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YIELDS, SILAGE QUALITY, CHEMICAL COMPOSITION AND FIBRE FRACTIONS AS AFFECTED BY FERTILIZER TREATMENTS IN BRACHIARIA RUZIZIENSIS (CONGO GRASS)

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ABSTRACT

This study was aimed at verifying the impacts of various fertilizer treatments on the yields, physicochemical characteristics, and quality of silages of Brachiaria ruziziensis (BR). The study utilized sixteen plots of BR with three different fertilizer treatments arranged in a randomized complete block design (RCBD). The fertilizer treatments include control (T1), Natsoil organic fertilizer (T2), Wonder organic fertilizer (T3), and poultry manure (T4), with each treatment replicated four times. The grass was harvested after 50 days of sowing BR seeds. The fresh herbage and dry matter yields were estimated immediately after harvesting, then silages were made from the harvested BR grass, with physicochemical characteristics of the silage examined after 21 days. Silage was prepared from each plot, resulting in 16 silage samples for chemical analysis. It was revealed that fertilizer treatments had a significant influence ($p<0.05$) on the fresh herbage and dry matter yield of BR. Wonder fertilized BR (T3) was superior to others in both yields, with 18.38 tons/ha/ha and 6.90tons/ha/ha respectively, followed by poultry manure fertilized BR (16.66tons/ha/ha and 6.19tons/ha/ha) and Natsoil fertilized BR (14.05tons/ha/ha and 5.23tons/ha/ha). The study showed that physicochemical characteristics were not significantly affected by fertilizer treatments ($p>0.05$), the values obtained were within the range recognized as a good silage quality. Fertilizer treatments considerably affected ($p<0.05$) the crude protein, crude fibre, and cellulose. The highest value of CP (6.00%) and the lowest CF (28.86%) were recorded in Wonder fertilized BR, while, lowest CP (5.25%) and highest CF (30.23%) were obtained in the control. It can be concluded that BR fertilized with Wonder fertilizer is a better forage option due to improved yield and silage chemical composition. Feeding such silage to animals will result in improved performance.

Keywords: Wonder Natsoil fresh herbage crude protein physicochemical

INTRODUCTION

Ruminant production in Nigeria depends largely on forage grasses and legumes as the major source of feed, which mainly exist naturally (Sani and Abdulmumini, 2023). The forages are seasonally influenced such that there is excess quality forage in the wet season and extreme shortage in the dry season, which results in huge economic loss. The scarcity of quality pasture is devastating, especially in the dry season and has been a major setback in exploring the genetic potential of the available breeds of animals. In consequence, this is accompanied by several devastating effects such as stress, immunosuppression and finally predisposition of ruminant animals to various diseases and death (Nwobodo et al., 2022). This hindrance can be further exacerbated due to the recent rise in the adoption and enactment of anti-grazing laws by various states in Nigeria. Hence establishment of pasture is a panacea to feed shortage and improved ruminant production.

Raising the yields of forage crops through sowing of high yield and nutrient rich forage species such as Brachiaria ruziziensis, embracing environmental friendly organic fertilization, and preservation of excess forages in wet season as silage will increase the availability of quality forage throughout the year; thereby ameliorating the deleterious effects of drought feed insufficiency. (Lamidi and Olongbese, 2014). Despite BR exhibiting beneficial features for lucrative ruminant production such as excellent acceptance, a good response to fertilization, and high fodder quality and nutritional content (Santos et al., 2011), quick establishment, strong growth at the start of the wet season, ability to work well in a consortium with legumes, dense flowering, and abundant seed yield (Valle et al., 2013), the information on its potential as a reliable silage under the influence of fertilizer organic fertilizers is insufficient. Information on nutritive value and yield is of great importance in the consideration of forage species for pasture and ruminant production. Likewise, the potency of the fertilizer to improve the soil structure and promote effective nutrient uptake by plants is also crucial for pasture production. However, this study is aimed at verifying the impacts of organic fertilizer treatments on the yield, chemical composition and silage quality of Brachiaria ruziziensis.

