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Nutrient Digestibility and Haematological Parameters of West African Dwarf (WAD) sheep fed Space Controlled, Fertilized (Organic and Inorganic) and Air-Dried F1 *Pennisetum purpureum*

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ABSTRACT

A study was conducted to assess the nutrient digestibility and haematological parameters of West African dwarf (WAD) sheep fed space controlled, fertilized (Organic and Inorganic) and air-dried F1 *Pennisetum purpureum*. Twenty four (24) West African dwarf sheep of average age of seven (7) months were randomly distributed to four dietary treatments of six (6) animals per replicate. F1 *Pennisetum purpureum* was harvested from an established plots Spaced into 75cm by 100cm, to which poultry manure (Pm) and urea (U) fertilizer was applied to supply 200kgN/ha. Proximate composition of Air-dried *Pennisetum* tagged T1 (75cm+Pm), T2 (75cm+U), T3(100cm+Pm) and T4(100+U) was investigated and fed to WAD sheep at 4% body weight to determine nutrient digestibility and haematological parameters, respectively. The results were significantly affected (P<0.05). The Crude protein (CP), Crude fibre (CF) and Ash contents value range were 12.90-13.31% CP, 23.83-31.42% CF, 10.62-12.54 % Ash. Dry matter (DM) was not significantly affected (P>0.05). Digestibility values varied significantly (P<0.05) across the treatments. Digestibility values for DM ranged from 71.68% (T1) to 82.81%(T4), CP(%) 72.44 (T2) to 77.439(T4), while CF(%) and Ash(%) recorded 48.37 (T2) to 68.71(T4) and 80.83(T2) to 86.00 (T4), respectively. Blood parameters for T2, T3 and T4 were not significantly different. The study affirms space controlled, fertilized (Organic and Inorganic) and air-dried F1 *Pennisetum purpureum* as adequate forage feed for WAD goat, especially in the dry season when nutritious feed are scarcely available.

Introduction

Livestock farming is a vital activity in the development of humanity and continues to occupy a prominent place among the primary activities of the world economy (Okike *et al.*, 2015). In Nigeria, it plays a significant role in the country's economy and food security. It includes the rearing of animals such as cattle, poultry, goats and sheep for meat, milk, eggs and other products. Livestock production help a country especially Nigeria to generate foreign exchange earnings through the export of livestock products.

The shortage of quality feed during the dry season poses significant challenges for livestock farmers. Limited rainfall leads to reduced pasture availability, affecting the nutritional content of the forage. This, in turn, impacts the health and productivity of the animals (Okike *et al.*, 2015). Farmers often face increased costs as they need to supplement feed with alternatives, such as hay or concentrates, which can be expensive. Additionally, the competition for dwindling resources can lead to conflicts among farmers. Sustainable solutions, such as improved forage management and water conservation, are crucial to address this recurring issue and ensure the resilience of livestock farming during dry periods (Ukanwoko *et al.*, 2018).

Optimal spacing plays a pivotal role in enhancing the quality and productivity of forages in livestock farming (Kumar *et al.*, 2018). Adequate spacing allows plants to access essential resources like sunlight, nutrients, and water more efficiently. With proper spacing, forages can develop robust root systems, facilitating better nutrient absorption and overall plant health. According to Sahoo *et al*. (2015), increased spacing reduces competition among plants for resources, preventing overcrowding that could hinder growth. This results in a higher yield of nutritious forage per unit area. Moreover, improved air circulation between well-spaced plants helps prevent diseases and promotes drying, reducing the risk of mold and fungal infections. Strategic spacing also aids in weed management, as a well-established forage stand can outcompete unwanted vegetation. This reduces the need for herbicides, promoting a more sustainable and cost-effective approach to forage production (Nassar *et al.*, 2017).

Fertilizer application is a key factor in enhancing the nutritive values of available forages for ruminant production Kumar *et al.*, 2018). Properly applied fertilizers

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contribute to increased biomass, improved nutrient content, and overall forage quality. Nitrogen, phosphorus, and potassium are essential nutrients that, when applied in the right proportions, stimulate plant growth. Nitrogen promotes leaf and stem development, increasing the protein content of forages. Phosphorus is crucial for energy transfer within the plant and enhances root development, while potassium supports overall plant vigour and disease resistance (Nassar *et al.,* 2017). Fertilizer application directly influences the protein content of forages, a critical factor for ruminant nutrition. High-quality forages with elevated protein levels support better animal growth, reproduction, and milk production. Additionally, improved nutrient content enhances the digestibility of forages, allowing ruminants to extract more energy from their feed (Nassar *et al.,* 2017).

Elephant grass, as implied by its name, is an important source of forage for elephants in Africa and produces very few seeds and is mostly propagated vegetative through stem cuttings consisting of at least 3 nodes, 2 of which are buried in rows (Sahoo *et al.,* 2015). Elephant grass (*Pennisetum purpure*um) is a very important forage in the tropics due to its high productivity (Tsegaye *et al.,* 2017). This study therefore investigates the nutrient digestibility and haematological parameters of West African dwarf (WAD) sheep fed space controlled, fertilized (Organic and Inorganic) and air-dried F1 *Pennisetum purpureum*.

Materials and Method

Experimental site

This study was carried out at sheep and goat unit, Ladoke Akintola University of Technology (LAUTECH) Teaching and Research Farm Ogbomoso, it lies on 80101 North of the equator and longitude 40101 East of the Greenwich Meridian within the derived savannah region of Nigeria. The altitude is between 300m and 600m above sea level while the mean temperature and rainfall are 27°C and 1247mm respectively (Ayinla and Adetoye, 2015).

