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COMPARATIVE STUDY ON THE NUTRITIVE VALUES OF SILAGE PRODUCED FROM NAPIER GRASS (*Pennisetum purpureum*) VARIETIES IN SHIKA, NIGERIA

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ABSTRACT
Seasonal feed scarcity is a major constraint to sustainable livestock production in tropical regions. Ensiling surplus forage is a key strategy to mitigate this issue. This study evaluated the nutritive value and fermentation characteristics of silage produced from four Napier grass varieties (Juncao, Super Napier, Hybrid Napier, and Elephant grass) cultivated in Shika, Nigeria. A Randomized Complete Block Design (RCBD) with three replications was used. The grasses were harvested at 10 weeks, chopped, and ensiled for 22 days using a bottle silo method. Silage samples were analyzed for physical properties, proximate composition, fiber fractions, and mineral content. Results indicated significant differences ($p<0.05$) among varieties. Super Napier grass silage had the lowest pH value of (3.93), Hybrid Napier and Elephant grass silages had pH values of 4.11 and 4.17 respectively, which are within the optimal range (pH < 4.2) for well-preserved silage, indicating efficient lactic acid production and inhibition of spoilage microorganisms and very sweet aromas. Elephant grass recorded the highest crude protein (12.07%) but also the highest fiber fractions (ADF 35.75%, NDF 69.32%), potentially limiting its digestibility. Juncao grass showed the most favorable fiber profile for intake (lowest NDF: 66.35%) and the highest phosphorus content (1.32%). It is concluded that while Hybrid Napier offers a balanced combination of good fermentation quality and moderate nutrient levels, Juncao grass presents exceptional potential as a mineral-rich, highly digestible silage source. The choice of variety should be based on specific nutritional goals and supplementation strategies.

Keywords: *Pennisetum purpureum*, silage quality, fermentation, proximate analysis, fiber fractions, ruminant nutrition.

1.0 INTRODUCTION
Livestock production in developing countries is predominantly constrained by the lack of continuity in the supply of quality feed, relying heavily on natural pastures and crop residues which are often low in both quality and quantity (Sarmini and Premaratne, 2017 Sarker *et al*., 2019). This directly results in low productivity of dairy animals (Premaratne and Premalal, 2006). The abundant production of grasses like Napier grass during the rainy season presents a critical opportunity for conservation as silage, providing high-quality feed during the dry season (Sarker *et al*., 2019). Napier grass (*Pennisetum purpureum* Schumach), a high-yielding perennial tropical grass, is a cornerstone of smallholder livestock systems in Africa (Kabirizi *et al*., 2013). However, its nutritive value is often compromised by high fiber and low crude protein content, especially when harvested at advanced maturity in the process of maximizing yield (Rusdy, 2018; Sarker *et al.*, 2019). Ensiling can preserve its quality, but the outcome is highly dependent on the grass variety and its inherent characteristics (Kung *et al*., 2003, as cited in Gulfam *et al*., 2016). Despite its importance, there is a dearth of comparative information on the silage quality from different Napier grass varieties available in Nigeria. This study, therefore, aimed to fill this gap by evaluating the nutritive value, comparing fermentation characteristics, and identifying the most nutritionally superior Napier grass variety for silage production in Shika, Nigeria.

2.0 MATERIALS AND METHODS
2.1 Location and Climate
The study was conducted at the National Animal Production Research Institute (NAPRI), Shika, Zaria, located in the Northern Guinea Savannah zone of Nigeria. The area experiences a tropical climate with a distinct wet (May-October) and dry (November-April) season. Meteorological data during the experimental period is presented in Table 1.