MATERIALS AND METHODS

Experimental Site: The research was carried out at the Teaching and Research farm of the Osun State University College of Agriculture, located in Ejigbo, Osun State, in the Southwest of Nigeria. The location exists within the Derived Guinea Savanna ecological zone of Nigeria. The average annual rainfall is 1330mm, which lasts from April to October. The temperature varies from 18oC to 33.88oC and it's rarely below 15oC or above 37.22oC. The average elevation of 426m with a latitude of 7. 54°N, 4.19°E (Google Earth, 2009).
Sources of materials for the experiment: The seeds of Brachiaria ruziziensis were purchased from Nigeria Animal Production Research Institute (NAPRI) Shika, Zaria while Natsoil and Wonder fertilizer were purchased from the accredited dealers in Ibadan and Oyo respectively. The poultry manure was obtained from the University of Osun State College of Agriculture farm Ejigbo.

Collection of soil sample and analysis: The soil sample was collected as described by (Yakubu et al., 2024). The soil samples were collected randomly in four different locations on the experimental field prior to planting at 0-15cm depth using an auger. The soil samples were thoroughly mixed, air-dried, and composited for physical and chemical analysis. Analysis of the soil from the site revealed that it was sandy loam with pH of 6.70; organic carbon 2.20 %, available phosphorus 40.40 mg kg-1, potassium 0.91 cmol/kg, calcium 4.56 cmol/kg, magnesium 2.81 cmol/kg, sodium 2.51 cmol/kg and total nitrogen 0.30%.

Experimental layout, design and treatments: The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. A total land area of 900 m² was divided into four blocks. Each block contained four plots (one per treatment), with each plot measuring 36 m² (6m x 6m) and an intra-row space of 0.5m and an inter-plot space of 1m (Ojo et al.2018). There were four treatments, T1 (no fertilizer), T2 (Natsoil), T3 (Wonder fertilizer), and T4 (poultry manure), with four replicates each. Establishment of Brachiaria ruziziensis (Congo grass): The land was ploughed twice and was left for two weeks after which it was harrowed once to ensure the field was well pulverized. The seeds were drilled in shallow furrows of 1cm at 20kg/ha in August 2023. The plots were weeded manually using hoe and this was done repeatedly to keep the plots weed free throughout the period of the experiment.

Application of fertilizers: Application of poultry manure was performed following the procedure described by (Ewetola et al. 2018). Before two weeks of sowing, poultry manure was incorporated into the treatment plots and mixed thoroughly with the soil. This was done to ensure mineralization of the poultry manure. Natsoil was applied in a similar way to ensure mineralization of the nutrients, while Wonder organic fertilizers were applied using the side placement method after 20days of planting with instructions from the producers of the two commercial organic fertilizers (Natsoil and Wonder) strictly followed. The fertilizer were applied at

100kgN/ha. The rate applied was in accordance with the nitrogen content of each fertilizer as previously determined. Natsoil comprises 2% N, 1% P and 1% K, while Wonder fertilizer consists of 3.4%N, 1.33%P and 1.09%K. The chemical analysis of poultry manure showed that it contained 1.66%N, 3.60%P, 19.20%K, 0.60%Mg, 3.2%Ca and 171.80ppmNa.

Determination of fresh herbage yield: A quadrant measuring 1m2 was tossed randomly 3 times on each plot. The grass covered by the quadrat was harvested at 5cm above the ground using a machete. The harvested grass at each toss was weighed using a weighing scale, and the average weight was calculated and expressed in tonnes per hectare.

Determination of dry matter yield: To determine the dry matter yield, 100g of harvested fresh herbage of BR was taken from each plot, and oven-dried at 650C for 48 hours. The oven dried sample was weighed and recorded to determine weight loss. Dry matter yield was estimated as the product of the percentage of dry matter and fresh herbage weight harvested from each plot, which was then projected in tonnes/ha (Ojo et al., 2018).

Preparation of silage of Brachiaria ruziziensis: The grass was harvested at bloom stage in November, 50 days after sowing, and using sharp machetes at 5cm above the ground and allowed to wilt for 3 hours before preservation. The grasses were carefully packed to avoid soil contamination to prevent clostridia spoilage in the silage. The wilted forages were chopped into 1-3cm using a machete, after which they were filled into an already weighed 20 litre plastic silo. The weight of the Brachiaria ruziziensis grass was determined using a weighing scale and each silo measured 4kg. The silages were compressed in layers with molasses added at each layer. The compressed silage was tightly sealed to prevent infiltration of air.

Determination of physicochemical characteristics of silage: After 21 days of ensiling, silages were opened for physicochemical examination. Parameters such as colour, aroma, and texture were assessed by assembling a group of seven people to judge physical qualities. This was done to increase the accuracy of the results and prevent bias (Alabi, 2014). The Temperature of the silage was determined by dipping a thermometer into the silage within the plastic container and left for two minutes. Also, the colours of the silage were determined with the aid of colour chat.

