INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY: APPLIED BUSINESS AND EDUCATION RESEARCH
2025, Vol. 6, No. 9, 4419 – 4428
http://dx.doi.org/10.11594/ijmaber.06.09.17

Research Article

Chemical Analysis of Local Guinea Grass (*Megathyrsus maximus* Jacq.) and Mombasa Grass (*Megathyrsus maximus* Jacq *cv. Mombasa*) Harvested at 30- and 45-day Cutting Intervals as Forage Grass for Ruminants in Leyte, Philippines

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Article history:
Submission 14 May 2025
Revised 31 August 2025
Accepted 23 September 2025

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ABSTRACT

The study was conducted to compare the proximate analysis of the Guinea grass (*Megathyrsus maximus* Jacq.) cultivars (i.e., Local Guinea grass; LG, Mombasa grass; MG) harvested at either 30- or 45-day cutting intervals (CI) in Leyte, Philippines. The Guinea grass cultivars were planted in four plots; at 65 days, all grasses were manually harvested by zeroing. Succeeding harvests followed either at 30- or 45-day CI for six months. The treatment combinations were as follows: LG30 (LG, 30-day CI), LG45 (LG, 45-day CI), MG30 (MG, 30-day CI), and MG45 (MG, 45-day CI). LG has significantly higher dry matter (DM; except 4th harvest), OM, and GE contents (3rd and 4th harvests) than MG. In contrast, MG has significantly higher CP (3rd harvest) and ash (except 3rd harvest) contents than LG. Between CI, Guinea grass cultivars harvested at 45-CI have significantly higher DM, ash (2nd harvest), and OM contents than those harvested at a 30-day CI. In contrast, Guinea grass cultivars harvested at 30-day CI have significantly higher CP (3rd harvest) and EE contents (interaction effect at 4th harvest) than those harvested at 45-day CI. MG can be offered for ruminants requiring high CP and ash contents on a grass-based diet, especially when harvested at a 30-day CI. LG can be offered to ruminants requiring a low plane of nutrition.

***Keywords**: Cutting interval, Local guinea grass, Mombasa grass, Nutrient composition*

How to cite:
Atole, A. F. F., Compendio, J. D. Z., Posas, O. B., Cuadra, L. J., & Gacutan, Jr., M. D. (2025). Chemical Analysis of Local Guinea Grass (*Megathyrsus maximus* Jacq.) and Mombasa Grass (*Megathyrsus maximus* Jacq *cv. Mombasa*) Harvested at 30- and 45-day Cutting Intervals as Forage Grass for Ruminants in Leyte, Philippines. *International Journal of Multidisciplinary: Applied Business and Education Research*. *6*(9), 4419 – 4428. doi: 10.11594/ijmaber.06.09.17

Introduction

Grasses are the cheapest and most available feed resource for ruminants. Many small-hold farmers, particularly those in marginal lands, rely on the natural vegetation as their feed resource for ruminants (Bestil, 2014). This is true in some areas in the Philippines (Leyte) where farmers tether their ruminants in places where grass growth is abundant. Some employ the cut-and-carry method of feeding by harvesting grasses elsewhere and feeding them directly to their ruminants. However, these farmers are unaware of the quality of grasses regarding nutrient composition, as they offer it to ruminants. Additionally, the age of the grasses fed was variable, and sometimes they are old and less digestible. Consequently, nutrients are less available, resulting in a poor plane of diet, thus affecting animal performance negatively.

