GSAR Journal of Agriculture and Veterinary Sciences
ISSN: 3048-9075 (Online)
Abbreviated key title: Glob.J. Agri.Vet.Sci.
Frequency: Monthly
Published By GSAR Publishers
Journal Homepage Link- https://gsarpublishers.com/journal-gjavs-home/

Influence of Cutting Age and Planting Year on the Proximate Composition of Megathyrsus maximus Interplanted with Turmeric and Ginger

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Article History

Received: 15/07/2025
Accepted: 27/07/2025
Published: 30/07/2025

Vol – 2 Issue –7

PP: -65-69

Abstract

The proximate analysis revealed that treatments had significant effects (P<0.05) on crude protein contents, with the highest values obtained in Megathyrsus alone (10.05 %) and Megathyrsus + ginger (10.14 %), while the lowest was observed in Megathyrsus + turmeric (9.71 %). Crude fibre, ether extract, ash, and dry matter contents were not significantly affected by treatments, although slight numerical differences were observed. Cutting age influenced nutrient composition, with crude protein declining gradually from 4 weeks (10.02 %) to 16 weeks (9.77 %), while crude fibre and ash increased with maturity. Carbohydrate contents peaked at 45.33 % under Megathyrsus + ginger + turmeric treatment. Across years, crude protein was significantly higher in 2020 (11.01 %) compared to subsequent years, while crude fibre progressively increased, reaching maximum levels in 2023 (25.32 %). Interaction effects between treatment and cutting age showed that crude protein content in sole Megathyrsus decreased significantly at 16 weeks, whereas Megathyrsus interplanted with ginger or ginger + turmeric maintained more stable protein levels across cutting ages. Similarly, interaction between cutting age and planting year revealed that crude fibre increased as the years progressed, especially at early cutting stages. These findings suggest that while interplanting with turmeric alone may slightly reduce protein levels, ginger inclusion supports higher protein retention in Megathyrsus. Furthermore, cutting forage at younger stages and during earlier planting years improves nutritive quality. The study underscores the potential of integrating medicinal plants into forage systems for improved livestock nutrition, consistent with sustainable agriculture goals.

Index Terms: *Forage quality, intercropping, Megathyrsus maximus, proximate composition, turmeric, ginger.*

Introduction

Intercropping is recognized as a sustainable agricultural practice that improves soil fertility, maximizes resource, and boosts overall crop productivity (Obi, 2015). In Nigeria, several studies have reported the agronomic and economic benefits of intercropping systems (Odoemena *et al.*, 2017; Lawal *et al.*, 2018). However, there is limited research on how inter-planting with medicinal plants affects the proximate composition of forage crops, particularly in the derived savannah zone where *Megathyrus maximus* is extensively grown. Turmeric and ginger are known for their medicinal and nutritional properties and have been successfully intercropped with other crops to enhance growth and nutrient uptake (Oloyede, 2016). Their potentials influence on the proximate composition of *Megathyrus maximus* remains underexplored, making this study essential for developing integrated crop-livestock systems that optimize both yield and nutrition. Increased demand for sustainable and nutritious forage for livestock has spurred interest in innovative agricultural practices that enhance both yield and nutritional quality of forage crops. *Megathyrus maximus* (Guinea grass) is a widely cultivated forage species known for its adaptability to various agro-climatic conditions and its potential to improve livestock productivity (Agishi, 2014). However, enhancing its proximate composition through strategic intercropping with medicinal plants such as turmeric (*Curcuma longa*) and ginger (*Zingiber officinale*) could offer

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an innovative approach to improving forage quality while simultaneously benefiting soil status and crop productivity. This study therefore explores the proximate composition of *Megathyrus maximus* inter-planted with turmeric and or ginger, at different cutting ages and over a three-year period. Proximate analysis, which assesses moisture, ash, crude protein, fiber, and fat content, is a critical measure of forage quality. It provides insights into the nutritional value of crops and their suitability in livestock production (Adeoye *et al.*, 2020).

