{ba}	4.13 ^{bac}	4.37 ^{ba}	3.13 ^{bc}	0.85
Nitrogen Absorbed	1.85 ^c	7.00 ^a	5.69 ^{ba}	4.44 ^{bac}	4.49 ^{bac}	3.34 ^{bc}	0.89
N-retention (%)	58.09 ^b	95.55 ^a	89.60 ^a	77.11 ^a	87.90 ^a	80.71 ^a	4.68
N-absorbed (%)	75.64 ^b	93.58 ^a	91.61 ^a	83.85 ^{ba}	90.36 ^a	85.69 ^a	3.10

^{abc} means with different superscripts along with the same row with different subscript along row differ significantly (p<0.05).

SEM: Standard error of the means.

T1: 100% Elephant grass.

T2: 60% Elephant grass + 0% Cassava peel + 40% Brewers Dried grain.

T3: 60% Elephant grass + 10% Cassava peel + 30% Brewers Dried grain.

T4: 60% Elephant grass + 20% Cassava peel + 20% Brewers Dried grain.

T5: 60% Elephant grass + 30% Cassava peel + 10% Brewers Dried grain.

T6: 60% Elephant grass + 40% Cassava peel + 0% Brewers Dried grain

4.0 CONCLUSION

The addition of cassava peels and BDG during the ensilage of elephant grass improves the fermentation process and promoted good pH. The nutritional quality of the elephant grass silages improves with the addition of cassava peels and BDG, increasing the dry matter and crude protein contents without, however, diminishing the neutral detergent fiber contents. They are highly digestible with good nutrients profile for feeding small ruminant animal hence this would minimize nutrient deficiencies faced especially during the dry season.

5.0 RECOMMENDATION

It can be recommended from this research that ensiling Elephant grass with 0-20% Cassava peel and 20-40% BDG for WAD goat diet as either basal or supplement diet, for better nutrient digestibility and nitrogen utilization to alleviate the nutrient requirement and body weight losses that are usually experienced during dry period.

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