The silage's pH was measured using the procedure described by (Babayemi 2009). Following an hour of standing time, 50g of the silage from each treatment was combined with 100ml of distilled water in a beaker, and the contents were then stirred. The pH of each treatment sample was then measured and recorded after a glass electrode of a pH meter that was attached to an electrical source was placed into the beaker holding the samples and left for ten seconds.

Preparation of sample: Samples of silage, weighing 500g each, were obtained from the treatments. They were oven-dried at 65°C until a consistent weight was accomplished. Samples that had been baked dry were crushed and sieved through a 1 mm sieve (Ewetola et al., 2022).

Chemical Analysis: The AOAC (2000) technique was used to determine the chemical composition of Brachiaria ruziziensis silage samples. The procedure of Van Soest et al., (1991) was adopted to determine neutral detergent fibre (NDF), acid detergent fibre (ADF), and acid detergent lignin (ADL). Cellulose was estimated as the difference between acid detergent lignin (ADL) and acid detergent fibre (ADF), and hemicellulose was calculated as the difference between NDF and ADF.

Statistics Analysis: Data obtained were subjected to two-way analysis of variance of the General Linear Model of SAS (2018), and means were separated using Duncan Multiple Range Test of the same statistical package. The following statistical model was applied to the data analysis:

$Y_{ij} = \mu + F_i + B_j + E_{ij}$

Where Y_{ij} = Observations for dependent variables (fresh herbage yield, chemical composition, dry matter yield, volatile fatty, methane gas production acids, and digestibility)

μ= population mean

F_i = effect of fertilizer types

E_{ij}= random error

RESULTS AND DISCUSSION

Effect of fertilizer types on fresh herbage and dry herbage yields of Brachiaria ruziziensis

Table 1 shows the effects of fertilizer types on fresh herbage and dry matter yield of Brachiaria ruziziensis. It reveals the yields were significantly influenced ($P<0.05$) by fertilizer treatments. The highest fresh herbage and dry matter yield (18.38tons/ha and 6.90ton/ha) were observed in the Brachiaria ruziziensis fertilized with Wonder fertilizer (T3) followed by Brachiaria ruziziensis fertilized with poultry manure (T4) (16.66 tons/ha and 6.19ton/ha) and those fertilized with Natsoil fertilizer (T2) (14.05tons/ha and 5.23tons/ha) while control (T1) had the lowest mean values (10.25tons/ha and 3.85tons/ha) recorded for both yields.

T1 = Control (No fertilizer) T2= Natsoil fertilizer T3= Wonder fertilizer T4= poultry manure

Yields of the grass is one of the essential qualities considered in the selection of grass species. High-yield species are more favoured because they produce a quantity adequate for immediate feeding and preservation. The results obtained in this study conformed with several other reports by (Ewetola et al., 2011; Edang et al., 2015; Islam et al., 2020; John et al.,2021; Mulisa et al., 2021) in which application of fertilizers resulted in a significant increase ($p<0.05$) in fresh and dry matter yield. John et al. (2021) reported that the application of fertilizer resulted in increased tiller density, plant height, number of leaves and other leave parameters such as leaf width, leaf length and stem-leaf ratio, which in consequence improved the fresh and herbage yield of the grass. Ewetola et al., (2011) observed significant differences in the yields of Panicum maximum var. Ntchisi and Andropogon tectorum fertilized with various fertilizer types, the difference was attributed to the ability of the organic fertilizers to release the nutrients to the soil, especially substantial amounts of nitrogen after mineralization (Ewetola et al., 2011). Ismael (2007) reported that manure significantly increased the yield of different forage species. Fertilizers enrich the soil with the required nutrients that support the growth of the plants. The significant differences observed in the yields of the present study further corroborated these findings. The variation in the yield could be due to the availability of nutrients caused by the application of organic fertilizers thereby caused the availability of more nutrients for plant uptake. The recorded dry yield in the current study (3.85-6.90tons/ha) is similar to the values (3.07-6.24tons/ha) obtained from the study of (Ojo et al., 2018) in which swine manure was used at a dosage of 0-15 tons/ha to fertilize Brachiaria ruzizensis. On the contrary, the recorded dry matter yield for this study is less than the values obtained from (Yakubu et al., 2024) where various green manures were used to fertilize Brachiaria ruziziensis. The dry matter yield recorded was between 4.68 and 9.92 tons/ha. The difference obtained from this study might be due to available nutrients in the soil promoted by a faster fixation of atmospheric nitrogen by the root nodules of the legume and also a more enhanced mineralization of soil organic nitrogen during legume residues decomposition which in turn increases the soil organic matter, which in consequence enhances soil Cation Exchange Capacity (CEC), improves soil aggregation; hence, and supports biological activity (Taminu et al., 2007). In another similar study, Shuaibu et al. (2018) investigated the effects of varying levels of organic fertilizer (Goat manure) on the yields of Brachiaria ruziziensis. The fresh herbage and dry matter yield reported ranged from 5.02 to 10.22 tons/ha and 1.88 to 5.26 tons/ha; these values were less than those recorded in this study. Therefore, application of T3 to the Brachiaria ruziziensis produced more herbage yield than other treatments due to its ability to release of soil nutrients to the Brachiaria ruziziensis. in conclusion, the highest yields recorded for the plot fertilized with Wonder fertilizer (T3) could be attributed to the ability of the fertilizer to supply more nutrients to the plants, so more of it could be have been absorbed by the Brachiaria ruziziensis, therefore, enhancing their growth and other yield parameters that culminate to the improved yields.

