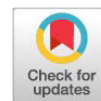


## Research Article



# Chemical Composition of Guinea Grass (*Megathyrsus maximus* Jacq.) Cultivars as Forage for Ruminants Under VSU Microclimate

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**Abstract** | This study compared the effects of cultivar and harvest age on the chemical composition of Guinea grass (*Megathyrsus maximus* Jacq.) grown under the microclimate at Visayas State University, Leyte, Philippines. The two factors were: Factor A: cultivar (Local Guinea grass; LG and Mombasa grass; MG), and Factor B: harvest age (30 and 45 days). The harvested samples were subjected to proximate analysis and fiber fraction assessment using the standard laboratory procedures. The data were analyzed using a 2x2 factorial experiment in a Randomized Complete Block Design with cultivars and harvest age as main effects. Dry matter ( $p=0.0068$ ) and organic matter ( $p<0.0001$ ) were significantly higher for LG than for MG, except for ash ( $p<0.0001$ ; higher for MG). These chemical compositions increased with harvest age. Interaction effects were observed between crude protein ( $p=0.0018$ ) and ether extract ( $p=0.0044$ ), while gross energy increased significantly with harvest age ( $p=0.0003$ ). Significant interaction effects were observed for neutral detergent fiber ( $p=0.0001$ ), acid detergent lignin ( $p=0.0206$ ; both highest for LG45), and hemicellulose ( $p=0.0015$ ; highest for MG45). Acid detergent fiber and cellulose were significantly higher for LG ( $p=0.0001$ ) and increased with harvest age. MG (specifically when harvested at 30 days) had higher crude protein and lower fiber fractions, making it a more favorable forage from a ruminant nutrition perspective than LG. This study highlights the importance of proper cultivar selection and harvest age, thus optimizing the feeding value of Guinea grass as forage for ruminants under the VSU microclimate.

**Keywords** | Chemical analysis, Fiber profile, Guinea grass, Harvest age, Microclimate, Mombasa grass

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## INTRODUCTION

Guinea grass (*Megathyrsus maximus* Jacq.) is widely cultivated by ruminant farmers due to its adaptability, ease of propagation, and high biomass yield. Of its cultivars, Local Guinea grass (LG) and Mombasa grass (MG; *Megathyrsus maximus* Jacq. cv. Mombasa) are especially common in tropical Southeast Asia, including the Philippines (Bestil *et al.*, 2014; Hare *et al.*, 2014; Bacorro *et al.*, 2018; Atole *et al.*, 2025). Numerous studies have shown that harvest

age significantly influences the nutrient composition of these grasses, which in turn affects ruminant feed intake (Hare *et al.*, 2013; Guadayo *et al.*, 2019). Delayed harvest ages consistently increase fiber [(NDF (neutral detergent fiber), ADF (acid detergent fiber), and ADL (acid detergent lignin)] concentrations in plant tissues, reducing rumen degradability. Conversely, harvesting grasses at a younger age can result in higher crude protein (CP), soluble carbohydrate, and mineral contents (Van Niekerk *et al.*, 2010; Machado *et al.*, 2020; Thongruang *et al.*, 2020; Ramirez *et al.*, 2022). Therefore,

Harvesting grasses while young typically enhances their nutritive value in ruminants. However, dry matter (DM), including other more soluble cellular components, may be lower than that of grasses harvested late. In fact, delaying the harvest age increases the herbage yield at the expense of forage acceptability and digestibility in ruminants (Guadayo *et al.*, 2019; Junges *et al.*, 2024; Atole *et al.*, 2025). This is exacerbated by the reduced leaf-to-stem ratio as the grass matures due to chemical composition imbalances that can diminish its nutritional integrity. Moreover, genetic differences in growth rate and cell wall development between LG and MG can complicate the situation (Ramirez *et al.*, 2022). Also, cultivar differences between LG and MG may greatly affect the chemical composition of their plant parts (Hare, 2020). Despite extensive research on the effects of harvest age on forage quality, information on the interaction between cultivar type and harvest age on the chemical composition of Guinea grass cultivars under specific microclimatic conditions is poorly characterized. This limits the development of precise, location-specific harvest recommendations to optimize forage quality and yield of LG and MG. On the other hand, the geography (e.g., soil type, topography) and microclimate (e.g., rainfall, temperature, humidity) at the Visayas State University (VSU) can affect plant growth, nutrient uptake, and fiber deposition. These conditions can influence the DM, OM (organic matter), ash, CP, NDF, ADF, and ADL of plants, making findings from other regions indirectly applicable. Therefore, site-specific findings are essential for developing effective harvest strategies and maximizing forage quality. Among the chemical composition of grasses, DM, OM, ash, CP, NDF, ADF, and ADL are essential indicators of their feeding value for ruminants (Bestil *et al.*, 2014; Guadayo *et al.*, 2019; Chen *et al.*, 2022). Forages with lower concentrations of detergent fiber fractions and their fiber components, and higher CP content and soluble sugars, promote better rumen microbial activity (Villalba *et al.*, 2021). This event improves nutrient digestibility and animal performance, aided by nutrient availability in the gut (Obregón-Cruz *et al.*, 2024). Therefore, understanding the impacts of Guinea grass cultivar and harvest age on forage production is essential from a ruminant nutrition perspective. Hence, this study compared the chemical composition of LG and MG harvested at 30 and 45 days. This study is pioneering in the Visayas, particularly in Region 8, an archipelagic area characterized by diverse microclimatic conditions resulting from its island geography.

