

Effects of phenological stages and ensiling length on chemical composition of *Megathyrsus maximus* ensiled with *Moringa oleifera* at different proportions

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ABSTRACT. This experiment investigated effects of phenological stages and ensiling length on chemical composition of *Megathyrsus maximus* ensiled with *Moringa oleifera* seeds at different proportions. The grass was harvested at 8 (vegetative stage) and 11 (reproductive stage) weeks after planting and were ensiled with *Moringa oleifera* seeds at different proportions (100:0, 75:25 and 50:50) for 30, 60, 90 and 120 days. Data collected were analyzed using the 2×3×4 factorial design. Result showed that the CP were significantly lower ($P < 0.05$) in sole *M. maximus* silage at both phenological stages for 120 days (70.38 and 63.99 g kg⁻¹) and also in sole *M. maximus* silage at reproductive stage ensiled for 90 days (68.82 g kg⁻¹). The value of NDF for all proportions decreased with increasing length of ensiling with lowest value at 120 days. The highest tannin content was recorded for 50% *M. oleifera* seed silage at reproductive stage ensiled for 30 days (4.15 g kg⁻¹). It can be concluded from this study that silages from both phenological stages containing *M. oleifera* seeds improved chemical composition as the ensiling length prolonged.

Keywords: grasses; tree seeds; silage; vegetative stage; reproductive stage.

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Introduction

In tropical countries where livestock production is mainly based on grass-dominated pastures, herbage mass during the dry season is generally not sufficient to satisfy the nutritional requirements of livestock because of the low yield and quality which drastically decline. Due to this, the performance of the animals is been affected losing about 20% of their body weight (Lamidi & Ologbose, 2014) leading to low in productivity of the animals. Nutritive contents of forages are high when they are still young while they reduced as they mature. In order to alleviate the problem of feed scarcity and to maintain their quality it becomes imperative to conserve the forages so as to meet the nutrient requirements of animals all year round. Sahoo (2018) described silage production in the tropics as a sustainable means of supplementing feed for ruminants in the dry season due to the fact that the production of silage is not dependent on weather conditions compared to hay making. The production of silage from tropical grasses is valuable because of its relatively lower production cost for animals (Wilkins, 2019).

However, grasses in the tropics grow and mature earlier than the ones from temperate region with the same age due to high temperature regime. This lead to fall in nutrients and digestibility because of the early growth and aging of the plants (Ojo et al., 2016). Babayemi and Igbekoyi (2008) therefore reported that silages made from grasses that have become lignified are poor in nutrients because of the low protein content. In other to utilize these grasses as livestock feeds, increasing the nutrient density with a rich protein source as supplement will improve fermentation and the nutritive value of the silages (Ojo et al., 2018).

Browse seeds have been reported to be high in CP and serve as potential feed for ruminants (Idowu et al., 2013). However, they contain secondary metabolites which limits their utilization by ruminants but are reduced to some extent without detrimental effect on the animals if they are been processed and conserved (Oyaniran, Ojo, Aderinboye, Bakare, & Olanite, 2018).

The silage quality is usually influenced by the stage of maturity and use of additives (Oliveira et al., 2020) and their changes are reflected by their chemical composition. The chemical composition of silage produced,

depends largely on stage of growth of the harvested plants as well as the changes from activities of plants enzymes during the storage periods (Souza et al., 2022).

For this study, we therefore hypothesize that the low quality of tropical grasses at advanced stage can be improved by conservation with inclusion of browse seeds. Hence, this study is to evaluate the effects of phenological stages and ensiling length on chemical composition of *M. maximus* ensiled with *M. oleifera* seeds at different proportions.

Material and methods

Location and climate of the study area

The study was conducted at the Federal University of Agriculture Abeokuta (FUNAAB) Nigeria, West Africa, located 76 m above sea level and falls within latitude 7° 15' north and longitude 3° 21' east with average annual rainfall of 1037 mm. Mean annual temperature and humidity are 34.0°C and 82%, respectively.

