

In vitro Digestibility of *Megathyrsus maximus* Interplanted with Turmeric and/or Ginger at Varying Cutting Ages and Planting Years

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Abstract

This study investigated the in vitro digestibility of *Megathyrsus maximus* interplanted with turmeric and/or ginger at varying cutting ages and planting years. The experiment was conducted at the Teaching and Research Farm, Ladoké Akintola University of Technology, Ogbomoso, using a factorial arrangement in a Randomized Complete Block Design (RCBD) with four replicates. Four treatments were evaluated: *Megathyrsus maximus* alone (T₁), *Megathyrsus maximus* interplanted with ginger (T₂), *Megathyrsus maximus* interplanted with turmeric (T₃), and *Megathyrsus maximus* interplanted with both ginger and turmeric (T₄). Gas production (CH₄ and CO₂) was measured over 24 hours. Results showed significant differences ($P < 0.05$) among treatments. *Megathyrsus maximus* alone produced the highest CH₄, while interplanting with ginger recorded the lowest. *Megathyrsus maximus* interplanted with Turmeric enhanced CO₂ production, whereas cutting age effects were not significant. Planting year influenced emissions, with 2022 recording the highest levels. These findings suggest that interplanting medicinal plants with *Megathyrsus maximus* can modulate ruminal fermentation and contribute to sustainable livestock production.

Keywords: In vitro Digestibility, *Megathyrsus maximus*, Turmeric, Interplanting, Sustainable Nutrition.

Introduction

The demand for high-quality forage in livestock production has spurred interest in sustainable agricultural practices that optimize forage digestibility (Capstaff & Miller, 2018). *Megathyrsus maximus* (commonly known as Guinea grass) is a widely cultivated forage species in tropical and subtropical regions, including Nigeria, due to its resilience and high biomass production (Idowu *et al.*, 2020). Enhancing *Megathyrsus maximus* nutritional profile and digestibility is crucial for improving livestock productivity (Saleem *et al.*, 2025;

Idowu *et al.*, 2023). One approach to achieving this is through inter-planting *Megathyrus maximus* with medicinal plants such as turmeric (*Curcuma longa*) and ginger (*Zingiber officinale*), which may influence the digestibility and nutrient composition of the forage (Adamu *et al.*, 2019; Ojo *et al.*, 2020). This study investigates the effects of intercropping *Megathyrus maximus* with turmeric and ginger, focusing on in vitro digestibility across varying treatments, cutting ages, and planting years. Digestibility is a key factor in determining the quality of forage, as it influences the efficiency with which animals convert feed into energy and nutrients (Moore *et al.*, 2020).

In vitro digestibility testing provides a controlled method for assessing the nutritional value of forages and has been used extensively in evaluating the effects of agronomic practices on forage quality (Foster *et al.*, 2023). Studies conducted in Nigeria have demonstrated the potential of intercropping systems to enhance forage digestibility by improving soil nutrient availability and modifying plant metabolic profiles (Gulwa *et al.*, 2018). Turmeric and ginger are known for their antioxidant and antimicrobial properties, which may promote soil health and plant growth, potentially enhancing the digestibility of the inter-planted forage (Eke *et al.*, 2022). Research by Rady *et al.* (2022) suggests that intercropping forage grasses with medicinal plants can improve overall feed quality by altering the cell wall structure, leading to better breakdown during digestion. Inter-planting *Megathyrus maximus* with turmeric and or ginger introduces additional bio-active compounds that may affect the plant's fiber structure and nutrient composition, thereby influencing digestibility.