Effect of fertilizer types on physicochemical characteristics of Brachiaria ruziziensis silage: Table 2 presents the results of the chemical characteristics of silage produced from Brachiaria ruziziensis. The moisture content, pH and temperature of Brachiaria ruziziensis silage grown with different fertilizer types are presented in the table. The light green colour was observed in T1, while T2 and T3 while T4 had a yellowish green colour and the silage of all treatments had a pleasant odour and smooth texture. There was no significant difference ($p>0.05$) in the values recorded for moisture contents, temperature and pH of the ensiled Brachiaria ruziziensis fertilized with various fertilizer treatments. The values obtained for moisture content ranged from 75.38 to 76.98% while the temperature and pH values of Brachiaria ruziziensis silage ranged from 28.50 to 28.75°C and 4.25-4.35.

Chemical and nutritional analysis may be unaffordable for many farmers, especially smallholder farmers; however, appearance, aroma, temperature, pH and texture indicate the occurrences during fermentation. The physical characteristics examined in this study were colour, aroma, texture and temperature as presented in Table 3. They determine the quality of the silage. Light green and yellow-green colours, firm texture and pleasant fruity aroma were observed from the physical examination of the silages of all treatments. The colour of the silage indicates the ensiling process, showing whether it's proceeding properly or otherwise. According to (t'Mannatje, 1999) as quoted by Alabi (2016), good silage usually preserves the original colour of the forage. The colour exhibited by the silages produced in the present study was nearly proximate to the original colour of the forage from which they were produced; therefore, they revealed features of quality silages. The normal colour obtained can be attributed to a short respiration during the ensiling process. This result agrees with those of (Babayemi et al., 2006; Shuaibu et al., 2018; Paulus et al. 2020). The results showed that the clostridial metabolisms that result in the formation of butyric acids were at a minimal level. Clostridia produce olive-green appearance in silage (Kung et al., 2018). Therefore, the appearance of silages in the present study was devoid of such appearance due to the dominance of lactic acid microorganisms as substantiated by the silage pH. The firm texture of the silage is also in consonance with the results obtained from the previously cited authors. According to Kung and Shaver (2002), the firm texture was expected to be the best texture of good silage. The firm texture is also an indication that clostridial metabolism is greatly reduced. Clostridia produce slimy silage with foul smells (Kung et al., 2018). This shows that the dry matter content of the forage used for making silage was sufficient, and lactic acid production lowered the pH to the level unfavourable for clostridial fermentation. Therefore, the texture obtained in this study showed that the silage was of good quality.

The aroma of complete silage is an indicator which determines the physical quality that is closely related to the fermentation process (Paulus et al., 2020). The ensilage process that occurs optimally can be indicated by the distinctive aroma of silage. The pleasant-fruit odour obtained in this study is in agreement with those of (Babayemi et al., 2006; Shuaibu et al., 2018; Paulus et al. 2020). The smell of silages stemmed from the volatile end products from the silage metabolism; the smell obtained from the present study could be from the formation of acetic acids or esters. The formation of butyric acids brings about a strong, foul, rancid butter smell, which is caused by the utilization of sugar and lactic acids. Hence, the silage produced in the present study is devoid of butyric acid and other spoilage organisms like mould, which produce a musty or mouldy smell with mycotoxin (Korosteleva et al., 2009).

