Physicochemical Composition of Silage Produced from Napier Grass (*Pennisetum purpureum*) Varieties in Shika, Nigeria

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Abstract
Silage production has been widely promoted as a viable strategy for conserving forages during periods of abundance to sustain livestock feeding in times of scarcity. This study was conducted at the National Animal Production Research Institute (NAPRI), Shika, Nigeria, to evaluate the comparative nutritive value and fermentation characteristics of silage produced from four (4) Napier grass varieties: Juncao, Super Napier, Hybrid Napier, and Elephant grass. A Randomized Complete Block Design was employed, and forages were harvested at 10 weeks of growth, chopped, and ensiled for 22 days in airtight containers. Laboratory analyses were conducted to determine proximate composition and physical characteristics were determined. Results indicated significant ($P<0.05$) varietal differences in both nutritional and fermentation qualities. Elephant grass exhibited the highest crude protein content (12.07%) but also the highest crude fiber (33.63%), which may reduce digestibility. Hybrid Napier combined high crude protein (11.86%) with excellent dry matter retention (95.01%), making it nutritionally balanced. Super Napier demonstrated optimal fermentation quality, recording the lowest silage pH (3.93), which is within the desirable range for silage stability. The findings suggest that Hybrid Napier and Juncao are the most promising varieties for silage production in Shika, Nigeria, due to their superior balance of nutrient composition and digestibility. While Elephant grass may contribute protein, its high crude fiber content limits efficiency, and Super Napier offers fermentation stability but requires dietary supplementation. This study underscores the importance of varietal selection in silage production as a strategy for sustainable livestock feeding and improved productivity in the Guinea Savannah zone of Nigeria.

Keywords: Napier grass, silage, physical, proximate, livestock feeding, Nigeria

Description of Problem

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 [8]. 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. Napier grass (*Pennisetum purpureum* Schumach), a high-yielding perennial tropical grass, is a cornerstone of smallholder livestock systems in Africa. However, its nutritive value is often compromised by high fiber and low crude protein content, especially when harvested at advanced maturity to maximize yield [3]. Ensiling can preserve its quality, but the outcome is highly dependent on the grass variety and its inherent characteristics [1]. 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 and comparing proximate characteristics in Shika, Nigeria.

Materials and Methods

Location of the Study

The experiment was conducted at National Animal Production Research Institute (NAPRI), under Feeds and Nutrition Research Programme Experimental Farm in

Shika, Ahmadu Bello University, Zaria-Kaduna State, Nigeria. Shika is located in the northern region of Nigeria, within the Guinea Savannah zone. The area experiences a tropical climate characterized by distinct wet and dry seasons. The wet season typically spans from May to October, while the dry season extends from November to April. Average annual rainfall ranges between 1,000 to 1,200 mm, and temperatures can vary from 15°C during the cooler months to 38°C in the hotter periods [6]. The soil in Shika is predominantly sandy loam, which is suitable for cultivating various forage crops, including Napier grass (*Pennisetum purpureum*).

Experimental Design

The study employed a Randomized Complete Block Design (RCBD) to assess the nutritive value of silage produced from different Napier grass varieties. The experimental treatments include multiple Napier grass varieties, each serving as a treatment group. Each treatment was replicated three times to ensure statistical validity. The plots were randomly assigned within each block to minimize the effects of spatial variability. This design was chosen for its effectiveness in controlling variability and providing reliable comparisons among treatments.

Collection and Preparation of Napier Grass Varieties

Selected Napier grass varieties were sourced from a reputable agricultural research institute, specifically, Feeds and Nutrition Research Programme, under the National Animal Production Research Institute (NAPRI), Shika, for cultivating these varieties. The grass was harvested at the optimal maturity stage, typically when the plant reaches about 1 meter in height or at approximately 8 to 10 weeks of growth, to ensure a balance between yield and nutritional quality. Post-harvest, the grass was chopped into lengths of 2 to 3 centimeters using a mechanical chopper to facilitate compaction and fermentation during the ensiling process.

Silage Production Process

The chopped Napier grass was ensiled using bottle method instead of trench silo, a common practice in tropical regions [7].

Laboratory Analysis of Silage Nutrients

After the fermentation period of 21 days, samples of the silage were collected for laboratory analysis to determine their nutritional composition. These analyses provided comprehensive understanding of the nutritional value and fermentation quality of the silage produced from each Napier grass variety.

Statistical Analysis

The data collected from the laboratory analyses was subjected to statistical analysis using analysis of variance (ANOVA) to determine the significant differences among the treatments. However, significant differences were separated using Duncan Multiple Range Test (DMRT) at a 5% significance level. Statistical software of SPSS was utilized for these analyses.

RESULTS AND DISCUSSION

Table 1 showed the sensory and physical characteristics of silage made from four Napier grass varieties: Juncao, Super Napier, Hybrid Napier, and Elephant grass. The pH values ranged from 3.93 (Super Napier) to 5.34 (Juncao)**.** Lower ($P<0.05$) pH indicates better fermentation quality and preservation, favoring Super Napier, Elephant grass and Hybrid Napier. High pH in Juncao suggests poor fermentation, possibly due to lower lactic acid production. All varieties had sweet to very sweet aroma, indicating acceptable fermentation, which is consistent with good silage standards [1]. Color varied from yellow-green to dark green, with Hybrid and Elephant grass having darker green, a sign of chlorophyll retention and better nutrient preservation. Texture was coarse across all samples, suggesting similar structural composition [2]. Lower pH and sweet aroma in Super Napier and Hybrid Napier indicate superior fermentation quality, aligning with

findings by [4], which highlighted pH ≤ 4.2 as optimal for tropical silages.

Table 2: Proximate composition: There was significant (P<0.05) effect of variety on the parameters measured. This table compares dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF), ash, and nitrogen-free extract (NFE). The DM was highest in Juncao and Hybrid Napier (>95%), indicating good preservation; Elephant grass had the lowest DM (86.82%), risking spoilage. The CP was significantly (P<0.05) highest in Elephant grass (12.07%), followed by Hybrid Napier (11.86%), crucial for livestock performance [3]. The EE declined from Juncao (0.28%) to Elephant grass (0.04%), affecting energy values. The CF and ash were highest in Elephant grass, which could limit digestibility [9]. The NFE, a source of readily digestible carbohydrates, was highest in Juncao (50.91%) and lowest in Elephant grass (42.03%). Hybrid Napier and Elephant grass have better protein content, but higher fiber in Elephant grass may reduce digestibility. Juncao excels in energy due to high NFE.

Table 1. Physical Characteristics of Silage Produced from Napier grass Varieties

Varieties	T^0C	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
Significant		*			

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

Table 2: 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
Significant	*	*	*	*	*	*

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

Conclusion and Application

Hybrid Napier and Juncao emerged as superior silage sources in terms of nutrient value and fermentation characteristics. Elephant grass, despite high CP, had higher fiber, which may hinder digestibility. Super Napier showed promising fermentation quality but moderate nutrient levels. It could be recommended to promote hybrid Napier and Juncao in ruminant feeding systems.

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