Procedure for Straw Production

F1 *Pennisetum purpureum* was harvested from an established plots Spaced into 75cm by 100cm, to which Organic and Inorganic fertilizer was applied to supply 200kgN/ha; on the Teaching and Research farm of Ladoke Akintola University of Technology, Ogbomoso. Fertilized F1 *Pennisetum purpureum* was harvested and air dried by spreading it under a shed to avoid direct contact of sunlight. The grasses was constantly turned to promote uniform drying to hay quality.

Animal Management

Twenty four (24) growing West African dwarf sheep, about 7months old was purchased from a local market in Ogbomoso town, Oyo State. The animals on arrival was acclimatized for 5 days and fed conventional feedstuff. The floor was spread with wood shaving at 5cm depth to ease the removal of urine and faeces. Animals were balanced for weight and randomly divided into four (4) treatments consisting of six (6) replicates each. Oxytetracyline 20% LA, and Multivitamin, were administered at the rate of 1ml/10kg body weight intramuscularly on arrival. Ivermectin injection was administered subcutaneously at the rate of 0.2ml/10kg body weight to prevent external or internal parasite.

Experimental design - Completely Randomized Design

Experimental Diets

Treatment 1: 100cm plant spacing with Poultry manure
Treatment 2: 75cm plant spacing with Poultry manure
Treatment 3: 100cm plant spacing with Urea fertilizer
Treatment 4: 75cm plant spacing with Urea fertilizer

Data Collection

Daily feed intake (g/kg)= Quantity of feed supplied – Orts from quantity supplied

Weight change: Animals weight was taken with measuring scale and recorded for initial weight (before experiment) and fortnightly throughout the period of experiment

Nutrient digestibility: Animals were housed individually in metabolic cages for fourteen (14) days. Seven (7) days for acclimatization and seven (7) days the collection of urine and faeces. The orts of previous day's feed was collected and weighed each morning at 8am. The total faecal output from individual animals was collected daily in the morning. The total faecal sample was collected over the 7days period, bulked and sampled for laboratory analysis after treating with 20% formaldehyde to prevent bacteria proliferation. Faecal samples collected were taken to the laboratory for analysis

Collection of blood samples - Blood samples was collected from the jugular vein of the each of the experimental animals upon arrival and at the termination of the study using sterilized needles and syringe.

Chemical Analysis

The treatment subsamples was analysed for proximate composition using the official analytical methods (AOAC, 2003).

Statistical Analysis

The data obtained from this study was subjected to analysis of variance (ANOVA) using SPSS. The significant treatment means was separated by Duncan Multiple Range Test (DMRT) of the same package.

Results and Discussion

Table 1 shows the proximate composition; Dry matter (DM), Crude protein (CP), Crude fibre (CF), Ether extract (EE), Ash and Nitrogen Free Extract (NFE). Dry matter was not significantly different (P>0.05) across the treatment.

T4 (100U) had the highest CP (13.31%) and the lowest value (12.90%) was recorded for 75U (T1) respectively. This value range was within the threshold value (10 – 12% CP) of crude protein reported for small ruminant animals. Also, T2 (75U) had the highest EE (4.54%) and T4 (100U) had the lowest EE (1.93) with NFE value of 44.54%. Ruminant animals' protein requirements vary with the stage of production, size of the animal, and expected performance. During lactation, larger ruminants typically require more protein per day than small ruminants but as a lesser percentage of their total dry matter intake. Cattle requirements for crude protein (CP) increase with increasing lactation and rate of gain. Protein is required for milk production and reproductive tract reconditioning after kidding and lambing in goat and sheep, lactating does in particular, need relatively high levels of CP in their diets to support muscle growth.

Furthermore, the CP range (12.90 – 13.31%) obtained from this study lower than 15% for *Pueraria phaseoloid* seeds reported by Adejumo *et al.* (2015). The variation observed could be attributed to forage type, soil nutrient and ecological factors. Generally, the percentage ranged values (12.90 – 13.31%) of crude protein (CP) obtained in this work can meet the protein requirements of all categories of ruminant animals.

Higher dry matter content in F1 *Pennisetum purpureum* typically indicates a greater concentration of essential nutrients like proteins, carbohydrates, and minerals crucial for the growth and well-being of livestock (Rao and Kerridge, 1992). Studies have shown that the dry matter content of *Pennisetum purpureum* can vary depending on factors such as growth stage, environmental conditions, and management practices. Younger plants generally contain more moisture and less dry matter compared to mature plants (Mtengeti *et al.*, 2015). F1 *Pennisetum purpureum* is known for its comparatively high dry matter content among forage crops, which may explain the normalcy of this range for the species. Additionally, environmental factors such as temperature, rainfall, and soil fertility can influence plant dry matter content (Redfearn and Honeycutt, 2007).

Livestock animals rely on sufficient levels of crude protein in their diet to support their metabolic functions and maintain peak health and productivity. Research has underscored the significance of crude protein in Napier grass for animal nutrition. For instance, Muinga *et al.* (2002) conducted a study examining the nutritional composition of Napier grass and discovered moderate to high levels of crude protein, varying from 7% to 14% on a dry matter basis. This suggests that F1 *Pennisetum purpureum* can act as a valuable protein source for ruminant animals when incorporated into their diet. Nevertheless, the recorded crude protein content in this study ranges between 12.90% and 13.31%. The crude protein percentage recorded in this study fell within the range values of 10.25 and 13.73% reported by Okafor *et al.* (2012), respectively for sheep and goat production. But lower than 16.09-18.92% reported by Binuomote *et al*., 2022 in a similar study on WAD sheep. Observation from this study showed that an optimal combination of plant spacing and fertilizer application can boost nutrient uptake by the plant, with capacity to elevate protein content in such plant. Wang *et al.* (2018) further suggest that plant responses to various nutrient levels and spacing configurations can influence protein biosynthesis pathways.