Temperature is one of the essential factors affecting silage colour. High temperature is caused by the activities of aerobic microorganisms. Infiltration of oxygen into the silo results in aerobic respiration that release a great deal of heat. Temperature may influence all phases of silage production and usage from the field to the feed bunk (Ren et al., 2019), Water-soluble carbohydrate contents are significantly affected by temperature, ensiling time and their interactions. Kim and Adesogan (2006) revealed that the higher ensiling temperature increased acid detergent insoluble crude protein (ADICP) concentration. The lower the temperature during ensiling, probably the less will be the colour change (Babayemi et al., 2006). It is essential to carry out dietary analysis when high temperature is observed in silage is due to proteolysis and unavailable protein. The values of temperature recorded for the silages of all treatments were below 30°C and indicated well-preserved silage. The results were similar to those reported by (Alabi, 2016; Shuaibu et al, 2024; Babayemi et al., 2006). Babayemi et al. (2006) reported that McDonald et al. (1995) that the temperature above 30°C turned the grass silage dark yellow or closer to brown due to the caramelization of sugars in the forage. Muck et al. (2003) reported that the higher ensiling temperature decreases or falls within the same range from 35 to 40 °C. This further demonstrates that the temperature of the silage from the present study falls within the normal range.

Generally, pH is one of the simplest and quickest ways of evaluating silage quality. The pH is influenced by the presence of water-soluble carbohydrates and the availability of lactic acids. The presence of additives can improve the quality of silage by improving the activity of lactic acid bacteria. The degree of acidity produced by lactic acid is the highest compared to the pH of other organic acids formed during the fermentation process. Therefore, the rate at which pH silage decreases is largely influenced by the number of lactic acid bacteria formed (Thalib et al., 2000). Additionally, the pH may be influenced by the moisture content and the buffering capacity of the original materials.

Silage that has been properly fermented will have a much lower pH (be more acidic) than the original forage (Babayemi et al., 2006). The pH values recorded for silage of all treatments (4.25-4.35) were within the range (Kung and Shaver, 2001) interpreted as a good silage. They stated that good quality grass and legume silage pH values in the tropics range between 4.3 and 4.7. The values were also related to those obtained in the studies of (Babayemi et al., 2006; Olorunisomo, 2011; Alabi, 2016). The values obtained in the quoted studies were 4.55-5.5, 3.75-4.70, 3.92-7.98 and 4.52-5.5. It can be inferred from the results of this study that silages prepared from each treatment are of good quality and required to feeding animals, with the expectation of tremendous performance due to the dominance of lactic acid bacteria as revealed from the results of the present study.

Effect of fertilizer types on the chemical composition of Brachiaria ruziziensis silage: The chemical composition of silage prepared from Congo grass (Brachiaria ruziziensis) fertilized with different organic fertilizers is presented in Table 4. The table revealed that only crude protein (CP) and crude fibre (CF) were significantly influenced ($p<0.05$) by fertilizer treatments among the evaluated parameters. The values

T1 = Control T2= Natsoil Fertilizer T3= Wonder Fertilizer T4= Poultry Manure

Recorded CP ranged between 5.25% to 6.00% and CF between 28.86%-30.23% ($p=0.05$). The lowest value of CP (5.25%) and highest value of CF (30.23%) was recorded for T1 (control) while T3 (Congo grass fertilized with Wonder fertilizer) had the highest CP value (6.00%) and lowest value of CF (28.86%) The lowest value of CP (5.30%) and highest value of CF (29.60%) was recorded for T2 among the fertilizer treatments while T4 (Congo grass fertilized with poultry manure) followed T3 for both CP and CF values.