## MATERIALS AND METHODS

### EXPERIMENTAL TREATMENTS AND DESIGN

Two factors were considered in this study: Factor A-Guinea grass cultivar (LG, MG), and Factor B-harvest age (30, 45 days). The following treatment combinations were compared: LG30-LG, harvested at 30 days; LG45-LG, harvested at 45 days; MG30-MG, harvested at 30 days; and MG45-MG, harvested at 45 days. A 2x2 factorial experiment in a Randomized Complete Block Design was employed to compare the effects of cultivar and harvest age on the chemical composition of LG and MG. The experimental area was an existing pasture previously utilized for cattle grazing, which has an inherent spatial variability. To control this variability, four blocks were established (four plots/block), each having the randomly assigned treatment combinations. The experimental area was blocked based on the identified factors (e.g., topography, light exposure, and soil characteristics) that may affect plant growth and nutrient composition. The experimental plots (i.e., experimental unit) within each block received the specific treatment combination and were randomly repeated in other blocks.

### ENVIRONMENTAL CONDITIONS OF THE EXPERIMENTAL AREA

VSU is located in the province of Leyte, which has a Type IV climate, defined by a distribution of year-round rainfall (Basconcillo *et al.*, 2016; Aclan and Sumaria, 2025). The study area is located at the foot of Mount Pangasugan, surrounded by tree-dominated vegetation and close to the sea, which contributes to its microclimatic conditions. An area with a microclimate is characterized by a small, localized environment with slightly different conditions than the regional climate. During the study, the mean rainfall (12.71 mm) and air temperature (25.02 °C) were recorded using data obtained from the PAGASA AGROMET Station, VSU, Visca, Baybay City, Leyte. The soil characteristics [(pH: 5.89, total OM: 1.84%, total N: 0.16%, avail P: 22.96 mg/kg, exchangeable K: 63.41 mg/kg, particle size: 7.66% clay, 18.66% silt, and 73.66% sand] by composite sampling from the plots were analyzed at the Central Analytical Services Laboratory, VSU, Visca, Baybay City, Leyte.

### LAND PREPARATION AND PLANTING OF GUINEA GRASS

Several portions of the pasture area at the Department of Animal Science, VSU, Leyte, Philippines, were plowed once and harrowed twice, then divided into four plots (2.5 x 5 m) per block. Four tillers per hill of Guinea grass were planted (0.5 x 0.5 m) and basally fertilized (10 days post-planting) once with complete

fertilizer (14-14-14) at a rate of 200 kg/ha. Weeding was carried out as needed, while watering depended on rainfall, reflecting the local practice of marginal ruminant farmers in Leyte, Philippines.

#### HARVESTING AND PREPARATION OF GUINEA GRASS FOR CHEMICAL ANALYSIS

Zeroing was performed when Guinea grass cultivars were 60 days old by manually cutting 15 cm above ground with scissors. These served as the baseline information for Factor B: harvest age. The next harvest from their respective plots follows the designated harvest age. Two kilograms of randomly collected and freshly chopped (1 inch long) Guinea grass cultivars from each plot were the composite sample source (50 g). Thereafter, five grams from the composite sample (replicated 3x) were oven-dried (105 °C) for eight hours or until constant weight was achieved. The samples intended for chemical analysis were oven-dried (60 °C) overnight or until constant weight was achieved (Atole and Bestil, 2014). The oven-dried samples were immediately ground using a mini-Wiley mill and passed through a 2-mm screen (1425 RPM, Model: 5KH39QN9777, GE Motors, USA; Atole and Bestil, 2019). The ground samples were kept in a sealed plastic container, labeled and stored in a cool, dry place until further analysis.