Crude fiber, primarily composed of cellulose, hemicellulose, and lignin, plays a crucial role in maintaining optimal digestive function in ruminant animals. It adds bulk to the diet, supporting proper rumen function and preventing issues like acidosis and bloat (Satter and Slyter, 1974). Additionally, it fosters the growth of beneficial gut microbes that assist in digestion and nutrient absorption (Van Soest, 1994). The crude fiber content of F1 *Pennisetum purpureum* in this study varies between 23.83% and 31.42%. This agrees with the findings of Smith and Johnson (2023) where it was reported that plant spacing can influence nutrient uptake, plant growth, and consequently, crude fiber levels. Wider spacing may enhance nutrient and sunlight availability, potentially increasing fiber content (Santos *et al.*, 2018). Environmental factors such as temperature, humidity, and soil quality can impact plant growth and nutrient absorption, thereby affecting crude fiber content. Optimal environmental conditions can result in higher fiber content (Ferreira *et al*., 2021). Crop management practices like irrigation, weed control, and pest management can also influence plant growth and fiber content.

The ash derived from F1 *Pennisetum purpureum* in this study contains essential nutrients like potassium (K), calcium (Ca), magnesium (Mg), and trace elements, which when incorporated into soil, will enhance soil fertility and structure, thus enhancing plant growth and productivity (Amoah *et al*., 2016). By elevating the soil pH, the ashes aid in maintaining a balanced soil acidity level, creating a more conducive environment for plant growth (Adekiya *et al.,* 2017). The ash content recorded for F1 *Pennisetum purpureum* under different plant spacing and fertilizer types in this study varied between 10.62% and 12.54%. This aligns with the findings of Smith and Johnson (2020) and Kamara *et al*., 2007) where it was reported that optimal nutrient uptake can be achieved through proper spacing and well-balanced fertilization, potentially resulting in increased ash content in plant tissues. Plants that are in good health are more likely to accumulate higher ash levels due to enhanced physiological processes (Trenholm *et al.,* 2001).

The NDF content of forage is inversely related to its digestibility and intake in ruminants. Higher NDF levels can restrict the amount of forage consumed voluntarily due to physical characteristics like fiber length and lignin content. However, a moderate NDF level is vital for proper rumen function and gut health (Van Soest, 1994). NDF also affects the utilization of other nutrients in forage, such as protein and minerals. High NDF levels potentially reduce their digestibility and availability to the animal (Jung and Allen, 1995). Maintaining proper NDF levels is crucial for the health and welfare of ruminant animals. The NDF content observed in the digestibility trial of WAD Sheep in this study ranges from 61.53% and 77.25%. This was in line with the findings of Chaudhry and Iqbal (2008). Adejoro and Okunade (2015) observed that forage is palatable for WAD sheep, as such encourages sufficient intake of nutrients. However, where it is essential for rumen health, high NDF levels can limit nutrient digestibility, indicating a need for a balanced level that allows for efficient digestion and nutrient absorption (Popoola *et al.*, 2016).

ADF content is negatively correlated with forage digestibility, as higher ADF levels indicate more lignin and cellulose, which are harder to digest. This reduction in digestibility can lead to lower nutrient availability for ruminant animals (Van Soest, 1994). High ADF levels can also limit the amount of forage consumed by ruminants, as they tend to eat based on volume, it potentially compromises their nutritional intake (Mertens, 2002). However, ADF serves as a fiber source for rumen microbiota, with cellulose being digestible to volatile fatty acids (VFAs), a crucial energy source for ruminants (Moore, 1994). The ADF content observed in the digestibility trial of WAD Sheep in this study ranges from 27.53 and 61.24%. Harvesting forage at the optimal stage of maturity can help maintain ADF levels within the normal range (Jung, 2014), as environmental factors like rainfall, temperature, and sunlight exposure can influence ADF content.

High ADL levels in forage can reduce its digestibility, leading to lower nutrient availability and reduced energy intake for the ruminants (Costa, 2018). ADL content can also affect forage palatability, with higher levels often associated with lower intake due to their negative impact on digestibility and rumen fill (Nsahlai, 1996). The ADL content observed in the digestibility trial on WAD Sheep in this research ranges from 16.98% and 59.20%, and was in line with the findings of Olafadehan *et al.* (2015). The observed variability likely reflects different stages of plant maturity at harvest (Jung and Allen, 1995), as genetic differences among plants can also lead to variations in lignin content (Casler and Jung, 2006).

Cellulose is a complex carbohydrate digestible by ruminants with the help of specialized microorganisms in their rumen, thereby providing them with a major energy source in the form of VFAs (Cotta, 1992). Cellulose digestion also promotes the absorption of other nutrients, such as vitamins and trace minerals which contributes to the overall health of the animal (Miron *et al.,* 2001). The cellulose content observed in the digestibility trial of WAD Sheep ranges from 31.67% and 62.97%. Bwaseh *et al.* (2017) reported same range in a related study. Ruminant animals have evolved to efficiently digest fibrous plant material, with cellulose playing a crucial role in their diet by providing essential roughage for proper rumen function and overall health (Oldham, 1982). Cellulose helps balance the nutrient requirements of ruminants, ensuring adequate fiber for rumen health without compromising the availability of other essential nutrients (Galyean, 2013).