Collection of samples and procedure of silage making

The matured pods of *M. oleifera* were harvested using a tree-pruning pole attached with a sickle at the end. The collected pods were sun-cured for three days, and the seeds were extracted by manually opening the pods. The seeds of all the plants were further sundried for three days and ground using hammer mill to pass through 3 mm sieve. *Megathyrus maximus* grass were harvested at vegetative (8 WAP) and early reproductive (11 WAP) stages which were planted at spacing of 0.5 × 0.5 m and fertilized approximately with 150 kg N ha⁻¹ of poultry manure. The grasses were chopped to about 2 cm long, wilted for 2 hours and were mixed uniformly with the tree seeds at different proportions (100% grass: 0% Moringa seeds, 75% grass: 25% Moringa seeds and 50% grass: 50% Moringa seeds). They were then packed according to the treatment into well labeled laboratory glass jar bottle silos of 960 mL, compressed and compacted to ensure anaerobic conditions. They were then stored for 30, 60, 90 and 120 days on the laboratory tables. The treatments were replicated 3 times.

Experimental design

The study was 2 × 3 × 4 factorial experiment. The factors were two phenological stages (vegetative and reproductive stages), three proportions of the grass and tree seeds (100:0, 75:25 and 50:50) and four ensiling length (30, 60, 90 and 120 days).

Chemical analyses of ensiled forages

Sub samples of each silage at different ensiling length were oven dried at 65°C to a constant weight and milled to pass through 1 mm sieve. Proximate composition (dry matter, crude protein, ether extract and ash) were determined according to Association of Official Analytical Chemists (AOAC, 2000), non-fibre carbohydrate (NFC g kg⁻¹) was calculated as: 1000 – NDF – CP – EE – Ash. Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) was carried out according to the procedure of Van Soest, Robertson, and Lewis (1991). Concentrations of minerals, calcium (Ca), potassium (K), phosphorus (P) and magnesium (Mg), in the silages were determined using atomic absorption spectrophotometer (Buck Scientific, East Norwalk, CT, USA) after wet digestion with concentrated sulphuric acid according to AOAC (2000).

Tannin content of the milled tree seeds was determined using the Vanillin-HCl method as described by Price and Betler (1977). Saponin content was determined according to the methods of Obadoni and Ochuko (2001).

Statistical analysis

All data obtained were subjected to three-way analysis of variance (ANOVA). Treatment means were separated using Turkey's HSD test. All data were analyzed using the R Statistical Software (R Core Team, 2020). Significance difference were tested at 5% probability level.

Results and discussion

Table 1 shows the effect of phenological stages, proportion and ensiling length on the proximate composition of *M. maximus* ensiled with *M. oleifera* seeds. The values of dry matter content reduced from 90 to 120 days of ensiling at different proportion and phenological stages with the lowest value recorded for sole

M. maximus silage at vegetative stage and ensiled for 120 days (859.36 g kg^{-1}). The highest value of CP content (152.98 g kg^{-1}) was recorded for 50% *M. oleifera* seed silage at vegetative stage ensiled for 30 days while the least were significantly lower ($P < 0.05$) in sole *M. maximus* silage at both phenological stages ensiled for 120 days (70.38 and 63.99 g kg^{-1}) and also sole *M. maximus* silage at reproductive stage ensiled for 90 days (68.82 g kg^{-1}). The result showed an increasing trend in CP and EE contents as the proportion of the seed in the silage increased at both phenological stages. This might be due to higher CP and EE in the seeds. In a similar trend, Ojo et al. (2018) reported that the CP increased with increasing level of treated *E. cyclocarpum* seeds ensiled with *P. purpureum*. The CP content also declined with prolonged ensiling length at both phenological stages. This was similar with findings of Okukenu et al. (2018) for *M. maximus* ensiled with *C. molle* at different proportion and storage duration. This could be as a result of proteolytic activities and the breaking down of the nutrients by the microbes during the fermentation. Sarıçiçek, Yıldırım, Kocabaş, and Demir (2016) evaluated changes in the quality of maize silage stored for different duration, and found out that extended duration of ensiling decreased dry matter and crude protein contents as storage advanced. The authors reported that as the ensiling period progressed from 90 – 202 days, CP content declined from 89.5 to 65.4 g kg^{-1} . The values of CP and ash contents at the vegetative stage for each silage with different proportions were higher than that of reproductive stage. This might be due to the dilution of CP content by an increased amount of structural carbohydrates as the plants matured (Agza, Kassa, Zewdu, Aklilu, & Alemu, 2013). The CP recorded for the silages were above 60 g kg^{-1} required by rumen microbes to build their protein body in which the feed intake of ruminants and rumen microbial activity would be affected if it falls below this threshold (Van Soest, 1994). The ash content obtained in this study was higher than the means of 40.5 g kg^{-1} reported by Okukenu et al. (2018). This might be due to age at harvest and status of the soil. The deficiency of some minerals in the soil have been reported to reduce the ash content in the plants (Oguntona, 1998). Tilahun, Asmare, and Mekuriaw (2017) also reported that as the plant matures the ash content reduces.