The digestibility and feeding value of grasses depend on their composition and age at feeding. For example, as the grass ages, important plant components of nutritional value drop (Bacorro et al., 2018; Thongruang et al., 2020). In contrast, the less preferred plant components rise, consequently affecting their digestibility and feeding value for ruminants (Bacorro et al., 2018; Thongruang et al., 2020; Van Man & Wiktorsson, 2003). When old grasses are fed to ruminants, nutrient digestibility and availability are negatively affected, resulting in compromised animal performance (Van Man & Wiktorsson, 2003). For example, as the grass ages, the crude protein (CP) intake significantly declines (Rinne et al., 1997; Van Man & Wiktorsson, 2003). Consequently, the ruminants' performance will be dramatically affected (Atole & Bestil, 2019). This can be attributed to the lower capability of rumen microbes to degrade fibrous feed materials as they age. Therefore, it is important to consider the type of grass (e.g., Guinea grass) and cutting interval (e.g., 30, 45 days) to optimize its nutrient value without compromising its digestibility and nutrient availability in ruminants.

Different Guinea grass cultivars have been extensively used for ruminant feeding elsewhere (Jaturasitha et al., 2009; Loresco et al., 2020; Maciel et al., 2018). In the Philippines, ruminant farming escalates, and thus, ruminant farmers will require a sufficient supply of grass not only to satisfy the dry matter (DM) requirement but also their nutritional needs. To achieve this, ruminant farmers must select high-yielding forage grass that produces more biomass per unit area (Mombasa grass; MG *Megathyrsus maximus* Jacq. cv. Mombasa; syn. *Panicum maximum* Jacq.**)**. Compared to the local Guinea grass (LG), Mombasa grass (MG) yields more herbage per unit area (Hare et al., 2013). Since MG is neoteric in the Philippines, particularly in Leyte, no study has been conducted comparing its chemical composition with LG. Therefore, it is important to compare the chemical composition of MG with LG; hence, this study. This study compared the chemical analysis of MG (introduced) with the LG (indigenous) at different cutting intervals (CI; i.e., 30 and 45 days) in Leyte, Philippines. This study revealed the nutrient contents of MG as an introduced forage grass for ruminants in the Philippine context, particularly in the province of Leyte.

Materials and Methods

Experimental Treatments and Design

Two factors were considered in this experiment: Factor A-Type of Guinea grass (LG, MG), and Factor B-Age of CI (30, 45 days). A 2x2 factorial experiment in Randomized Complete Block Design was implemented to determine the chemical composition of the grasses as influenced by CI. The variability in soil characteristics, elevation, shading, and location of the pasture area was the basis for blocking; thus, four sites were used as blocks.

Source of Guinea Grass Cultivars

The Guinea grass cultivars were planted in plots (3 m x 5 m) in a pasture area of the Department of Animal Science, Visayas State University, Visca, Baybay City, Leyte, Philippines. The planting distance was observed at 50 cm x 50 cm and covered with soil (PCARRD, 2002; Pengelly et al., 2018). A complete fertilizer (14-14-14) at a rate of 200 kg/ha once at planting was applied (Hare et al., 2014). At 65 days post-planting, the Guinea grass cultivars were manually harvested 15 cm above ground. This served as the baseline performance in all treatments regarding the CI.

Preparation of Guinea Grass Cultivars for Chemical Analysis

The harvested Guinea grass cultivars were separately chopped to an inch and oven-dried in a forced-draft oven at 65°C for two days or until constant weight was achieved. The oven-dried samples were hammer-milled using a mini-Wiley mill and allowed to pass a 2-mm screen (Atole & Bestil, 2019). The ground samples were kept in a tightly sealed container for future use. This procedure was repeatedly performed until the four harvest periods were completed. Representative samples were analyzed in duplicate to measure the % DM (oven-dried at 105^0C for 8 h), % ash (ignition), % organic matter (OM; %DM-%Ash), % CP (micro Kjeldahl digestion and distillation), gross energy (GE; bomb calorimeter), and % ether extract (EE; Soxhlet fat extraction) following the (AOAC, 1995).

Statistical Design and Analysis

The data were analyzed in the analysis of variance in a 2x2 factorial experiment following a Randomized Complete Block Design. Tukey's Honestly Significance Difference Test was used to compare differences among treatments using Statistical Analysis System software (9.4 TS1M8 edition). At $\alpha=0.05$, the interaction and main effects were deemed significant.