#### CHEMICAL ANALYSIS OF GUINEA GRASS

The chemical composition of the Guinea grass cultivars was analyzed at the Animal Nutrition Laboratory of the Department of Animal Science, VSU, Visca, Baybay City, Leyte, Philippines. Samples from each plot in duplicate were analyzed for %DM (105 °C for 8 h), %ash (ashing at 600 °C for 4 h), % OM (100-

%ash), %CP (micro Kjeldahl digestion and distillation), %NDF, %ADF, %acid detergent lignin (ADL; Van Soest and Robertson, 1979), %hemicellulose (%NDF-%ADF), %cellulose (%ADF-%ADL), gross energy (GE; bomb calorimeter, Static Jacket Calorimeter, IKA-Werke GmbH and Co. KG, Germany), and %ether extract (EE; Soxhlet fat extraction) following the AOAC (1995) procedures.

#### STATISTICAL ANALYSIS

The data were analyzed using analysis of variance for a 2x2 factorial experiment arranged in a Randomized Complete Block Design. Treatment means were compared using Tukey's Honestly Significant Difference test using the Statistical Analysis System computer program. Main and interaction effects were considered significant at  $P \leq 0.05$ .

## RESULTS

#### DRY MATTER, ORGANIC MATTER, AND ASH CONTENTS

Table 1 showed no interaction effects between cultivar and harvest age for %DM ( $p=0.3206$ ), %ash ( $p=0.2574$ ), and %OM ( $p=0.2569$ ). However, main effects were observed with LG containing significantly higher DM ( $p=0.0068$ ) than MG, with values increasing at 45 days of harvest ( $p<0.0001$ ). In contrast, MG has significantly higher ash content ( $p<0.0001$ ) than LG, with values increasing at 45 days of harvest ( $p=0.0078$ ). LG had significantly higher OM content ( $p<0.0001$ ) than MG, but OM content decreased at 45 days of harvest ( $p=0.0077$ ). This indicates a greater proportion of organic nutrients available for animal utilization. In contrast, MG had a significantly higher ash content than LG, with values increasing at 45 days post-harvest.

**Table 1:** The chemical analysis of LG and MG harvested at 30 and 45 days.

| Parameters        | LG                 |                    | MG                 |                    | SEM   | P-values |        |        |
|-------------------|--------------------|--------------------|--------------------|--------------------|-------|----------|--------|--------|
|                   | 30-d               | 45-d               | 30-d               | 45-d               |       | A        | B      | AxB    |
| DM (%)            | 21.95              | 23.85              | 21.35              | 23.52              | 0.09  | 0.0068   | <.0001 | 0.3206 |
| Ash (%)           | 10.72              | 11.69              | 12.56              | 13.03              | 0.15  | <.0001   | 0.0078 | 0.2574 |
| OM (%)            | 89.28              | 88.31              | 87.44              | 86.97              | 0.14  | <.0001   | 0.0077 | 0.2569 |
| CP (%)            | 4.47 <sup>b</sup>  | 4.02 <sup>c</sup>  | 5.18 <sup>a</sup>  | 4.21 <sup>b</sup>  | 0.04  | <.0001   | <.0001 | 0.0018 |
| EE (%)            | 2.48 <sup>a</sup>  | 2.21 <sup>c</sup>  | 2.40 <sup>ab</sup> | 2.34 <sup>b</sup>  | 0.02  | 0.5319   | 0.0003 | 0.0044 |
| GE (Cal/g)        | 3616               | 3801               | 3582               | 3736               | 21.10 | 0.1308   | 0.0003 | 0.6077 |
| NDF (%)           | 68.05 <sup>c</sup> | 72.59 <sup>a</sup> | 63.05 <sup>d</sup> | 70.14 <sup>b</sup> | 0.14  | <.0001   | <.0001 | 0.0001 |
| ADF (%)           | 40.93              | 43.18              | 35.84              | 38.49              | 0.12  | <.0001   | <.0001 | 0.3062 |
| ADL (%)           | 4.70 <sup>b</sup>  | 6.27 <sup>a</sup>  | 4.04 <sup>c</sup>  | 4.85 <sup>b</sup>  | 0.09  | <.0001   | <.0001 | 0.0206 |
| Hemicellulose (%) | 27.13 <sup>c</sup> | 29.42 <sup>b</sup> | 27.21 <sup>c</sup> | 31.65 <sup>a</sup> | 0.16  | 0.0009   | <.0001 | 0.0015 |
| Cellulose (%)     | 36.23              | 36.90              | 31.80              | 33.64              | 0.18  | <.0001   | 0.0011 | 0.0565 |

\*Treatments with similar superscripts in each row are not significantly different.