The year of planting and environmental factors such as soil health and climate can further impact forage quality, as shown by Capstaff and Miller (2018). The timing of harvest, or cutting age, also plays a significant role in forage quality. Younger plants generally have higher nutrient content and digestibility, while older plants tend to accumulate more fiber, reducing their digestibility (Moore *et al.*, 2001). Therefore, understanding how varying cutting ages and planting years influence the digestibility of inter-planted *Megathyrus maximus* is essential for optimizing its use in livestock feeding systems. This research aims to evaluate the in-vitro digestibility of *Megathyrus maximus* inter-planted with turmeric and ginger, considering different treatments, cutting ages, and planting years. The findings will contribute to sustainable forage production in Nigeria's derived savannah, offering practical solutions for improving livestock nutrition. Specifically, the objectives were to:

- i. assess the digestibility of *Megathyrus maximus* interplanted with turmeric and/or ginger;
- ii. evaluate methane and carbon dioxide production across treatments;
- iii. determine the effects of cutting age and planting year on digestibility and gas emissions.

Materials and Methods

Experimental site

The experiment was carried out at the Teaching and Research farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria (Latitude 8° 8' 31.7940¹ N, Longitude 4° 14'

42.6696¹ E). The experimental site is located in the derived savannah zone of Nigeria. The climate of the site is characterized by high and uniform temperature and is influenced by the northwest trade wind with cold wind and dry effect starting from October to April. The prevailing wind during the dry season is known as harmattan while May to September is rainy season. The ambient temperature ranges between twenty-eight degree Celsius (28 °C) to thirty three degree Celsius (33 °C) and relative humidity of about seventy four percent (74 %) except for January. Monthly and daily rainfalls are characterized by high temporal and spatial variations which range from zero (0) to three hundred and thirty-eight millimeters (338 mm) and over one thousand six hundred and seventy-three millimeters (1673 mm) per annum and usually occur between April and October with a marked dry season from late October to early April of the following year.

Experimental design

A factorial experiment was employed with three factors planting treatment (inter-planting of *Megathyrsus maximus* with turmeric and or ginger), different cutting ages four, eight, twelve and sixteen (4, 8, 12 and 16 weeks post-planting), and years of planting (2020, 2021, 2022 and 2023) in a Randomized Complete Block Design (RCBD) with four (4) replicates.

Plant Materials

The plant materials included *Megathyrsus maximus* (Guinea grass) seeds, obtained from established pasture plot. Turmeric (*Curcuma longa*) and ginger (*Zingiber officinale*) rhizomes were sourced from local market (Sabo), in Ogbomoso, Nigeria.

Soil Preparation and Planting

The soil was analyzed for physico-chemical properties prior to planting. Necessary amendments are made based on soil nutrient status to ensure optimal growing conditions. *Megathyrsus maximus* was sown at a spacing of forty by forty centimeters (40 cm by 40 cm). Turmeric and ginger rhizomes were inter-planted within the same plots at twenty by twenty centimeters (20 cm by 20 cm) distances from the grass.

Treatments

The treatments include

- *Megathyrsus maximus* alone (control) (T₁).
- *Megathyrsus maximus* inter-planted with turmeric (T₂).
- *Megathyrsus maximus* inter-planted with ginger (T₃).
- *Megathyrsus maximus* inter-planted with turmeric and/or ginger (T₄).

Sampling and Harvesting

Plants are harvested at different cutting ages four, eight, twelve and sixteen (4, 8, 12 and 16 weeks) from each treatment plot. Biomass yield was recorded at each harvest, and samples were taken for digestibility analysis.

In vitro Digestibility Analysis

Samples from each treatment and cutting age were subjected to in-vitro digestibility analysis using the method of Tilley and Terry (1963).

Rumen Fluid Collection

Rumen fluid was collected from fistulated animals (Sheep) fed on a standard diet. The rumen fluid was strained through four (4) layers of cheesecloth and kept at thirty-nine degree Celsius (39°C).

Sample Preparation: Harvested grass of *Megathyrus maximus* inter-planted with turmeric and/or ginger samples were dried at sixty degree Celsius (60°C), grind, and weighed before incubation.

- **Incubation:** One gram (1 g) of each samples were incubated in one hundred milliliters (100 ml) of buffered rumen fluid in glass syringes at thirty-nine degree Celsius (39 °C) for twenty four (24) hours.
- **Digestibility Measurements:** Gas production was measured at intervals, and digestibility was calculated based on the remaining undigested material.