The chemical composition of grasses is also a measure of grass quality as it provides information on the feed value of the forage. Feed value is the potential of the feed to supply the nutrients required by an animal both quantitatively and qualitatively, to support a desired type of production. One of the most significant factors that influences the feed value of a forage is chemical composition. Minimizing dry matter loss is essential in producing quality silage. The CP values obtained in this study (5.25-6.00%) were within the range (4.52-5.50%) compared to those reported by (Olorunisomo, 2011) 4.52-5.50, (Ribeiro et al., 2014) 3.60 - 7.20% and (Shuaibu et al., 2018), 3.04-7.20%. All CP values recorded in this study were below 7%, lower than the critical value of 7% or 70 g/kg recommended for small ruminants (NRC, 1981) and also lower than the minimum protein requirement of 10-12% recommended by ARC (1985) for ruminants. The low protein content suggested that there is a need for protein supplementation. The differences observed between the control and treatment might be due to the nutrient composition of the forage used for the silage and available soil nutrients. It has been widely reported that fertilization of fodder crops provides more nutrients, especially nitrogen, which can be absorbed by the plants for making protein (Yakubu et al., 2024; Ojo et al, 2018; Mulisa et al., 2021). The quality of the silage depends on the source of forage used for the silage. Also, the nutrient loss due to the activity of the microbes and proteolytic enzymes may cause protein degradation, thereby reducing the protein content of the silage (Barbara et al., 2023). The available soil nutrients might have favoured T3 with the highest crude protein value, which, in consequence, might have improved the quality and the silage made from it.

The values of crude fibre obtained in this study (28.86-30.23%) are in accordance with the results reported by (Olorunisomo, 2011,) 29.50-35.00% and (Yakubu et al., 2024), 32.00-46.27%. The similarities observed in those studies, and this might be influenced by the stage of harvest and available soil nutrients. It has been reported that the crude fibre increases with the age of forages, thus higher structural and saturation values also increase. Various reports have it that fertilization improves crude protein and it increases with increasing nitrogen content of the fertilizer applied (Ojo et al, 2018, Yakubu et al., 2024). A report by Ojo et al. (2018) confirmed that application of organic fertilizer (swine manure) of up to 10 tons/ha brought about a decrease in crude fibre content. The decrease in fibre constituents of the Brachiaria ruziziensis in the study with manure application could be linked to the increased uptake of essential nutrients, especially nitrogen made available by the manure used in the study. The nutrients in the fertilizer taken up by the plants might have reduced the rate of fibre build up which agrees with the reports of (Cox et al. 1998) that fibre content decreases with fertilizer application. It can be deduced that the available nutrients provided by the organic fertilizer applied were able to suppress the crude fibre content of the forage used for making silage.

The Ash content of a forage provides essential information on the mineral constituents of the forage. The ash content is influenced by the available nutrients in the soil for plant uptake (Ojo et al., 2018). The ash content of the present study (10.36-10.77%) compared well with the range of values (10.30-11.7%) obtained from the study of Andropogon gayanus silage by (Babayemi, 2006) and 9.30% obtained from Brachiaria brizantha by (Paul et al., 2006) and 11.6% for Hyparrhenia rufa. The values obtained in the present study were less than those reported for Andropogon timorensis (14.3%) (Paul et al., 2006), elephant grass (7.5-8.9% and 13.40%) (Olorunisomo, 2011) reported for Bothriochloa radicans by the same author. High ash content lowers metabolizable energy and causes poor fermentation. The ash contents obtained from all treatments are within the range crucial for productive animal production. Silage with such ash content does not require mineral supplements (Babayemi et al., 2006).

Ether extract is also referred to as oil and fat content. High ether extract content in the silage reduces fibre digestion. The ether extract below 5% is considered suitable for silage, and above that impedes the digestion of fibre (Ondarza et al., 2024). The ether extract in this study (2.15- 2.37%) was below the 7.3-8.1% reported by (Babayemi et al.2006; Ojo et al., 2018; Yakubu et al., 2024). On the other hand, the results of this study were found to be higher than those of (Olorunisomo, 2011), ranging from 0.79 to 0.88% and Paul et al. 2006 also reported 1.9% for Andropogon timorensis, 1.6% for Brachiaria brizantha, 0.9 for Chloris gayana and 1.4% for Cynodon dactylon. The difference in the ether extract content of the silage is due to the fat content of the materials from which the silage is produced. High ether extract reported in sorghum silage was attributed to the high-fat content of the silage (Oliveira et al., 2021). Insignificant results obtained in this study might also be due similar fat content of the Brachiaria ruziziensis used for making the silage.