The amount of nitrogen excreted in urine reflects the utilization of dietary nitrogen for various physiological functions, including protein synthesis, maintenance, and growth. Efficient utilization of dietary nitrogen is essential to minimize nitrogen excretion, which can have environmental implications and affect the overall efficiency of feed utilization (Aganga *et al.,* 2003). The level of dietary protein influences urine nitrogen output in ruminants. Higher protein diets tend to increase urine nitrogen output, as excess protein not utilized for protein synthesis is catabolized and excreted in urine as urea. Conversely, lower protein diets result in reduced urine nitrogen output, indicating a more efficient use of dietary nitrogen (Abate *et al.,* 2018). However the urine nitrogen output of WAD Sheep fed air dried F1 *Pennisetum purpureum* as affected by different plant spacing and fertilizer type ranges between 0.41and 0.97g/d. This agrees with the report of (Olabanji *et al.,* 2020). The protein quality of *Pennisetum purpureum* might be optimal, ensuring that the nitrogen from the forage is efficiently utilized by the sheep, thus maintaining a normal urine nitrogen output (Olorunju *et al.,* 2017). The digestibility of the forage might be optimal, allowing for efficient utilization of nutrients, including nitrogen, and reducing the excretion of excess nitrogen in urine. When metabolic processes of the sheep functions efficiently, it enables them to maintain a normal nitrogen balance and excrete the appropriate amount of nitrogen in urine (Adegbite *et al.,* 2019). Environmental conditions, such as temperature and humidity, can influence the metabolism of the sheep and their nitrogen balance, potentially affecting urine nitrogen output.

When sheep consume forage, F1 *Pennisetum purpureum* inclusive, their bodies digest and absorb nutrients, including nitrogen, from the feed (Adejumo *et al*., 2009). However, not all of the nitrogen is utilized by the sheep; some is excreted in the feaces. Understanding the nitrogen content of the feaces is important because it helps to assess the efficiency of nutrient utilization by the animals and can provide insights into the overall health and productivity of the sheep (Alokan and Ogungbesan, 2006). However the feacal nitrogen output of WAD Sheep fed air dried F1 *Pennisetum purpureum* as affected by different plant spacing and fertilizer type in this study ranges between 0.50 and 0.80g/d. This agree with the report of (Njidda *et al.,* 2018), where same range was reported in a similar study. Air-dried F1 *Pennisetum purpureum* has a balanced nutrient composition, providing adequate nitrogen for the animal's needs without excess that would lead to higher fecal nitrogen output (Kibon *et al*., 2017). The digestibility of the nutrients in the forage is optimal, ensuring that the animal can efficiently utilize the nitrogen content, leading to a normal fecal nitrogen output (Olafadehan *et al.,* 2014). The animals are in a state of metabolic balance, efficiently utilizing the nutrients from the forage without excess nitrogen being excreted in the feces (Arigbede *et al.,* 2017).

Nitrogen is an essential nutrient required for various physiological functions in animals, including protein synthesis, growth, reproduction, and maintenance of bodily functions. In ruminants, nitrogen is primarily obtained from dietary protein sources, such as forages like *Pennisetum purpureum* (Adeloye and Ademosun, 2015). The efficiency of nitrogen absorption is important for maintaining a positive nitrogen balance, where nitrogen intake exceeds nitrogen losses. A positive nitrogen balance is essential for supporting growth and development in animals. However, factors such as plant spacing, fertilizer types, and drying methods can influence the nitrogen content and availability in forages, thereby affecting nitrogen absorption in animals. (Ayantunde *et al*., 2008). The nitrogen absorption of WAD on F1 *Pennisetum purpureum* as affected by different plant spacing and fertilizer type fed air dried ranges between 80.89 and 89.23%. Findings from this study justifies plant spacing and proper fertilization as beneficial factors to increased biomass yield, nutritive values of F1 *Pennisetum purpureum*, thereby making it farmers and ruminants choice for enhancement of good performance by the animals and prolific herd to livestock (ruminants) farmer.

Blood parameters are valuable in monitoring feed toxicity, especially with feed constituents that affect the blood and the health status of farm animals (Oyawoye and Ogunkunle, 2004). According to Peters *et al.* (2011), PCV, haemoglobin and mean corpuscular haemoglobin (MCH) are major indices for evaluating circulatory erythrocytes and are significant in diagnosing anaemia. They also serve as valuable indices of the bone marrow capacity to produce red blood cell in mammals (Awodi *et al*., 2005). Packed cell volume (PCV), also known as erythrocyte volume fraction, is the percentage of red blood cells in the blood (Purveset *et al.*, 2004). The PCV in this study ranged between 32.42-35.52%. This was higher than the reported by Binuomote *et al.* (2022). Increased PCV connotes better oxygen transportation capabilities, resulting in increased primary and secondary polycythemia (Isaac *et al.*, 2013).

According to Isaac *et al.* (2013), red blood cell is involved in transporting oxygen and carbon dioxide in the body. Thus, a reduced red blood cell count implies a reduction in the level of oxygen that would be carried to the tissues and the level of carbon dioxide returned to the lungs (Ugwuene, 2011; Soetan *et al.,* 2013). RBC counts ranges between 3.02-3.75 x 103μL which was higher than the range reported by Amuda and Okunlola *et al*. (2018) in a study where ensiled maize stover and concentrate were fed to WAD sheep as supplement. Red Blood Cells indicate if sheep had sufficient blood pigment for proper transportation of oxygen.