Effect of phenological stages, proportion and ensiling length on fibre fraction of silage is shown on Table 2. Sole *M. maximus* silage at reproductive stage and ensiled for 120 days had the highest value of ADF content (385.64 g kg^{-1}). The NDF and hemicellulose contents decline as the proportion of seed in silage decreased with prolonged ensiling length at both phenological stages. This is in line with the findings of Dele et al. (2013) on silage produced from Guinea grass and agro by-product as affected by storage duration. This could be attributed to rate of degradation of fibre content by bacteria during fermentation with prolonged ensiling length (Yahaya et al., 2001). The values of NDF and hemicellulose contents ranged from 445.75 – 691.65 and 110.91 – 382.78 g kg^{-1} respectively with the highest recorded for sole *M. maximus* silage at reproductive stage at 30 days and least recorded for 50 % *M. oleifera* seed silage at vegetative stage at 120 days of ensiling. The NDF content of sole *M. maximus* ensiled for 30 and 60 days was slightly higher than 628.2 g kg^{-1} reported by Ekanem, Olorunnisomo, and Matthew (2019) for sole *M. maximus* silage and also higher than the range of 318.80 – 424.40, 603.1 g kg^{-1} for *P. purpureum* ensiled with treated *E. cyclocarpum* seeds at different proportion (Ojo et al., 2018). This variation could be due to age at harvest. However, the NDF contents of the silage in this study were at level that can be easily degradable which is below 70% if fed to animals (Turgut, Yanar, Tuzemen, Tan, & Comakli, 2008). The ADF values obtained in this study were within the range of 220–500 g kg^{-1} reported for forage plants (Slater, 1991). The ADL content also decreased as the proportion of seed in silage decreased at both phenological stages.

Effects of phenological stages, proportion and ensiling length on the mineral composition and anti-nutritional factor of *M. maximus* ensiled with *M. oleifera* seed is presented in Table 3. The values of Ca and P contents ranged from 3.05 – 8.06 and 1.64 – 6.92 g kg^{-1} respectively with lowest value in sole *M. maximus* silage at reproductive stage ensiled at 90 days and highest obtained in 25% *M. oleifera* seed silage at vegetative stage ensiled at 30 days. Lowest value of K content was obtained in 50% *M. oleifera* seed silage at vegetative stage ensiled for 30 days (11.91 g kg^{-1}). Calcium and P contents recorded for sole *M. maximus* silage in this study were lower than 7.02 and 2.44 g kg^{-1} respectively reported by Ojo et al. (2016) for *M. maximus* ensiled for 42 days. The difference could be due to mineral contents in the soil that was available for uptake by plant. Calcium and P contents observed in this study were higher than the range of 2 – 6 g kg^{-1} and 0.18–0.48% respectively required for ruminants (Dele et al., 2018). Potassium content was above 0.8% recommended for grazing animals (Dele et al., 2018).

Table 1. Effects of phenological stages, proportion and ensiling length on the proximate composition of *M. maximus* ensiled with *M. oleifera* seed.