Materials and Methods

Soil sampling

Soil samples were taken randomly using soil auger at about 15cm depth before the commencement of the planting and after the planting to determine the effect of the rhizomes on the nutrients in the soil. Samples collected were analyzed to determine the presence of *curcumin* and *gingerol* which are the active ingredient present in turmeric and ginger. Other physicochemical properties were also determined. Samples were collected at every sampling time (4, 8, 12 and 16 weeks) within the randomly thrown 1 m^2 quadrant.

Forage sample collection

Laboratory and chemicals analysis of samples

The dry matter content (DM), crude protein (CP), ether extract (EE) and ash (Inorganic minerals) were determined according to AOAC (2005) methods, while the neutral detergent fibre (NDF), acid detergent (ADF), acid detergent lignin (ADL), is determined according to Van Soet *et al.* (1991) procedure.

Proximate analysis

The proximate analysis of samples was carried out to quantitatively to determine the moisture (Moisture), Crude Protein (CP), Fat, Crude Fibre (CF), Ash and carbohydrate content of the samples.

Moisture content determination

This was carried out using the conventional method (A.O.A.C; 2010). Two moisture cans were dried in the oven and then put into desiccators to cool. Five gram (5 g) of the sample was put in each of the moisture can and placed in the oven and dried at 105 ^{0}C for 3 hours. It was brought out and transferred into desiccators to cool before weighing. The cycle of heating, cooling and weighing was repeated until a constant weight was obtained which was determined by weight difference and expressed as a percentage of the sample weighed; the mathematical expression below was used in determining the moisture content.

% moisture = $W2$-$W3$/$W2$-$W1$ x 100;

where: $W1$ = weight of empty can;

$W2$ = weight of can + sample before drying;

$W3$ = weight of can + sample at constant weight.

Ash content determination

The method recommended by A.O.A.C. (1990) was used to determine the ash content. The crucibles were dried and cooled in a desiccator before use. Five (5) g of the sample was weighed into the crucibles, covered and placed in a muffle furnace at temperature of 550 ^{o}C. This temperature was maintained for 2 hours until a whitish ash is obtained. The muffle furnace was switched off and the crucibles were removed and placed in a desiccator to cool. The crucibles containing the samples were weighed and the percentage ash content was determined using the mathematical expression below:

% Ash = $W2$-$W3$/$W2$-$W1$ x 100

Where: $W1$ = weight of crucible;

$W2$ = weight of sample + crucible;

$W3$ = weight of crucible + ash.

Fibre determination

Crude fibre was determined as described by (Joslyn, 1990). Exactly two grams (2 g) of the sample was treated with twenty millimeters (20 ml) of 1.25M H2SO4 and boiled for thirty (30) minutes. The resultant mixtures were filtered under suction, washed with hot distilled water and boiled again for another thirty (30) minutes with 1.25ml NaOH. The digested sample was then washed severally with hot distilled water. The washed sample was scrapped into a crucible, dried at 100 ^{o}C for 1 hour, cooled and weighed. The loss in weight on incinerator was taken as the weight of the crude fibre. The mathematical expression for determining crude fibre is;

Crude fibre = loss in weight on incineration/weight of original sample x 100.

Fat determination

Fat content is determined with the use of soxhlet extractor. The extractor was placed into a pre-weighed dried distillation flask. Then the solvent (acetone) was introduced into the distillation flask via the condenser end attached to the soxhlet extractor. The setup was held in place with a retort stand clamp. Cooled water jet was allowed to flow into the condenser and the heated solvent was refluxed as a result, the lipid in the soxhlet chamber was extracted in the process of continuous refluxing. When the lipid was observably extracted; to concentrate the lipid; the flask was then dried with the air oven at 600^{o}C to constant weight and re-weighed to obtain the weight of lipid (Pearson, 1976). The mathematical expression for Ash determination is presented below.

% Ash = $W2$-$W3$/$W2$-$W1$ x100

Where: $W1$ = weight of empty flask;

$W2$ = weight of sample;

$W3$= weight of flask + oil extract.