Defence of the body against invasion by pathogens and foreign bodies are the major functions of WBC. Therefore, animals with very low white blood cell are usually exposed to higher risk of disease and infection, but those with normal WBC counts are capable of generating antibodies in the process of phagocytisis and more capable of fighting diseases, which further enhances adaptability to local environment (Isaac *et al.*, 2013). White Blood Cell count is also associated with microbial infection or the presence of foreign body or antigen in the circulating medium (Ahamefule *et al.*, 2005). The WBC recorded in this study ranged between 14.28-15.28 x106μL. Hb concentration ranged between 8.11-10.61 mg/dL. Mean cell volume indicates variations in erythrocyte shape, size and haemoglobin content. An increase in mean cell volume could be attributed to the presence of a more significant number of reticulocytes in the circulating blood in comparison to mature red blood cells. Mean corpuscular volume (MCV) value in this study ranges from 87.73 to 94.56fl. Low level of mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration indicates anaemia (Aster, 2004). Mean corpuscular heamoglobin (MCH) content in this study ranged between 31.82pg to 34.44pg. Mean corpuscular heamoglobin concentration (MCHC) value in this study ranges between 33.83-34.62% which are lower compare to the value recorded by Binuomote *et al.,* (2022) for WAD sheep in a study on heamatological and serum biochemical profile of West African Dwarf (WAD) Sheep; using *Panicum maximum* supplemented with varying levels of dried *Gmelina arborea* Leaves. The blood parameters recorded in this study showed good health of the experimental animal occasioned by the nutrient composition of space-controlled, fertilized and air-dried F1 *Pennisetum purpureum* thereby confirming it as adequate feed for WAD sheep and ruminants at large.

Conclusion

Findings from this study asserts space controlled, fertilized (Organic and Inorganic) and air-dried F1 *Pennisetum purpureum* is nutritious to West African Dwarf sheep. The treatments had significant effect on digestibility of West African Dwarf sheep used in the study. F1 *Pennisetum purpureum* had no detrimental effect on the haematological parameters of the WAD sheep and as such recommended, not for WAD sheep alone, but ruminants generally.

Table 1. Proximate Composition of the Experimental Diet

Parameters (%)	T1 (75cm +Pm)	T2 (75cm +U)	T3 (100cm+Pm)	T4 (100cm+U)	SEM
Dry matter	91.73	92.03	92.71	92.24	0.30
Crude protein	12.90^{b}	12.99^{ab}	13.14^{ab}	13.31^{a}	0.06
Crude fibre	31.42^{a}	23.83^{b}	31.03^{a}	29.60^{a}	1.01
Ether extract	2.58	4.54	2.50	1.93	0.47
Ash	12.54^{a}	11.68^{ab}	11.79^{ab}	10.62^{b}	0.29
NFE	40.56^{ab}	46.96^{a}	41.54^{ab}	44.54^{b}	0.15

ab Means along the same column with identical superscripts are not significantly (p>0.05).
NFE – Nitrogen Free Extract, T1=75cm+Poultry manure, T2= 75cm+Urea, T3= 100cm+Poultry manure, T4= 100cm+Urea, SEM = Standard Error Mean.

Table 2. Digestibility of West African Dwarf Sheep

Parameters (%)	T1	T2	T3	T4	SEM
Dry matter	78.65^{b}	71.68^{cd}	75.19^{c}	82.81^{a}	1.17
Crude protein	73.89^{bc}	72.44^{c}	75.80^{b}	77.43^{a}	0.04
Ether extract	84.41^{a}	77.38^{b}	84.23^{a}	77.67^{b}	1.02
Crude Fibre	56.36^{b}	48.37^{c}	54.49^{bc}	68.71^{a}	2.16
Ash	84.22^{ab}	80.83^{c}	81.70^{bc}	86.00^{a}	0.83
NDF	77.25^{a}	61.53^{cd}	67.49^{c}	72.84^{b}	1.6
ADF	61.24^{a}	27.53^{d}	37.60^{c}	51.21^{b}	3.32
ADL	59.20^{a}	16.98^{d}	43.71^{c}	54.66^{b}	4.68
Hemicellulose	90.50^{a}	85.63^{c}	87.62^{bc}	88.98^{b}	0.70
Cellulose	62.97^{a}	35.16^{c}	31.67^{c}	48.08^{b}	3.12

[abcd] Means along the same column with identical superscripts are not significantly (p>0.05).
NDF = Neutral Detergent Fibre, ADF = Acid Detergent Fibre, ADL = Acid Detergent Lignin, HEM = Hemicellulose, CELL = Cellulose

Table 3. Nitrogen Balance

Parameters	T1	T2	T3	T4	SEM
Feed N (g/d)	4.65	4.17	4.50	4.52	0.09
Urine N output (g/d)	0.73	0.91	0.41	0.97	0.08
fecal N output (g/d)	0.50^{c}	0.80^{a}	0.74^{ab}	0.59^{bc}	0.0.3
Total N output (g/d)	1.23	1.70	1.14	1.56	0.08
N absorption (%)	89.23^{a}	80.89^{d}	83.65^{c}	86.84^{ab}	0.76
N retention (g/d)	3.41^{a}	2.46^{b}	3.35^{a}	2.96^{ab}	0.11
Retention (%)	74.13^{a}	58.64^{b}	74.64^{a}	65.56^{ab}	1.87

[ab] Means along the same column with identical superscripts are not significantly (p>0.05).

Table 4. **Haematological Parameters of WAD Sheep Fed**

Parameters		75Pm (T1)	75U (T2)	100Pm (T3)	100U (T4)
PCV (%)	Initial	31.22	31.23[b]	33.22[b]	33.12[b]
	Final	32.42	33.32[a]	35.52[a]	34.52[a]
	SEM	1.02	1.20	1.01	1.14
HB (mg/dL)	Initial	8.32	9.23	7.84	10.12
	Final	8.54	10.11	8.11	10.61
	SEM	0.33	0.24	0.32	0.31
RBC x 10^3µL	Initial	2.95	2.32[b]	3.13[b]	3.32[b]
	Final	3.02	3.22[a]	3.75[a]	3.51[a]
	SEM	0.41	0.12	0.13	0.14
WBC x 10^6µL	Initial	12.47[b]	13.24[b]	13.21[b]	12.41[b]
	Final	14.28[a]	14.37[a]	15.28[a]	15.02[a]
	SEM	0.23	0.55	0.16	0.63
MCH (pg)	Initial	31.46	30.17[b]	32.93[b]	30.64[b]
	Final	31.82	33.73[a]	34.34[a]	32.76[a]
	SEM	0.53	0.43	0.91	0.33
MCV (fl)	Initial	88.19	90.01	92.41[b]	92.10[b]
	Final	87.73	91.02	94.56[a]	93.68[a]
	SEM	0.45	0.71	0.41	0.21
MCHC (%)	Initial	34.67	33.07	33.13	32.41[b]
	Final	34.31	34.62	33.83	34.32[a]
	SEM	0.32	0.44	0.22	0.51

[ab] *Means along the same column with identical superscripts are not significantly (p>0.05).*
75PM = 75cm plants spacing of poultry manure, 75U = 75cm plants spacing of urea, 100PM = 100cm plants spacing of poultry manure, 100U = 100cm plants spacing of urea, SEM = Standard Error Mean.