Duration	Stage	Proportion	DM	CP	EE	ASH	NFC
30 days	Vegetative	MM 100: MO 0	935.99 ^a	81.78 ^c	51.47 ^c	99.67 ^b	122.33 ^c
		MM 75: MO 25	955.23 ^a	134.01 ^{ab}	68.69 ^c	73.91 ^c	94.84 ^d
		MM 50: MO 50	970.54 ^a	152.96 ^a	103.03 ^{ab}	80.47 ^b	65.97 ^e
	Reproductive	MM 100: MO 0	946.95 ^a	74.12 ^d	58.89 ^c	44.65 ^d	130.69 ^{bc}
		MM 75: MO 25	962.30 ^a	110.14 ^b	61.37 ^c	49.40 ^d	106.11 ^c
		MM 50: MO 50	977.23 ^a	126.35 ^b	68.25 ^c	49.63 ^d	107.74 ^c
60 days	Vegetative	MM 100: MO 0	929.66 ^{ab}	77.47 ^d	56.17 ^c	101.52 ^{ab}	132.56 ^{bc}
		MM 75: MO 25	949.64 ^a	129.17 ^b	74.89 ^c	74.73 ^c	105.69 ^c
		MM 50: MO 50	964.48 ^a	145.94 ^a	109.32 ^{ab}	79.59 ^{bc}	78.78 ^d
	Reproductive	MM 100: MO 0	947.15 ^a	70.60 ^d	63.06 ^c	44.37 ^d	143.34 ^{bc}
		MM 75: MO 25	969.34 ^a	104.08 ^{bc}	65.24 ^c	49.73 ^d	123.48 ^c
		MM 50: MO 50	970.23 ^a	120.31 ^b	73.67 ^c	49.66 ^d	119.26 ^c
90 days	Vegetative	MM 100: MO 0	895.54 ^b	75.23 ^d	69.87 ^c	76.33 ^c	243.47 ^a
		MM 75: MO 25	909.06 ^{ab}	124.67 ^b	91.40 ^b	96.53 ^b	184.87 ^{ab}
		MM 50: MO 50	919.70 ^{ab}	141.77 ^a	121.43 ^a	117.50 ^a	173.49 ^{ab}
	Reproductive	MM 100: MO 0	901.68 ^{ab}	68.82 ^d	60.43 ^c	71.33 ^c	202.41 ^a
		MM 75: MO 25	921.95 ^{ab}	101.83 ^{bc}	87.60 ^b	81.70 ^b	167.67 ^b
		MM 50: MO 50	918.56 ^{ab}	116.86 ^b	112.30 ^a	84.93 ^b	169.74 ^b
120 days	Vegetative	MM 100: MO 0	859.36 ^b	70.38 ^d	65.22 ^c	71.15 ^c	262.41 ^a
		MM 75: MO 25	867.33 ^b	115.40 ^b	86.62 ^b	89.66 ^b	214.97 ^a
		MM 50: MO 50	867.75 ^b	130.71 ^{ab}	115.25 ^a	108.68 ^{ab}	199.62 ^{ab}
	Reproductive	MM 100: MO 0	858.42 ^b	63.99 ^d	56.95 ^c	67.04 ^c	223.07 ^a
		MM 75: MO 25	877.62 ^b	95.27 ^c	82.96 ^b	75.61 ^c	188.81 ^{ab}
		MM 50: MO 50	872.50 ^b	109.81 ^{bc}	103.83 ^{ab}	78.48 ^c	195.34 ^{ab}
SEM			10.34	1.75	0.64	0.72	5.59
P-value			< .0001	< .0001	< .0001	< .0001	< .0001

^{a, b, c} means on the same column with different superscripts are significantly different ($P < 0.05$), SEM = standard error of means, DM = dry matter, CP = crude protein, EE = ether extract, NFC = non fibre carbohydrate. MM 100: MO 0 = *M. maximus* 100: *M. oleifera* 0; MM 75: MO 25 = *M. maximus* 75: *M. oleifera* 25; MM 50: MO 50 = *M. maximus* 50: *M. oleifera* 50.

Table 2. Effect of phenological stages, proportion and ensiling length on the fibre fractions of *M. maximus* ensiled with *M. oleifera* seed.