Crude protein determination (kjeldahl method)

About 0.1g of sample was weighed and added into a clean conical flask of two hundred and fifty millimeters (250 ml) capacity. Three grams (3 g) digestion catalyst was added into the flask and twenty millimeters (20 ml) concentrated sulphuric acid was also added and the flask was heated to digest the content from black to sky blue colouration. The digest was cooled to room temperature and was diluted to one hundred millimeters (100 ml) with distilled water. About twenty milliliters (20 ml) diluted digest was measured into a distillation flask and the flask was held in place on an electro-thermal heater hot plate. To the distillation flask was attached

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condenser, forty percent (40 %) Sodium hydroxide is injected into the digest via a syringe at the head to the micro arm steel head until the digest becomes strongly alkaline. The mixture was heated to boil and the ammonia gas was distilled via the condenser into the receiver beaker. The colour of the acid changed from purple to greenish. Ammonia distillate was introduced into the acid. The distillate was titrated with 0.1ml Hydrochloric acid back to purple colour from greenish. The volume of hydrochloric acid added to effect the change was recorded as titer value. Crude protein is calculated using the following mathematical expression:

% N = titer value x 1.4 x100

Carbohydrate determination

Carbohydrate was determined by weight difference using the following mathematical expression

% carbohydrate = 100 – (% moisture + % ash + % fat + % crude + % fibre + % crude protein).

Results and Discussion

Effect of Treatments

The proximate analysis of *Megathyrsus maximus* interplanted with turmeric and ginger at varying treatments is presented in Table 1. The results revealed significant ($P<0.05$) differences in crude protein (CP) among treatments, while crude fibre (CF), ether extract (EE), ash, carbohydrate (CHO), and dry matter (DM) contents were not significantly affected ($P>0.05$). Crude protein was highest in Megathyrsus alone (10.05%) and Megathyrsus + ginger (10.14%), followed by Megathyrsus + ginger + turmeric (9.93%). The lowest CP value (9.71%) was recorded in Megathyrsus + turmeric. This indicates that intercropping with ginger supports protein retention, while turmeric slightly reduces it.

Effect of Cutting Age

Cutting age did not significantly ($P>0.05$) affect proximate parameters, but numerical trends revealed increases in CF, EE, ash, and DM as plants matured from 4 to 16 weeks. In contrast, CP and CHO increased at early stages (4 and 8 weeks) but declined at 16 weeks, showing a typical maturity-related reduction in forage quality. These findings suggest that younger forage has higher nutritive value, especially in protein content, while later stages accumulate more fibre.

Effect of Planting Year

Planting year had a significant ($P<0.05$) influence on CP and CF. The highest CP (11.01%) was recorded in 2020, whereas subsequent years (2021–2023) recorded lower values. Crude fibre content increased steadily across planting years, peaking at 25.32% in 2023. This pattern suggests that environmental variability and soil nutrient dynamics across years may influence forage quality.

Interaction of Treatment and Cutting Age

Interaction between treatments and cutting ages (Table 2) showed that Megathyrsus alone had significantly higher CP values at 4, 8, and 12 weeks (10.18%, 10.17%, and 10.04%, respectively), which declined at 16 weeks (9.82%). In contrast, Megathyrsus + ginger maintained stable CP levels across all cutting ages, while Megathyrsus + turmeric recorded higher CP at 4 and 8 weeks (10.04% and 10.18%) but declined thereafter. Interestingly, Megathyrsus + ginger + turmeric showed a progressive increase in CP with advancing maturity, peaking at 12 and 16 weeks (10.18%).

Interaction of Cutting Age and Planting Year

The interaction of cutting age and planting year (Table 3) also indicated significant ($P<0.05$) effects on CP and CF. At 4 weeks of cutting, the highest CF value (26.22%) was recorded in 2023, while earlier planting years showed comparatively lower fibre contents, indicating that crude fibre accumulation tends to increase with stand persistence. Similarly, at 8 weeks, CF values continued to rise with planting years, reaching 25.57% in 2022 and 26.22% in 2023, compared to lower levels in 2020 and 2021. At 12 weeks, CF was highest in the third year (2022) with a value of 25.42%, while at 16 weeks, CF peaked in 2021 (25.72%) and remained high in 2023 (25.01%). These results demonstrate that crude fibre content consistently increased as cutting ages advanced across planting years.