Statistical Analysis

- Data collected on in-vitro digestibility parameters were subjected to analysis of variance (ANOVA) using SAS (2003), significant means ($P < 0.05$). Differences in cutting ages, and years of planting were separated by Duncan Multiple Range Test (DMRT) statistical software. An ethical approval statement for rumen fluid collection from fistulated sheep was obtained from the institutional animal care and use committee.

Table 1: Mean values of in vitro digestibility of *Megathyrus maximus* interplanted with turmeric and/or ginger at varying cutting ages and planting years

Parameters/ hours Treatment:	3	6	9	12	15	18	21	24	CH ₄	CO ₂
<i>Megathyrus</i> only	4.12 ^a	7.00	11.44	11.90	14.05 ^a	14.54	14.98	15.49	7.85 ^a	7.68 ^b
<i>Megathyrus</i> and ginger	3.44 ^b	7.91	10.23	11.05	12.33 ^b	13.05	13.30	13.93	6.53 ^b	7.65 ^b
<i>Megathyrus</i> and turmeric	4.18 ^a	7.00	11.20	12.23	13.52 ^{ab}	14.55	15.07	15.61	6.50 ^b	9.16 ^a
<i>Megathyrus</i> , ginger and turmeric	4.07 ^a	7.07	10.95	11.79	12.83 ^{ab}	13.74	14.33	14.98	6.93 ^{ab}	8.29 ^{ab}
S.E.M	0.63	0.76	1.15	1.33	1.41	1.44	1.54	1.52	0.93	1.07
Cutting Ages:										
4 weeks	4.00	7.10	11.26	12.17	13.31	14.12	14.62	15.14	7.10	8.26
8 weeks	4.07	7.12	11.02	11.67	13.35	14.05	14.35	14.91	7.09	7.93
12 weeks	3.95	7.35	10.70	11.40	13.00	13.86	14.42	15.00	6.77	8.37
16 weeks	3.79	7.14	10.83	11.74	13.05	13.83	14.29	14.95	6.81	8.26
S.E.M	0.64	0.76	1.13	1.30	1.41	1.46	1.58	1.54	1.02	1.09
Years of planting:										
2020	3.76	7.13	10.67	11.44	12.87	13.82	14.24	14.82	6.80	8.16
2021	3.86	7.02	10.76	11.62	13.33	14.00	14.31	14.86	7.02	7.90
2022	4.31	7.48	11.52	12.31	13.74	14.62	15.10	15.81	7.43	8.62
2023	3.90	7.07	10.88	11.61	12.78	13.41	14.02	14.51	6.51	8.15
S.E.M	0.62	0.77	1.20	1.33	1.46	1.51	1.61	1.59	1.10	1.06

^{ab}Means along the same column at each variable with different superscripts are significantly (P<0.05) different CH₄ (Methane gas) CO₂ (Carbondioxide), S.E.M: Standard Error of the Means

Results

The mean values of in vitro digestibility parameters of *Megathyrus maximus* interplanted with turmeric and/or ginger at varying cutting ages and years of planting are presented in Table 1. There were significant (P < 0.05) differences in CH₄ and CO₂ production among treatments. *Megathyrus interplanted* with turmeric produced the highest CO₂ values, whereas *Megathyrus* alone recorded the highest CH₄ output. Cutting age did not significantly affect gas production, while planting year influenced both CH₄ and CO₂, with the highest values observed in 2022.

Discussion

The in-vitro digestibility of *Megathyrus maximus* inter-planted with turmeric and ginger at varying cutting ages and years of planting that revealed significant difference between the *Megathyrus maximus* interplant with turmeric and ginger at different cutting ages and years of planting. These obtained values observed in this work are similar to those reported in the literature by Juárez *et al.* (2009); Milera *et al.* (2017) and Patiño *et al.* (2018). At the beginning of the vegetative stage, protein and organic matter digestibility from tropical grasses are generally high. Santos *et al.* (2011) mentioned that the quality and productivity of the pastures are influenced by environmental factors (temperature, light, and humidity), in addition to the intrinsic properties of each plant. Among the quality components of forage, digestibility is a very valuable indicator. Likewise, the protein and fiber contents also reveal the nutritional value of the pasture, since, when the former is higher and the latter is lower, the quality will be higher. A limitation of this study is that environmental variability and rumen fluid source may have influenced gas production. Future studies should validate these findings under field conditions and across multiple ruminant species.