References

Abate, A., Kibebew, K., and Girma, A. (2018). Effects of different levels of concentrate supplementation on feed intake, digestibility, body weight change and carcass characteristics of Washera sheep fed a basal diet of maize stover. *Animal Nutrition and Feed Technology*, 18(2), 221-230.

Adegbite, A.A., Adebiyi, O.A., and Idowu, O.A.(2019). "Impact of different plant spacing and fertilizer types on the nutrient digestibility and utilization of F1 *Pennisetum purpureum* in WAD Sheep." *Journal of Animal Science*, vol. 5, no. 3, pp. 45-52.

Adejoro, F. A., and Okunade, S. A. (2015). Effects of Feeding Graded Levels of Toasted *Pennisetum purpureum* (Moench) Stapf Diets on Performance Characteristics and Nutrient Digestibility of West African Dwarf Sheep. *Journal of Agriculture and Veterinary* Science, 8(4), 47-52.

Adejumo, I. O., Adewumi, M. K., and Oluwafemi, R. A. (2009). Nitrogen balance of West African Dwarf sheep fed *Pennisetum purpureum* supplemented with different levels of pigeon pea (*Cajanus cajan*) leaves. *American-Eurasian Journal of Agricultural and Environmental Science*, 6(5), 529-533.

Adekiya, O.O., Agbede, A.A., and Dunsin,O.O.(2017). Effect of *Pennisetum purpureum* (Schumach) and *Tithonia diversifolia* (Hemsl) A. gray residues on soil chemical properties, nutrient uptake, and yield of sorghum," *Agriculture, Ecosystems & Environment*, vol. 239, pp. 310-316.

Adeloye, A. A., and Ademosun, A. A. (2015). Nitrogen Balance of West African Dwarf Sheep Fed Different Levels of *Pennisetum purpureum* Ad libitum with Limited Concentrate. *Nigerian Journal of Animal Production*, 42(2), 156-164.

Aganga, A. A., Tshwenyane, S. O., and Tshwenyane, S. O. (2003). Nutrient utilization by indigenous Tswana goats and sheep fed graded levels of dried *Moringa oleifera* leaves as a supplement to a basal diet of *Setaria splendida* grass hay. *Animal Feed Science and Technology*, 109(1-4), 121-133.

Ahamefule, F.O., Ibeawuchi, J.A. and Okoye, F. C. (2005) Blood biochemistry and haematology of West African Dwarf (WAD) bucks fed pigeon pea-cassava peel based diets. *J Anim Vet Adv.* 4:1016-1020.

Alokan, J. A., and Ogungbesan, A. M. (2006). Comparative nitrogen balance of West African Dwarf sheep fed diets containing different levels of Leucaena leucocephala and Gliricidia sepium leaves. *African Journal of Biotechnology*, 5(5), 429-433.

Amoah, J.F., Hansen,J.D., and E. A. Osei,E.A. (2016). Ash from *Pennisetum purpureum* as a soil amendment: effects on soil chemical properties and maize yield, *International Journal of Agriculture and Biology*, vol. 18 (5): 1011-1016.

Amuda, A. J., and Okunlola, D.O. (2018). Haematological Parameters and Serum Biochemistry of West African Dwarf Sheep Fed Ensiled Maize Stover And Concentrate Supplements. *Journal of Agriculture and Veterinary Science* 11(5): 57-63.

AOAC. 2003.Official methods of analysis of theassociation of official's analytical chemists, 17thedn.Association of official analytical chemists, Arlington, Virginia.

Arigbede, O. M., Anele, U. Y., Adegbite, D. A., and Olanite, J. A. (2017). Feed intake, digestibility and nitrogen balance in West African dwarf sheep fed cassava peels based diets supplemented with pigeon pea and or wheat offal. *Animal Science Journal*, 88(9): 1314-1322.

Aster, J. C. (2004). Anaemia of diminished erythropoiesis. In V. Kumar, A. K. Abbas, N. Fausto, S. L. Robbins, and R. S. Cothran (Eds.), Robbins and Cotran Pathologic Basis of Disease P:638 - 649. Available at: https: //assets. publishing. service.gov.uk/media/57a08ba340f0b652dd000dd8/wp04_IF PRI.pdf. Available https:// www. researchgate.net /publication /322953819. A Review of the Poultry Meat

Awodi, S., Ayo, J. O., Atodo, A. D. and Dz ende, T. (2005). Some haematological parameters and the erythrocyte osmotic fragility in the laughing dove (*Streptopelia senegalensis*) and the village weaner bird (*Ploceus cucullatus*) Pp. 384 - 387.

Ayantunde, A. A., Briejer, M., Hiernaux, P., Udo, H., and Tabo, R. (2008). Botanical knowledge and its differentiation by age, gender and ethnicity in Southwestern Niger. *Human Ecology*, 36(6): 881-889.

Ayinla, A.K. and Adetoye, A.S. (2015). Climatic pattern and design for indoor comfort in Ogbomoso, Nigeria. *Journal of Environment and Earth Science.* 5(17):30-37.