General Discussion

The progressive rise in fibre with later years and longer maturity periods reflects the physiological changes associated with forage growth, where structural carbohydrates accumulate at the expense of crude protein. While early harvests (4–8 weeks) are more nutritive due to higher CP, later harvests and prolonged stand persistence reduce digestibility because of increased fibre fractions. These findings emphasize the importance of strategic harvesting at younger stages and early establishment years to optimize nutritive value of Megathyrsus maximus intercropped with turmeric and ginger.

Conclusion

This study demonstrated that interplanting *Megathyrsus maximus* with turmeric and ginger significantly influenced its proximate composition under different cutting ages and planting years. Crude protein was highest in sole *Megathyrsus* and *Megathyrsus* + ginger treatments, while crude fibre progressively increased with plant maturity and stand persistence across years. Younger forage (4–8 weeks) and earlier planting years (2020) provided superior nutritive quality, whereas later harvests and prolonged years of establishment reduced crude protein and increased fibre fractions.

The findings suggest that ginger intercropping supports protein retention in *Megathyrsus maximus*, making it a promising strategy for enhancing forage quality in tropical livestock systems. In contrast, turmeric inclusion slightly reduced crude protein levels, indicating that its integration may require careful management.

Practically, farmers are encouraged to harvest at early stages (4–8 weeks) and to integrate ginger with *Megathyrsus maximus* to improve livestock nutrition and productivity. Future research should focus on evaluating the digestibility and animal performance responses to these forage mixtures,

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as well as investigating long-term soil nutrient dynamics in intercrop systems with medicinal plants.

Acknowledgment

The authors wish to thank their respective institutions for the support provided during this study.

Tables and Figures

Table 1:

Parameters /%	CP	CF	EE	ASH	CHO	DM
Treatment: Megathyrus only	10.05a	24.39	2.40	10.07	45.23	91.99
Megathyrus and ginger	10.14a	24.22	2.40	9.91	45.08	91.80
Megathyrus and trmeric	9.71b	24.53	2.40	10.11	45.14	92.09
Megathyrus, ginger and tur	9.93a	24.55	2.41	10.24	45.33	91.89
S.E.M	0.46	0.82	0.06	0.32	0.74	0.35
Cutting Age:						
4 weeks	10.02	24.35	2.40	10.03	45.06	91.86
8 weeks	10.02	24.35	2.40	10.03	45.06	91.86
12 weeks	10.02	24.25	2.41	10.06	45.31	92.04
16 weeks	9.77	24.74	2.41	10.22	44.88	92.02
S.E.M	0.48	0.83	0.06	0.34	0.75	0.36
Year of planting:						
2020	11.01a	22.67c	2.44	10.09	45.74a	91.96
2021	9.77b	24.59b	2.38	10.06	45.10a	91.90
2022	9.53b	25.11ab	2.40	10.02	45.05ab	92.11
2023	9.52b	25.32a	2.39	10.18	44.40b	91.81
S.E.M	0.45	0.78	0.06	0.33	0.76	0.36

Table 2:

Treatment	Cutting Age	CP
Megathyrus only	4	10.18a
	8	10.17a
	12	10.04a
	16	9.82b
S.E.M		4.51
Megathyrus and ginger	4	10.17
	8	10.04
	12	10.29
	16	10.04
S.E.M		4.53
Megathyrus and turmeric	4	10.04a
	8	10.18a
	12	9.57b
	16	9.07b
S.E.M		2.56
Megathyrus, ginger and turmeric	4	9.68b
	8	9.68b
	12	10.18a
	16	10.18a
S.E.M		3.58

Table 3:

Cutting Age	Year	CP	CF
Week 4	2020	11.60	21.64d
	2021	10.09	23.98c
	2022	0.31	25.57b
	2023	9.07	26.22a
S.E.M		2.88	4.61
Week 8	2020	11.60	21.64c
	2021	10.09	23.98b
	2022	0.31	25.57a

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	2023	9.07	26.22a
S.E.M		2.88	4.61
Week 12	2020	10.74	23.07b
	2021	9.63	24.68b
	2022	9.41	25.42a
	2023	10.30	23.82b
S.E.M		3.67	6.48
Week 16	2020	10.10	24.36b
	2021	9.26	25.72a
	2022	10.10	23.86b
	2023	9.64	25.01a
S.E.M		3.63	6.23

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