Results and Discussion

Dry Matter

Table 1 shows the DM content of Guinea grass cultivars harvested at different CI and periods. No interaction effects (AxB) were observed in the different harvest periods; hence, the main effects were discussed. LG had significantly higher DM than MG in all periods and when averaged, except for the 4th harvest (p=0.0576). Harvesting Guinea grass cultivars at 45 days CI resulted in a significantly higher DM content in all periods, and when averaged, compared to 30-day CI.

Table 1. The DM (%) content of Guinea grass cultivars at different CI and periods

Harvest Period	LG		MG		SEM	P-values		
	30-d	45-d	30-d	45-d		A	B	AxB
1st	21.67	24.40	20.70	22.40	0.24	0.0016	<0.0001	0.1570
2nd	21.78	23.82	20.89	22.07	0.14	<0.0001	<0.0001	0.0534
3rd	21.32	23.84	20.72	22.55	0.28	0.0436	0.0004	0.4123
4th	22.13	25.48	20.83	23.98	0.45	0.0576	0.0007	0.8819
Average	21.72	24.38	20.79	22.75	0.15	0.0002	<0.0001	0.1401

This study has shown that the locally adapted LG in Leyte, Philippines, had superior DM content than the introduced cultivar (i.e., MG). Despite the rise in the country's environmental temperature in 2024, which the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) reported to be the hottest year since 1951 (PAGASA, 2024), with 1.55 °C higher than the average pre-industrial period (1850-1900; WMO, 2024) the Guinea grass cultivars were able to adapt to the extreme heat. LG contains a higher proportion of stems than leaves compared to MG, and increases as the grass matures (Ordóñes et al., 2025). The stems contain a high amount of fiber due to increased lignin deposition to support plant growth (Hare et al., 2013). The increase in fiber deposition in Guinea grass results in a higher DM content, particularly at an advanced age (Junges et al., 2024; Ordóñes et al., 2022). Consequently, the absence of fertilizer N and irrigation employed during the experiment could have aggravated the low DM obtained. In a different study, applying N fertilizer and irrigating the Guinea grass significantly increased the yield and decreased the fiber content (Alsunaydi et al., 2024; Galindo et al., 2019; Garcez Neto, 2012). Therefore, the amount of fiber content, particularly in the stems as the grass matures, contributes to the increase in the DM content of Guinea grass.

Ash

Table 2 showed no interaction effects (AxB) in all periods. MG has significantly higher ash content in all periods and when averaged, except for the 3rd harvest (p=0.2897). Harvesting Guinea grass at 45-day CI showed significantly higher ash content than at 30-day CI in the 2nd harvest period.

Table 2. The ash (%) content of Guinea grass cultivars at different CI and periods

Harvest Period	LG		MG		SEM	P-values		
	30-d	45-d	30-d	45-d		A	B	AxB
1st	10.61	10.86	11.64	12.02	0.24	0.0111	0.3855	0.8690
2nd	11.21	12.54	9.24	9.79	0.17	0.0020	0.0218	0.8711
3rd	11.33	12.65	12.61	13.05	0.53	0.2897	0.2646	0.5706
4th	12.32	12.27	14.66	13.82	0.61	0.0111	0.4844	0.5303
Average	11.21	11.77	12.64	12.79	0.16	0.0005	0.1580	0.4009