### CRUDE PROTEIN AND ENERGY CONTENTS

Interaction effects were observed for %CP ( $p=0.0018$ ) and %EE ( $p=0.0044$ ). MG30 had the significantly highest CP content among other treatments. MG30 and LG30 have the significantly highest EE content. In contrast, GE was not affected by cultivar type, but was significantly affected by harvest age ( $p=0.0003$ ), with higher GE values obtained at 45 days compared with 30 days.

### VAN SOEST FIBER COMPONENTS

Interaction effects were observed for the %NDF ( $p=0.0001$ ), %ADL ( $p=0.0206$ ), and %hemicellulose ( $p=0.0015$ ). For %NDF and %ADL, LG45 had the significantly highest values recorded, while for %hemicellulose, MG45 had the significantly highest value ( $p=0.0015$ ). In contrast, no interaction effects were observed, but main effects were detected for %ADF and %cellulose. LG had significantly higher ADF ( $p<0.0001$ ) and %cellulose contents ( $p<0.0001$ ) than MG, with values increasing at 45 days of harvest ( $p<0.0001$ ).

## DISCUSSION

The cultivar type and harvest age greatly affected the chemical composition of Guinea grass. The increasing DM contents with harvest age (i.e., 45 days) indicate plant maturity and a reduction in grass moisture content. During this event, the Van Soest detergent fiber fractions, particularly the fiber fractions (cellulose and hemicellulose), have increased the structural tissue development of plant parts. Although soil mineral dynamics were not assessed in this study, previous studies have shown that mineral accumulation tends to increase at grass maturity (Darch *et al.*, 2020; Peng *et al.*, 2024), which supports our findings. Additionally, at a later age, higher mineral accumulation is associated with reproductive stages (Maillard *et al.*, 2015), which may consequently dilute the proportion of organic nutrients, thereby decreasing OM content at 45 days. Therefore, delaying the harvest age provides higher biomass production and mineral accumulation in grasses, providing a better forage supply when feed is scarce.

The concentration of CP was greatly affected by the cultivar, harvest age, and their interaction. The decline in CP concentration at 45-day harvest compared to 30-day harvest in this study reflects the effect of maturity on grass quality. This trend may be associated with a dilution effect as structural components increase; the proportions of nitrogenous and energy-rich constituents in plant parts relatively decrease (Wolele *et al.*, 2025). In addition, previous studies suggest that at maturation, grass morphology changes, such as a decrease in leaf-to-stem ratio (Morillo *et al.*, 1997; Wolele *et al.*, 2025), although it was not directly assessed in

the present study. This is associated with greater structural carbohydrate accumulation and lignification for stem development, rigidity, and structural integrity (Ramirez *et al.*, 2022), which supports our findings. The cultivar type may also affect the variation in CP contents, as MG has been reported to contain higher levels of protein in the leaves than in stems, which is associated with early harvest stages (i.e., 30 days; Barbosa *et al.*, 2012; Hare *et al.*, 2014; Thongruang *et al.*, 2020; González Marcillo *et al.*, 2021; Junges *et al.*, 2024). In contrast, the extended harvest age (i.e., 45 days) employed in this study resulted in reduced CP content compared to the young stage (i.e., 30 days), which conforms to the previous reports (Hare *et al.*, 2013; Bacorro *et al.*, 2018; González Marcillo *et al.*, 2021; Junges *et al.*, 2024). From a ruminant nutrition perspective, harvesting young grasses will provide higher CP contents than harvesting grasses later.