Duration	Stage	Proportion	NDF	ADF	ADL	HEM	CELL
30 days	Vegetative	MM 100: MO 0	644.75 ^a	281.24 ^c	79.86 ^a	363.51 ^a	201.38 ^b
		MM 75: MO 25	628.55 ^a	294.15 ^c	64.33 ^{ab}	334.40 ^a	229.82 ^{ab}
		MM 50: MO 50	597.57 ^{ab}	260.84 ^c	60.48 ^{ab}	336.73 ^a	200.37 ^b
	Reproductive	MM 100: MO 0	691.65 ^a	308.88 ^{bc}	68.34 ^a	382.78 ^a	240.54 ^{ab}
		MM 75: MO 25	672.97 ^a	330.57 ^b	53.00 ^{ab}	342.41 ^a	277.57 ^{ab}
		MM 50: MO 50	648.04 ^a	286.62 ^c	41.62 ^b	361.42 ^a	245.00 ^{ab}
60 days	Vegetative	MM 100: MO 0	632.28 ^a	274.72 ^c	74.85 ^a	357.57 ^a	199.87 ^b
		MM 75: MO 25	615.52 ^a	288.14 ^c	59.15 ^{ab}	327.38 ^a	228.99 ^{ab}
		MM 50: MO 50	586.37 ^{ab}	256.71 ^c	56.94 ^{ab}	329.65 ^a	199.78 ^b
	Reproductive	MM 100: MO 0	678.62 ^a	301.33 ^{bc}	64.63 ^a	377.29 ^a	236.71 ^{ab}
		MM 75: MO 25	657.48 ^a	322.84 ^b	49.38 ^b	334.64 ^a	273.46 ^a
		MM 50: MO 50	637.11 ^a	281.60 ^c	39.85 ^c	355.50 ^a	241.75 ^{ab}
90 days	Vegetative	MM 100: MO 0	535.10 ^b	354.43 ^{ab}	66.03 ^a	180.67 ^{bc}	288.40 ^a
		MM 75: MO 25	502.53 ^{bc}	342.13 ^{ab}	53.60 ^{ab}	160.40 ^c	288.53 ^a
		MM 50: MO 50	445.80 ^c	321.43 ^b	44.30 ^b	124.37 ^c	277.13 ^a
	Reproductive	MM 100: MO 0	597.00 ^{ab}	368.63 ^a	70.57 ^a	228.37 ^b	298.07 ^a
		MM 75: MO 25	561.20 ^b	355.23 ^{ab}	60.13 ^{ab}	205.97 ^b	295.10 ^a
		MM 50: MO 50	516.17 ^b	340.13 ^{ab}	51.60 ^{ab}	176.03 ^c	288.53 ^a
120 days	Vegetative	MM 100: MO 0	530.83 ^b	366.30 ^{ab}	67.66 ^a	164.53 ^c	298.64 ^a
		MM 75: MO 25	493.35 ^c	358.36 ^{ab}	54.92 ^{ab}	134.99 ^c	303.44 ^a
		MM 50: MO 50	445.75 ^c	334.85 ^b	45.64 ^b	110.91 ^c	289.21 ^a
	Reproductive	MM 100: MO 0	588.95 ^{ab}	385.64 ^a	72.37 ^a	203.31 ^b	313.27 ^a
		MM 75: MO 25	557.35 ^b	368.86 ^a	61.51 ^{ab}	188.49 ^{bc}	307.35 ^a
		MM 50: MO 50	512.54 ^b	359.19 ^{ab}	53.07 ^{ab}	153.35 ^c	306.12 ^a
SEM			4.60	2.00	0.43	5.40	2.16
P-value			< .0001	< .0001	< .0001	< .0001	< .0001

^{a, b, c} means on the same column with different superscripts are significantly different ($P < 0.05$), SEM = standard error of means NDF = neutral detergent fibre, ADF = acid detergent fibre, ADL = acid detergent lignin MM 100: MO 0 = *M. maximus* 100: *M. oleifera* 0; MM 75: MO 25 = *M. maximus* 75: *M. oleifera* 25; MM 50: MO 50 = *M. maximus* 50: *M. oleifera* 50.

Table 3. Effects of phenological stages, stages, proportion and ensiling length on the mineral composition and anti-nutritional factor of *M. maximus* ensiled with *M. oleifera* seed.