The ash content of Guinea grass increased as the plant aged. This can be attributed to the strength needed by the stems to sustain their stance integrity to support the increasing leaf biomass. Our finding was within the range of ash content (12.19-14.52%) reported by González Marcillo et al. (2021). Additionally, the ash content reported by González Marcillo et al. (2021) at 45-day CI was comparable to our findings in the dry season. MG has a higher leaf:stem than LG (Hare et al., 2014; Thongruang et al., 2020). The higher proportion of leaves in MG allows for more mineral accumulation than in stems (Bonfim-Silva, 2023). The ash content in grasses is mainly composed of Ca, Mg, P, and K (Bonfim-Silva, 2023). However, we observed that as the grass matures, the ash content increases. During reproductive stages (flowering and seed development), grasses' demand for minerals increases (Maillard et al., 2015). The minerals from the stems are then mobilized and transferred via the phloem to the actively growing plant parts, such as leaves and seeds (Maillard et al., 2015). Therefore, ash accumulation not only supports the grass's upright position but also prepares for more important physiological functions.

Organic Matter

Table 3 showed no interaction effects (AxB) in all periods. LG has significantly higher OM than MG in all harvest periods except for the 3rd harvest (p=0.0542). Additionally, harvesting Guinea grass cultivars at 45 days had significantly higher OM content than at 30-day CI, except for the 3rd harvest (p=0.1426).

Table 3. The OM (%) content of Guinea grass cultivars at different CI and periods

Harvest Period	LG		MG		SEM	P-values		
	30-d	45-d	30-d	45-d		A	B	AxB
1st	11.06	13.54	9.06	10.39	0.55	0.0012	0.0073	0.3242
2nd	11.21	12.54	9.24	9.79	0.21	0.0001	0.0115	0.2183
3rd	9.98	11.18	8.11	9.49	0.57	0.0542	0.1426	0.9122
4th	9.81	13.21	6.16	10.16	0.70	0.0081	0.0046	0.7679
Average	10.52	12.62	8.14	9.96	0.31	0.0003	0.0015	0.7500

The age of the grass at harvesting affects its OM content. Our finding conforms to the report of Junges et al. (2024) that as the Guinea grass matures, OM increases. The high DM content of LG in this study contributes to its high OM content. Specifically, LG is high in neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) contents, contributing to a high OM content when compared to other grass species (Lima et al., 2018). In contrast, Galindo et al. (2018) explained that MG has lower fiber contents than LG; thus, it has lower OM contents. Furthermore, we observed that when Guinea grass is harvested at 45-day

CI instead of 30-day CI, the OM has increased. Accumulation of OM is gradual; thus, mature grasses have more time for OM build-up than younger grasses (Hoogerkamp, 1973; Iepema et al., 2020). This is aided by the longer period of photosynthetic activity of old plants, which results in the accumulation of more carbon-based compounds than the younger grasses (Jahan et al., 2023). Additionally, the increasing OM content of maturing grasses can be attributed to the growing plant parts (e.g., stem, leaves), thus increasing the indigestible components like fiber in its biomass (Junges et al., 2024). Nguyen et al. (2024) explained that the grass stage of maturity can affect the OM content, particularly when CI is extended. Several researchers observed that the build-up of fibrous components is faster for maturing grasses than for younger grasses, consequently increasing the OM in plant parts (Goudenhooft et al., 2018; Jahan et al., 2023; Sarkar et al., 2009). During this event, the prolonged regrowth enables fiber components like NDF to accumulate more in the plant parts, leading to a higher OM content compared to shorter CI (i.e., short regrowth; Nguyen et al., 2024). Therefore, regardless of the cultivar, age at harvesting greatly contributes to the OM contents of grasses.

Crude Protein

Table 4 showed no interaction effects (AxB) for CP in all periods. MG had significantly higher (p=0.0022) CP compared to LG in the 3rd harvest and when all harvest periods were averaged (p=0.0139). Harvesting Guinea grass cultivars at 30-day CI instead of 45-day CI resulted in a significantly higher CP, except in the 2nd harvest (p=0.0876). When averaged, the 30-day CI instead of the 45-day CI resulted in a significantly higher (p=0.0005) CP content.