Nitrogen-free extract is the portion of non-structural carbohydrates (Sugar and starch) in the feed. Carbohydrates are tremendously significant from a nutritional viewpoint and are the key fermentation substrate (Kung Jr et al., 2018). The values obtained from the present study ranged from 51.00% to 52.67% were less than those reported by Paul et al. (2006) for tropical grasses, though they were not ensiled. 69%, 82.7%, 80.9%, and 86.7% were recorded for Andropogon timorensis, Brachiaria brizantha, Bothriochloa radicans and Chloris gayana. The NFE in the present study was also above the range (29.89-40.77) reported by (Yakubu et al., 2024) for ensiled Brachiaria ruziziensis, while it was within the range reported by (Olorunisomo, 2011), which ranged from 51.14% to 56.29% for ensiled elephant grass. The disparity observed in those studies might be attributed to the inevitable loss of dry matter, which occurs in the field, during filling and fermentation. Aerobic deterioration brings about a loss of water-soluble carbohydrates. Water-soluble carbohydrates are readily available for lactic acid bacteria for conversion into lactic acids (Wang et al., 2019), some of those carbohydrates are lost in various processes involved in silage making (Barbara et al., 2023). Since nitrogen extract comprises non-structural carbohydrates then the loss of it might be responsible for low nitrogen-free extract. The results of the chemical composition for this study showed that silage of T3 had better nutritive values than the silage of other treatments; therefore, it presents a better option for enhancing the performance of animals than the silage of other treatments.

The fibre fractions of the ensiled Congo grass (Brachiaria ruziziensis) fertilized with different fertilizer types are shown in Table 4. The two major wall fractions in fodder and forage materials are NDF and ADF. ADF is referred to as the portion of the cell wall comprised of cellulose and lignin. It is an indication of the digestibility of forage by animals (Marais, 2004). Digestibility decreases with increasing ADF. ADF increases with the age of the fodder crop. NDF is the cell wall fraction comprised of cellulose, lignin and hemicellulose. Both cellulose and hemicellulose exhibit partial digestibility, while lignin is the indigestible portion of the NDF. An increased level of lignin reduces digestibility and feed intake. The value of NDF indicates the quantity of forage animal can consume. The rising fibre content leads to the consumption of less forage, which is also accompanied by the prolonged ruminal retention time of the forage in the rumen ((Marais, 2004). The results of ADF and NDF of the present study ranged from 34.27% to 35.77% and from 68.02% to 69.61% are within the range (from 38.7% and 67.7%) reported by (Arroquy et al., 2014) in which silage of various fertilized tropical grasses were examined and also close to the range (31.8%-33.7% and 59.00%-61.00%) obtained by (Shuaibu et al., 2018) in which unfertilized Brachiaria ruziziensis was used. Contrary to the result of this present study, (Babayemi, 2006) and Yakubu et al. (2024) reported lower ADF and NDF values for ensiled Brachiaria ruziziensis and Andropogon gayanus. Babayemi (2006) reported values ranging from 21.2% to 24.0% for ADF and 36.3% to 47.8% for NDF, while Yakubu et al. (2024) reported 22% ADF at high nitrogen application, and NDF ranged from 41.58% to 58.57%. In the other reports, the values recorded were higher than those recorded in the present study. Paul et al. (2006) reported high NDF of 74.8%, 71.8% and 78.4% for Brachiaria brizantha, Bothriochloa radicans and Chloris gayana. The insignificant difference in fibre fraction observed in this study contradicts the findings of Yakubu et al. (2024), in which fertilizer types had notable effects on the fibre fraction of ensiled Brachiaria ruziziensis. Ojo et al. (2018) also showed that an increased level of organic manure lowers ADF and NDF values, and this is also corroborated further by the findings of Shuaibu et al. (2018), in which an increase in the level of organic manure caused a decrease in ADF and NDF. Though T1 has the highest value of NDF, ADF and ADL compared to other fertilized treatments, the difference is not significant; maybe increasing fertilizer dosage could have had a significant impact. In addition, the high level of fibre fraction in this present study could be due to the stage of harvesting and soil nutrients not adequate to suppress the rising fibre fractions. The values of NDF in this study are higher than the critical level (45%), which could allow good intake and energy supply, respectively, in ruminants (Mutimura and Ghimire, 2021). Therefore, this will impede the feed intake and digestibility. The ADF of the present study is within the range (30% to 40%) recommended as quality silage (Mutimura and Ghimire, 2021). In another study, Amuda et al. (2020) reported that roughage feeds that contained values of 45% NDF could be classified as high quality, those with values ranging from 45-65% as medium and those with values higher than 65% as low quality. Despite the successful silage process, the underlying forage was inherently high in fibre, which is a nutritional limitation. According to Kellems and Church (1998), as quoted by (Amuda et al., 2020), roughage with less than 40% ADF is high quality, and above 40% is regarded as poor quality. Based on this classification, the values recorded in this study are within the range classified as high quality. The ADL recorded in this study (13.17-13.75%) was within the range (13.23-15.33%) obtained by (Amuda and Tubasen, 2023). This low ADL shows that the silage is of good quality.