Similarly, to CP, EE concentration is affected by cultivar type, harvest age, and their interaction. The EE levels from Guinea grass in this study were proximate to values reported by several researchers (1.6-2.34%; Ogunwole *et al.*, 2011; Kondo *et al.*, 2015; Quang *et al.*, 2015). The decline in EE at 45 days reflects the effect of plant maturity on the cellular components (e.g., Barbosa *et al.*, 2012). A greater association with grass age and the accumulation of its structural components in plant parts has been reported (Babayemi, 2009; Barbosa *et al.*, 2012). This suggests an increase in carbon fiber density in the fibrous tissues, particularly in the stems. Consequently, this may reduce the proportion of lipid-containing cellular contents in plant tissues (Barbosa *et al.*, 2012). Contrastingly, previous studies suggest that young grasses have more metabolically active tissues, which may contribute to higher lipid concentrations (Barbosa *et al.*, 2012). Although these physiological events were not measured in this study, the higher EE content observed in younger Guinea grass may provide a greater supply of dietary lipids. Therefore, younger forage may offer nutritional advantages, supporting the energy requirements and milk synthesis in lactating ruminants.

The increased GE levels at 45 days may be associated with greater fiber accumulation in plant tissues. However, higher GE levels at later harvests do not necessarily translate into greater metabolizable energy availability for ruminants. This is associated with an increased cell wall deposition, and lignification reduces forage digestibility. Consequently, the proportion of GE utilized by the animal becomes limited. Furthermore, delaying the harvest period (i.e., 45 days) substantially increased the detergent fiber fractions and their components, as exhibited by higher NDF, ADL, and hemicellulose concentrations. The findings in this study are consistent with previous reports, indicating higher fiber accumulation at later harvests

due to greater deposition of structural components required to plant support (Van Soest, 1988; Kondo *et al.*, 2015; Bacorro *et al.*, 2018). While structural changes were not directly measured in this study, they are widely associated with reduced forage quality at later harvest.

The higher concentrations of detergent fibers (except NDF) and fiber fractions in LG imply higher structural carbohydrate deposition in plant parts. The increased concentrations of ADF and ADL at later harvest highlights the development of more lignified structural tissues in Guinea grass (e.g., LG) harvested at 45 days. Although the leaf-to-stem ratio was not directly evaluated in this study, such variations between cultivars have been reported to influence shifts in fiber composition of plant parts (Carvajal-Tapia *et al.*, 2023; Wolele *et al.*, 2025). The higher cellulose concentrations in LG, particularly at 45 days, reflect greater structural carbohydrate accumulation at later harvest age. These findings were consistent with the previous report, suggesting that cultivar variation influences cell wall components and lignification (Ramirez *et al.*, 2022). From a ruminant nutrition perspective, higher concentrations of cellulose and lignin are associated with reduced accessibility of structural carbohydrates by rumen microbes (Heuzé and Tran, 2020; Hare *et al.*, 2013; Jusoh *et al.*, 2014; Marques *et al.*, 2024). Therefore, farmers may opt to decide the optimum harvest age, considering the drawbacks of harvesting grasses later on their structural carbohydrate accumulation.

## CONCLUSIONS

The cultivar type and harvest age significantly influenced the chemical composition of Guinea grass. MG has higher concentrations of nutritive cellular components, particularly CP, EE, and hemicellulose, than LG. The more favorable fiber profile of MG, particularly when harvested at 30 days, reflects the influence of harvest age on forage quality. Given the MG's advantage when harvested earlier, it may provide a better chemical composition than LG. From a ruminant nutrition perspective, the lower fiber levels and higher cellular components of MG30 are associated with improved forage utilization. However, rumen degradability and feeding value were not assessed in this study. Comparing the agronomic and chemical characteristics of Guinea grass cultivars influenced by various management practices, such as fertilization and water management, is recommended. The effects of geographic variation among Philippine islands on the agronomic characteristics and chemical composition of Guinea grass cultivars can be tested. Assessing the silage quality from MG and LG (using inoculants, a wider range of harvest ages) and their rumen degradability at varying

harvest ages may provide a more comprehensive understanding of their feeding value in ruminants (at different physiological conditions).

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## NOVELTY STATEMENT

This study is among the first to evaluate the interactive effects of Guinea grass cultivar and harvest age on the chemical composition of forage under the distinct microclimatic conditions of VSU, Leyte, Philippines. Unlike previous studies that focused primarily on either cultivar or cutting interval, this study provides site-specific evidence demonstrating that MG harvested at 30 days offers superior nutritional quality, thereby generating practical recommendations for optimizing forage management and ruminant feeding in similar tropical environments.

## AUTHOR'S CONTRIBUTION

The author conducted, analyzed, and drafted this research.

## GENERATIVE AI AND AI ASSISTED TECHNOLOGY STATEMENT

The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

## CONFLICT OF INTEREST

The author declares no conflict of interest in the conduct of the study.

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