The decrease in digestibility with years of planting in tropical grass considered produces more CH₄ than the fermentation of carbohydrates without fiber (Van Kessel and Russell, 1996). It is proposed that high soluble carbohydrate content will encourage the rumen to produce propionate, decrease the pH of the rumen, and block methanogens, which will reduce the amount of CH₄ produced per unit of organic matter (OM) fermented (Khan *et al.*, 2020). Ribeiro Jr *et al.* (2014) examined the CH₄ production in in vitro digestibility of *Megathyrus maximus* inter-planted with turmeric and ginger after four (4) to sixteen (16) weeks of regrowth; they discovered that while acetate increased with maturation, propionate decreased in relation to total Volatile Fatty Acid (VFA). Less CH₄ generation milliliters per gram of dry matter (mL/g of DM incubated) and/or milliliters per gram of dry matter (mL/g of DM digested) together with more immature swards was anticipated since the decreased fiber content causes fermentation to shift in favor of propionate formation. On the other hand, when forages mature, their fiber content rises, encouraging the synthesis of acetate and increasing the amount of hydrogen available for methanogenesis and CH₄ generation. Nevertheless, in this study, maturity with forages had no effect on the amount of CH₄ produced in vitro milliliters per gram of dry matter (mL/g of DM incubated) and/or milliliters per gram of dry matter mL/g of DM digested). The overall Volatile Fatty Acid (VFA) profiles, which also did not change with maturity for forages are consistent with the results. The use of more immature swards (perennial ryegrass) enhanced herbage digestibility and led to higher VFA output and CH₄/g DM incubated, but no difference was observed when CH₄ was expressed per gram/ DM digested (Navarro-Villa *et al.*, 2011). Purcell *et al.* (2011) conducted study on perennial ryegrass and found that as the herbage matured, its digestibility decreased. This was accompanied by a decrease in CH₄ output/g DM incubated but an increase in CH₄ output/g DM digested. Purcell *et al.* (2011) suggested that as grass ages, there is a minor linear increase in pH along with decreases in Water-Soluble Carbohydrates (WSC) and CP and increases in Neutral Detergent Fiber, Organic

Matter (NDFom) and Acid Detergent Fiber, Organic Matter (ADFom), which together provide an environment that favors the action of cellulolytic bacteria. Methanogenesis increased as a result of a linear increase in the ratios of acetic and butyric acid and a decrease in propionic acid. The current observation on the in vitro digestibility conformed to the findings of Perotti *et al.* (2021) on climatic soil and vegetation drivers of forage yield and quality differ across the first three growth cycles of intensively managed permanent grasslands.

Conclusion

This study demonstrates that inter-planting *Megathyrsus maximus* with turmeric and/or ginger has a notable influence on in vitro digestibility, particularly on methane (CH₄) and carbon dioxide (CO₂) gas production. While inter-planting with turmeric significantly enhanced CO₂ production—suggestive of higher microbial fermentation activity, inter-planting with ginger consistently led to the lowest gas production, including CH₄, indicating a potential methane-suppressing effect. However, differences in cutting age and planting year did not significantly affect gas production.

The results support the hypothesis that medicinal plants like turmeric and ginger can influence ruminal fermentation dynamics when used in forage systems. The variation in digestibility values over time suggests that plant bioactive compounds and forage maturity may interact to alter ruminal microbial activity and fermentation efficiency.

Recommendations

- i. Interplanting *Megathyrsus maximus* with turmeric can improve digestibility and microbial fermentation.
- ii. Interplanting with ginger may reduce methane emissions, supporting low-emission livestock production.
- iii. Adoption of interplanting strategies should consider environmental conditions and further field validation.

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