The hemicellulose and cellulose are cell wall constituents and polysaccharides. They are very indigestible in monogastrics but digestible in ruminants through fermentation by rumen microbes (Amuda and Tubasen, 2023). Hemicellulose values obtained for silages in this study range from 33.30 to 34.03% while cellulose range from 21.10 to 22.02%. The values obtained in this study for hemicellulose were higher than those reported by (Amuda and Tubasen, 2023) in ensiled Panicum maximum which ranged from 25.03 to 28.27% while 17.77-18.70% were recorded for cellulose. McDonald et al. (1995) reported that ruminants can be fed solely on feed that contains 40% cellulose and 20% hemicellulose. The hemicellulose of the present study is more than 20% but cellulose was less than 40%. According to Amuda and Tubasen (2023), these values are considered not too high for ruminants due to the nature of their stomach and the presence of cellulolytic bacteria and fibrolytic fungi in the rumen which assist in degrading the feed fibre content mainly cellulose and hemicellulose. Since forages with low fibre fractions present better nutritional advantages than those with high fibre values therefore feeding animals with T3 silage translates into improved feed intake and digestibility which enhance the performance of the animals.

CONCLUSION

The study revealed that yields of Brachiaria ruziziensis were influenced by fertilizer treatments with Wonder fertilizer being superior to other fertilizer treatments. In addition, the silages of Brachiaria ruziziensis fertilized with Wonder fertilizer showed dominance in chemical composition with low fibre contents which indicates improved forage quality over others. The quality of silage were unaffected by fertilizer treatments which indicates that they can all be considered for silage preservation. However, the silage of Brachiaria ruziziensis fertilized with Wonder fertilizer having shown superiority in all parameters evaluated in this study, could be considered as feeding materials for ruminant animals. However, the crude protein level recorded in this study shows that feeding animals solitarily on these silage could impaire the optimum improved performance of the animals, therefore the supplmemntation of the silage with protein and rich ingredients are highly essential for improved performance of the animals.

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TABLES

Table 1: Yields of Brachiaria ruziziensis grass fertilized with organic fertilizers

Parameters (tons/ha)	T1	T2	T3	T4	SEM	P value
Fresh herbage yield	10.25^{d}	14.05^{c}	18.38^{a}	16.66^{b}	0.82	<.0001
Dried herbage yield	3.85^{d}	5.23^{c}	6.90^{a}	6.19^{b}	0.30	<.0001

abcd: means with different superscript in the same row are significantly different ($p<0.05$).

Table 2 Chemical characteristics of Brachiaria ruziziensis silage fertilized with organic fertilizers

Treatment	**Treatment**	**Treatment**	**Treatment**	**Treatment**	**Treatment**	
Parameters	T1	T2	T3	T4	SEM	P value
DM	23.02	24.62	23.50	23.50	0.57	0.3655
pH	4.35	4.42	4.25	4.25	0.05	0.6850
TEMP (oC)	28.50	28.50	28.75	28.75	0.36	0.8727
MC	76.98	75.38	76.50	76.50	0.31	0.0777

Table 4: Chemical Composition of Brachiaria ruziziensis silage fertilized with organic fertilizers

Parameters (%)	T1	T2	T3	T4	SEM	P value
Dry matter	92.65	92.66	92.57	92.39	0.08	0.4784
Crude protein	5.25^{b}	5.30^{b}	6.00^{a}	5.82^{b}	0.10	0.0366
Crude fibre	30.23^{a}	29.62^{b}	28.86^{c}	29.86^{b}	0.16	0.0191
Ash	10.36	10.76	11.11	10.77	0.13	0.5651
Ether extract	2.15	2.27	2.37	2.27	0.04	0.5124
Nitrogen free extract	51.00	51.84	52.67	51.24	0.38	0.6106
Neutral detergent fibre	69.61	69.30	68.02	68.30	0.32	0.1814
Acid detergent fibre	35.77	35.27	34.27	35.00	0.24	0.3230
Acid detergent lignin	13.75	13.67	13.17	13.60	0.16	0.8522
Hemicellulose	33.84	34.03	33.75	33.30	0.37	0.4747
Cellulose	22.02	21.60	21.10	21.40	0.15	0.0633

abcd: means with different superscript in the same row are significantly different ($p<0.05$).