Table 4. The CP (%) content of Guinea grass cultivars at different CI and periods

Harvest	LG		MG			P-values		
Period	30-d	45-d	30-d	45-d	SEM	A	B	AxB
1st	5.04	4.13	5.71	4.19	0.12	0.0622	<0.0001	0.1136
2nd	5.16	4.63	5.57	4.79	0.24	0.4277	0.0876	0.7310
3rd	6.06	4.87	7.68	6.48	0.27	0.0022	0.0122	0.9807
4th	5.31	3.97	5.77	4.18	0.33	0.4886	0.0117	0.7857
Average	5.39	4.4	6.18	4.91	0.15	0.0139	0.0005	0.5266

MG's significantly higher CP content than LG can be attributed to the higher leaf:ratio. Thongruang et al. (2020) explained that leaves from MG contain more CP than stems and even in other Guinea grass cultivars (e.g., LG). Additionally, MG is an improved Guinea grass that was genetically selected and bred for high-quality foliage production (Barbosa et al., 2012; Hare et al., 2014). However, the CP concentration in the plant parts decreases as they mature. The CI employed in this study significantly reduced the CP levels of Guinea grass cultivars when harvested later (i.e., 45-day CI) compared to when harvested young (i.e., 30-day CI). The longer regrowth periods provide extended time for lignification of stems, thus reducing CP contents due to increased stem development and fiber deposition (Ordóñes et al., 2022; Thongruang et al., 2020). Our findings conform with the report elsewhere that harvesting Guinea grass at 30-day CI instead of later CI will improve forage quality in terms of CP levels (Bacorro et al., 2018; González Marcillo et al., 2021; Hare et al., 2013; Junges et al., 2024). Therefore, harvesting should be shortened and frequent to maximize the protein content in Guinea grass.

Gross Energy

Table 5 showed no interaction effects (AxB) in all periods. LG showed a significantly higher GE content than MG in the 3rd (p=0.0119) and 4th (p=0.0244) harvest periods. Harvesting Guinea grass at 45-day CI instead of 30-day CI resulted in a significantly higher GE content in all periods, except in the 4th harvest (p=0.0570). When all harvest periods were averaged, the 45-day CI resulted in a significantly higher GE content than the 30-day CI (p=0.0017).

Table 5. The GE (Cal/g) content of Guinea grass cultivars at different CI and periods

Harvest Period	LG		MG		SEM	P-values		
	30-d	45-d	30-d	45-d		A	B	AxB
1st	3577	3693	3520	3623	33.20	0.2109	0.0442	0.8929
2nd	3446	3826	3519	3827	42.47	0.5570	0.0003	0.5570
3rd	3650	3934	3622	3816	16.49	0.0119	<0.0001	0.0888
4th	3736	3811	3716	3726	13.69	0.0244	0.0570	0.1301
Average	3602	3816	3594	3748	29.52	0.3864	0.0017	0.4906

LG is superior to MG in terms of GE content. The higher DM and fiber contents of LG than MG in this study contributed to this. Moran (2005) explained that grasses containing a higher DM content contain more energy sources per unit of feed, resulting in a higher GE content. Since LG has a higher DM content than MG, the energy-yielding nutrients concentrate more in LG than in MG (Moran, 2005). Although fiber has a lower energy value than soluble carbohydrates, its type and amount influence forage digestibility, as do the GE values (Nivyobizi et al., 2010; Quintero-Anzueta et al., 2021). For example, LG has 63.27-69.88% NDF and 39.81-46.96% ADF on a DM basis (Bacorro et al., 2018). In contrast, Thongruang et al. (2020) reported lower NDF and ADF values obtained from MG with 68.28% and 43.68%, thus contributing less to its GE. The extended CI (i.e., 45 days) increased the GE content of Guinea grass than when it was harvested early (i.e., 30 days). When grasses mature (e.g., boot stage), the DM content changes, and so does their composition. The increase in the DM content is due to the increased accumulation of structural carbohydrates (Pathot & Berhanu, 2023). Consequently, the levels of energy-containing components (e.g., fiber) have also increased per unit of DM (Pathot & Berhanu, 2023). Despite the inferior fiber digestibility characteristics of grasses, they contribute to their GE content (Pathot & Berhanu, 2023). Therefore, the concentration of GE in grasses is affected by their composition, type of fiber present, and age at harvest.