Table1: Metrological Distribution of the Experimental Location

Month	Max T (^{0}C)	Relative Humidity (%)	Rainfall (mm)
May	34.58	52.74	4.53
June	30.50	66.48	5.70
July	28.16	73.21	7.69
August	29.10	75.69	11.02
September	30.00	69.28	6.52
October	32.84	53.84	1.57
Total	**185.18**	**391.24**	**37.03**
Means	**30.86**	**65.21**	**6.17**

Source: Institute of Agricultural Research (IAR) Weather Station, Samaru, 2024

2.2 Experimental Design and Silage Production

The study employed a Randomized Complete Block Design (RCBD) with three replications. Four Napier grass varieties (Juncao, Super Napier, Hybrid Napier, and Elephant grass) were harvested at the experimental plot of Feeds and Nutrition Research Programme of the Institute. The harvest was done after 10 weeks of regrowth, and chopped to 2-3 cm lengths. The chopped forage was ensiled using a bottle silo method, compacted to expel air, sealed to maintain anaerobic conditions, and fermented for 22 days.

2.3 Analytical Procedures

Proximate analysis (AOAC, 2005) was used to determine dry matter, crude protein, ether extract, crude fiber, and ash. Fiber fractions were determined according to Van Soest (1994). Fermentation parameters including pH, color, aroma and texture were determined as described by Ishiaku *et al.*, (2020). Calcium and phosphorus contents were determined by standard mineral analysis methods.

2.4 Statistical Analysis

Data were analyzed using Analysis of Variance (ANOVA) in SPSS software Version 18, (2005). Significantly different means were separated using Duncan's Multiple Range Test (DMRT) at a 5% significance level.

3.0 RESULTS AND DISCUSSION

The physical characteristics of the silages are presented in Table 2. All silages maintained a stable temperature (18-19°C). A key indicator of fermentation quality pH, varied significantly ($p<0.05$) among varieties. Super Napier and Elephant grass silages had the lowest pH values (3.93 and 4.11, respectively), which are within the optimal range (pH < 4.2) for well-preserved silage, indicating efficient lactic acid production and inhibition of spoilage microorganisms as reported by (Kung *et al*., 2018). Juncao grass had a significantly higher pH (5.34), suggesting suboptimal fermentation, potentially due to lower fermentable sugar content or inadequate lactic acid bacteria populations. All varieties had a sweet to very sweet aroma, confirming the absence of spoilage and the presence of desirable fermentation end-products. The color ranged from yellow-green to dark green, with Hybrid and Elephant grass retaining a darker green color, indicative of better chlorophyll preservation as reported by (Ishiaku *et al*., 2020).

Table 2: Physical Characteristics of Silage Produced from Napier grass Varieties

Varieties	T^{0}C	pH	Aroma	Color	Texture
Juncao grass*	18.33	5.34^c	Sweet	Yellow green	Coarse
Super Napier	18.34	3.93^a	Sweet	Yellow green	Coarse
Hybrid Napier	19.00	4.17^b	Very sweet	Dark green	Coarse
Elephant grass	19.00	4.11^b	Very sweet	Dark green	Coarse
SEM	1.16	0.24	NA	NA	NA
LOS	NS	*	NA	NA	NA

abc Means with the same alphabet within columns are not significantly (P>0.05) different

The nutritive composition of the silages is shown in Table 3. Dry Matter (DM) content was highest and similar (p>0.05) for Juncao, Super Napier, and Hybrid Napier (>95%), but significantly lower for Elephant grass (86.82%). A lower DM content can increase effluent loss and risk of clostridial fermentation (McDonald *et al*., 1991). Elephant grass silage had the highest CP content (12.07%), followed by Hybrid Napier (11.86%), making them valuable protein sources for ruminants. This aligns with (Islam *et al*., 2023) findings, that certain Napier varieties can achieve CP levels sufficient for moderate milk production. However, Elephant grass also had the highest CF (33.63%), which could negatively impact digestibility (Van Soest, 1994). Juncao grass had the highest NFE (50.91%), a measure of readily digestible carbohydrates, indicating its high potential energy value.