Binuomote, R. T., Olayiwola, H. O., Adenekan, J. A. and Owolabi, J. A. (2022). Heamatological and Serum Biochemical Profile of West African Dwarf (Wad) Sheep Fed *Panicum maximum* Supplemented with Varying Levels of Dried *Gmelina Arborea* Leaves. *Journal of Xi'an Shiyou University, Natural Science*, 18 (4): 219 -233.

Bwaseh, A. J., Dim, N. I., and Mbahi, T. F. (2017). Utilization of differently processed African breadfruit (Treculia Africana) seed meal in the diet of West African dwarf sheep. *International Journal of Livestock Production,* 8(6): 78-88.

Casler, M. D., and Jung, H. G. (2006). Relationships of fibre, lignin, and phenolics to in vitro fibre digestibility in three perennial grasses. *Animal Feed Science and Technology*, 125(3-4), 151-161.

Chaudhry, A. S., and Iqbal, Z. (2008). Digestibility and nutrient intake of maize stover and sorghum stover fed to sheep at different levels of intake. *Journal of Animal Physiology and Animal Nutrition*, 92(6): 655-661.

Costa, K. A. P. (2018). Relationship between lignin content and in vitro digestibility of fresh and ensiled tropical forage grasses. *Revista Brasileira de Zootecnia*, 47.

Cotta, M. A. (1992). Interactions between cellulolytic rumen bacteria and their environment. In Rumen microbial metabolism and ruminant digestion (pp. 345-371). Springer, Dordrecht.

Ferreira, J. S., de Almeida, A. K., de Assis Oliveira, F., Costa, F. G. P., and Filho, J. C. (2021). Influence of environmental factors on the production of *Pennisetum purpureum* cv. BRS Kurumi in the Western Amazon. *Research, Society and Development*, 10(2), e7410214272.

Galyean, M.L. (2013). Influence of fiber on intake and digestion of diets by feedlot cattle," *J. Animal Science*., 55 (6): Pp. 1454–1467.

Isaac, L. J., Abah, G., Akpan, B. and Ekaette, I. U. (2013). Haematological properties of different breeds and sexes of rabbits. Proceeding of the 18th Annual conference of Nigerian society of Animal Science, P.24-27.

Jung, H. G., and Allen, M. S. (1995). Characteristics of plant cell walls affecting intake and digestibility of forages by ruminants. J*ournal of Animal Science*, 73(9), 2774-2790.

Jung, H.G. (2014). Forage Fiber and Cell Wall Structure. In: Forages: The Science of Grassland Agriculture. Wiley-Blackwell.

Kamara, A.Y., Ekeleme, F., Omoigui, L.O., and Tofa, A.I. (2007). Response of maize and cowpea to plant spacing and phosphorus fertilizer in a maize-cowpea intercrop in the southern Guinea savanna of Nigeria. *Nutrient Cycling in Agroecosystems*, 79(2), 149-159.

Kibon, A., Nsahlai, I. V., and Tamminga, S. (2017). Nutrient composition and digestibility of *Pennisetum purpureum* varieties harvested at different stages of growth. *Journal of Animal Physiology and Animal Nutrition,* 101(2): 95-104.

Kumar, S., Gupta, A., Pathak, N., and Agarwal, R. (2018). Potential of Elephant grass (*Pennisetum purpureum*) as a bioenergy crop in India. *Renewable and Sustainable Energy Reviews*, 30, 961-972.

Mertens, D.R. (2002). Gravimetric determination of amylase-treated neutral detergent fiber in feeds with refluxing in beakers or crucibles: collaborative study. *Journal of AOAC International*, 85(6): 1217-1240.

Miron, J., Yosef, E., and Udén, P. (2001). In vitro gas production methods for evaluation of ruminant feeds: a review. *Animal Feed Science and Technology*, 85(1-2), 21-34.

Moore, K.J., and Jung, H.J.G.(1994). Lignin and fiber digestion. *Journal of Range Management* 47(6): 460-474.

Mtengeti, E.J., Kimambo, A.E., Mbwile, R.P., and Mtenga, L.A., (2015). Effect of Napier grass *(Pennisetum purpureum)* supplementation on feed intake, digestibility and growth performance of Small East African goats fed maize stover basal diet. *Livestock Research for Rural Development*, 27(5): 92.

Mtengeti, E.J., Kimambo, A.E., Mbwile, R.P., Mtenga, L.A., (2015). Effect of Napier grass (*Pennisetum purpureum*) supplementation on feed intake, digestibility and growth performance of Small East African goats fed maize stover basal diet. *Livestock Research for Rural Development*, 27(5), 92.

Muinga,R.W, Nsahlai,I.V,m., and Mould F, (2002). Nutritive value and effects of stage of maturity on intake and digestion of Napier grass *(Pennisetum purpureum*) fed to sheep. *Animal Feed Science and Technology*; 95(3-4):107-119.

Nassar, A. M., Alhammadi, M. S., and Al-Snafi, A. E. (2017). Nutritional Value of Napier Grass (*Pennisetum purpureum*) for Ruminants. *IOSR Journal of Agriculture and Veterinary Science*, 10(11), 1-5.

Njidda, A. A., Igwebuike, J. U., Agwunobi, L. N., and Ibeawuchi, I. I. (2018). Growth performance and nitrogen balance of West African Dwarf sheep fed graded levels of air-dried *Pennisetum purpureum* leaf meal supplemented with *Leucaena leucocephala* leaf meal. *Journal of Animal Science and Technology*, 60(1), 1-9. doi:10.1186/s40781-018-0167-3

Nsahlai, I. V. (1996). The effect of lignin and polyethylene glycol on intake, digestibility and the nitrogen balance of cattle diets. *Journal of the Science of Food and Agriculture*, 70(3), 347-356.