Ether Extract

Table 6 shows an interaction effect (AxB) in the fourth harvest. The EE content of MG30 and LG30 is comparable but is significantly higher (p=0.0204) compared to LG45 and MG45. No difference was noted in EE between the two cultivars across the harvest periods. In contrast, the main effect of CI was observed in the 1st to 3rd harvest periods with 45-day CI to contain significantly lower EE (p=0.0003, p=0.0003, and p=0.0013) compared to 30-day CI, respectively. When all harvest periods were averaged, harvesting Guinea grass cultivars at a 45-day CI contained a significantly lower EE (p=0.0001) compared to a 30-day CI.

Table 6. The EE (%) content of Guinea grass cultivars at different CI and periods

Harvest Period	LG		MG		SEM	P-values		
	30-d	45-d	30-d	45-d		A	B	AxB
1st	2.42	2.32	2.44	2.35	0.01	0.2888	0.0003	0.6918
2nd	2.28	2.19	2.31	2.23	0.01	0.0523	0.0003	0.6471
3rd	2.48	2.38	2.52	2.42	0.02	0.1104	0.0013	0.9411
4th	2.52[a]	2.39[b]	2.60[a]	2.33[b]	0.03	0.6803	<0.0001	0.0204
Average	2.43	2.32	2.47	2.33	0.01	0.2064	0.0001	0.4841

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

We did not find a significant difference in EE content between cultivars, but there was between CI. Although MG is an improved cultivar of Guinea grass, it shares similar origin (i.e., genotype) and morphological and physiological characteristics, resulting in comparable chemical compositions (e.g., EE; Heuzé & Tran, 2020; Kelyni et al., 2022). Both cultivars belong to the Poaceae family, and their similarity in leaf structure and metabolic pathways results in comparable nutrient profiles (Kelyni et al., 2022). The levels of EE from Guinea grass cultivars in this study (2.24-2.47%) were within the values reported elsewhere (1.6-2.34%; Kondo et al., 2011; Quang et al., 2015). In contrast, different CI results in a significant difference in EE contents. Harvesting Guinea grass at 30-day CI had better EE contents than at 45-day CI. Barbosa et al. (2012) explained that young Guinea grass has young tillers exhibiting higher leaf appearance and elongation rates than older grasses. These characteristics of younger grasses result in a greater photosynthetic capacity than older grasses, thus promoting lipid accumulation (Barbosa et al., 2012). In contrast, as the grass matures, the fiber concentration increases, which reduces the concentration of EE in the plant parts (Babayemi, 2009; Barbosa et al., 2012). Therefore, to maximize the high EE content of grasses for ruminant feeding, harvest them while young and more digestible.

Conclusion

Based on this study, most of LG's chemical characteristics were superior to MG's. The DM, OM, and GE contents of LGs were significantly higher than those of MG. MG's ash and CP contents were significantly higher than those of LG. The interaction effect was observed only in EE, with MG30 and LG30 being significantly higher than MG45 and LG45. For CI, DM, ash, OM, GE, and EE were significantly higher at 45-day CI than at 30-day CI, except for CP. For growing ruminants, MG can be fed, especially when harvested at 30-day CI. LG can be fed to ruminants in the maintenance stage (those requiring a low plane of nutrition), especially when harvested at 45-day CI.

Acknowledgment

The researchers would like to acknowledge the Department of Science and Technology-*Accelerated Science and Technology Human Resource Development Program at VSU for the financial support provided for experimenting. They also acknowledge the Department of Animal Science at VSU for using their resources.*

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