Table 3: Proximate Composition of Napier Grass Varieties Harvested at 10 Weeks of Age

Varieties	DM	CP	EE	CF	Ash	NFE
Juncao grass*	95.31^{a}	10.06^{c}	0.28^{a}	27.96^{c}	10.56^{b}	50.91^{a}
Super Napier	94.89^{a}	11.27^{b}	0.20^{b}	30.19^{b}	10.98^{b}	47.36^{b}
Hybrid Napier	95.01^{a}	11.86^{a}	0.13^{c}	31.25^{b}	11.45^{ab}	45.32^{c}
Elephant grass	86.82^{b}	12.07^{a}	0.04^{d}	33.63^{a}	12.23^{a}	42.03^{d}
SEM	1.16	0.24	0.02	0.64	0.22	1.00
LOS	*	*	*	*	*	*

abc Means with the same alphabet in columns are not significantly (P>0.05) different

The fiber analysis (Table 4) is critical for predicting voluntary intake and digestibility. Juncao grass had the lowest ADF (34.42%) and NDF (66.35%) values. Since NDF is negatively correlated with intake, Juncao silage is predicted to have the highest voluntary consumption as reported by (Cherney and Cherney, 2020). Conversely, Elephant grass and Super Napier had the highest NDF values (>69%), which may limit intake. Hemicellulose and lignin contents were generally high across all varieties, consistent with the nature of tropical grasses at 10 weeks of harvest. The mineral composition is shown in Table 5. Phosphorus content was significantly highest in Juncao grass silage (1.32%), vastly exceeding the dietary requirements for ruminants (0.35-0.45%; NRC, 2001). This makes Juncao an excellent natural source of this essential mineral for bone development and metabolic functions. Calcium content was statistically similar but numerically highest in Juncao (0.28%), though all varieties would likely provide calcium supplementation in a complete ration.

Table 4: Fiber Fraction of Napier Grass Varieties Harvested at 10 Weeks of age

Varieties	ADF	NDF	HEMICELLULOSE	LIGNIN
Juncao grass	34.42^{b}	66.35^{b}	31.93^{b}	6.31^{ab}
Super Napier	35.75^{b}	68.79^{a}	33.04^{a}	5.99^{b}
Hybrid Napier	37.62^{a}	69.04^{a}	31.42^{b}	6.66^{ab}
Elephant grass	35.75^{b}	69.32^{a}	33.57^{a}	6.53^{a}
SEM	0.41	0.37	0.31	0.10
LOS	*	*	*	*

abc Means with the same alphabet within columns are not significantly (P>0.05) different

Table 5: Ca and Phosphorus Content of Napier grass Varieties Harvested At 10 Weeks Age

Varieties	Ca (%)	P (%)
Juncao grass	0.280^{a}	1.316^{a}
Super Napier	0.167^{c}	0.879^{b}
Hybrid Napier	0.195^{b}	0.323^{c}
Elephant grass	0.185^{b}	0.378^{c}
SEM	0.02	0.13
LOS	*	*

abc Means with the same alphabet are not significantly (P>0.05) different

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 CONCLUSION

The study demonstrates significant variation in the nutritive value and fermentation quality of silage from different Napier grass varieties. No single variety was superior in all aspects: Hybrid Napier and Elephant grass exhibited the best fermentation characteristics (low pH, and sweet aroma). Elephant grass had the highest crude protein but also the highest fiber, which may restrict its digestibility and intake. Finally, Juncao grass emerged as a standout variety for its high dry matter, favorable fiber profile for high intake, exceptional energy (NFE) content, and remarkably high phosphorus levels, though its higher pH requires improved fermentation management.

4.2 RECOMMENDATIONS

It is recommended that:

1. Hybrid Napier be promoted for its balanced combination of good fermentation quality and solid nutrient content.
2. Juncao grass be further investigated and adopted for its superior mineral content and digestibility potential, with research focused on using additives (e.g., molasses, inoculants) to improve its fermentation.
3. Farmers should be trained on the specific attributes of each variety to make informed choices based on their feeding strategies and available supplementation.

Conflict of Interest: No conflict of interest by the authors

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