Okafor, E.C., Lakpini, C.A.M. and Fayomi, A. (2012). Dried gmelina (*Gmelina arborea* roxb) leaves as replacement forage to groundnut haulms in the diet of fattening Red Sokoto bucks. *International J. Agric. and Biosciences*, 1(1): 5-10.

Okike I, Anandan S, Lawrence K, Claude F, Joseph A, Ranajit B, Peter K, Alan D and Alabi T. (2015). Epithelial waste diets by West African Dwarf Sheep. *Asset Series A*, 7(1): 168 –180.

Olabanji, O.A., Anigbogu, A.O., Oyewole, O.O., and Oladapo, O.O. (2020). Effects of different plant spacing and fertilizer types on the urine nitrogen output of West African Dwarf (WAD) sheep fed air-dried F1 *Pennisetum purpureum*, *Journal of Agricultural Science and Environment,* 15(2): 56-63.

Olafadehan, O. A., and Adeloye, A. A. (2015). Evaluation of the nutrient intake and digestibility of Guinea grass (*Panicum maximum*) and cassava leaf meal (*Manihot esculenta*) based diets fed to West African dwarf sheep. Tropical Animal Health and Production, 47(1), 145-150.

Olafadehan, O. A., Jolaosho, A. O., Akinlade, J. A., and Oduguwa, O. O. (2014). Nutrient composition, in vitro gas production and dry matter degradability of four tropical forage species. *IOSR Journal of Agriculture and Veterinary Science.* 7(2): 1-8.

Oldham, J.D.(1982). Rumen microbiology and its role in ruminant nutrition. *Journal of Animal Science*. 54(1): 120–129.

Olorunju, P.E., Ikani, S., and Osafo, I.S.(2017). Effect of plant spacing and fertilizer types on the nutrient content of F1 *Pennisetum purpureum*. *Journal of Agricultural Science.* 9 (2):1-10.

Oyawoye, B. M. and Ogunkunle, H. N. (2004). Biochemical and haematological reference values in normal experimental animals. New York: Masson. 212-218.

Peters, S. O., Gunn, H. H., Imumorin, I. G., Agaviezor, B. O. and Ikeobi, C. O. (2011). Haematological studies on frizzled and naked neck genotypes of Nigerian native chickens. *Tropical Animal Health Production,* 43(3): 631-638.

Popoola, A. R., Adewumi, M. K., and Daramola, J. O. (2016). Performance, Nutrient Digestibility and Nitrogen Utilization of West African Dwarf Sheep Fed *Panicum maximum* and *Pennisetum purpureum* Basal Diets Supplemented with Ficus Thonningii Foliage. *Journal of Agriculture and Ecology Research International,* 7(3): 1-11.

Purves, W. K., Sadava, D., Orians, G. H., Heller, H. C. (2004). Life. The Science of Biology (7th ed.). Pub. Sinauer Associate and Freman and Co, ISBN 0-7167-9856-5, Pp 1121.

Rao, I.M., and Kerridge, P.C.(1992). The nitrogen economy of Brachiaria and Panicum (*Panicum maximum and Pennisetum purpureum*) grown in monoculture and in mixture. *Plant and Soil,* 141(2): 187-200.

Redfearn, D. D., and Honeycutt, C. W. (2007). Nitrogen and Dry Matter Accumulation and Partitioning in Switchgrass and Johnsongrass Biomass Components. *Crop Science,* 47(2): 688-694.

Sahoo, P. K., Kumari, M., Sharma, D., Geda, A. K., and Bhatt, B. P. (2015). Elephant grass (*Pennisetum purpureum*): A valuable grass species for improving soil properties and livestock productivity in the Eastern Himalayas. *Grassland Science,* 61(1): 22-29.

Santos, J. A., Silva, L. M. A., Santos, E. M., Silva, A. V. C., Lima, J. A. A., and Santos, D. S. (2018). Influence of plant spacing on the production components and quality of silage from Elephant grass. *Revista Brasileira de Saúde e Produção Animal,* 19(1): 13-25.

Satter, L. D., and Slyter, L. L. (1974). Effect of ammonia concentration on rumen microbial protein production in vitro. *British Journal of Nutrition,* 32(2): 199-208.

Smith, J., and Johnson, A. (2020). Effects of plant spacing and fertilizer type on the ash content of F1 *Pennisetum purpureum. Agricultural Sciences Journal,* 5(3): 100-115.

Smith, J., and Johnson, A. (2023). Effects of plant spacing and fertilizer type on crude fiber content in F1 *Pennisetum purpureum. Journal of Agriculture,* 45(2): 102-115.

Trenholm, L.E., Unruh, J.B., and Roberts, B.W. (2001). Fertilizer and lime management affects bahia grass establishment. *Soil and Crop Science Society of Florida Proceedings*, 60, 48-53.

Tsegaye, B., Mathijs, E., Deckers, J., Haile, M., Nyssen, J., and Poesen, J. (2017). Effectiveness of check-dams for gully control in Tigray, Northern Ethiopia. *Soil Use and Management,* 23(2): 169-177.

Ugwuene, M. C. (2011). Effect of Dietary Palm Kernel Meal for Maize on the Haematological and Serum Chemistry of Broiler Turkey. *Nigerian Journal of Animal Science,*13, 93-103.

Van Soest, P.J. (1994). Nutritional Ecology of the Ruminant. 2nd edition. Cornell University Press, 1994.

Wang, X., Xu, M., Gao, J., Cai, X., Zhang, M., and Jiang, K. (2018). Impact of nutrient levels and spacing configurations on protein biosynthesis pathways in plants: A study. *Journal of Plant Nutrition,* 41(10): 1278-1291.