Duration	Stage	Proportion	Ca	P	Ca:P	K	Na	Mg	T	S
30 days	V	MM 100: MO 0	4.60 ^c	2.39 ^d	1.92 ^b	27.06 ^a	0.11 ^c	6.00 ^a	ND	ND
		MM 75: MO 25	8.06 ^a	6.92 ^a	1.17 ^d	21.80 ^{ab}	0.15 ^c	7.92 ^a	3.59 ^{cd}	6.30 ^{cd}
		MM 50: MO 50	7.99 ^a	4.98 ^b	1.63 ^c	14.90 ^c	0.17 ^c	7.02 ^a	4.15 ^b	7.36 ^a
	R	MM 100: MO 0	4.26 ^c	2.05 ^d	2.08 ^b	24.03 ^a	0.09 ^c	5.76 ^{ab}	ND	ND
		MM 75: MO 25	6.22 ^{ab}	5.45 ^{ab}	1.15 ^d	20.07 ^{ab}	0.13 ^c	6.62 ^a	3.79 ^{bc}	5.39 ^{fg}
		MM 50: MO 50	6.32 ^{ab}	4.23 ^b	1.51 ^c	12.85 ^c	0.17 ^c	7.30 ^a	4.82 ^a	5.98 ^{cde}
60 days	V	MM 100: MO 0	3.67 ^d	1.83 ^d	2.00 ^b	21.66 ^{ab}	0.09 ^c	4.68 ^b	ND	ND
		MM 75: MO 25	6.16 ^{ab}	5.42 ^{ab}	1.14 ^d	17.84 ^{bc}	0.13 ^c	5.97 ^{ab}	3.46 ^{cde}	5.77 ^{def}
		MM 50: MO 50	6.33 ^{ab}	4.06 ^{bc}	1.61 ^c	11.91 ^d	0.13 ^c	6.13 ^a	3.48 ^{cde}	6.90 ^{ab}
	R	MM 100: MO 0	3.24 ^d	1.69 ^d	1.91 ^b	18.77 ^b	0.07 ^c	4.21 ^b	ND	ND
		MM 75: MO 25	5.29 ^b	4.52 ^b	1.17 ^d	15.74 ^{bc}	0.11 ^c	5.53 ^{ab}	3.64 ^{cd}	5.94 ^{cdef}
		MM 50: MO 50	5.58 ^b	3.52 ^c	1.61 ^c	10.44 ^c	0.13 ^c	5.93 ^a	3.87 ^{bc}	6.48 ^{bc}
90 days	V	MM 100: MO 0	3.33 ^d	2.09 ^d	1.59 ^c	17.13 ^{bc}	0.91 ^{ab}	2.62 ^c	ND	ND
		MM 75: MO 25	7.00 ^a	3.05 ^c	2.29 ^{ab}	15.35 ^{bc}	1.26 ^a	3.58 ^b	3.27 ^{de}	5.52 ^{ef}
		MM 50: MO 50	5.17 ^b	4.55 ^b	1.13 ^d	13.42 ^c	1.29 ^a	4.10 ^b	3.51 ^{cde}	6.52 ^{bc}
	R	MM 100: MO 0	3.05 ^d	1.64 ^d	1.87 ^b	14.31 ^c	0.71 ^b	2.13 ^c	ND	ND
		MM 75: MO 25	4.98 ^{bc}	1.89 ^d	2.63 ^a	13.81 ^c	1.07 ^b	1.69 ^d	3.46 ^{cde}	6.02 ^{cde}
		MM 50: MO 50	4.41 ^c	1.99 ^d	2.22 ^{ab}	12.49 ^c	1.31 ^a	2.71 ^c	3.65 ^{cd}	6.18 ^{cd}
120 days	V	MM 100: MO 0	3.33 ^d	2.08 ^d	1.60 ^c	16.65 ^{bc}	0.92 ^{ab}	2.54 ^c	ND	ND
		MM 75: MO 25	6.91 ^a	3.11 ^c	2.22 ^{ab}	14.99 ^c	1.28 ^a	3.42 ^b	2.39 ^f	4.41 ^{hi}
		MM 50: MO 50	5.15 ^b	4.66 ^b	1.10 ^d	13.03 ^c	1.27 ^a	4.00 ^b	2.48 ^f	4.92 ^{gh}
	R	MM 100: MO 0	3.10 ^d	1.69 ^d	1.86 ^b	13.79 ^c	0.72 ^b	2.09 ^c	ND	ND
		MM 75: MO 25	4.93 ^{bc}	1.87 ^d	2.63 ^a	13.30 ^c	1.08 ^b	1.65 ^d	2.46 ^f	4.30 ⁱ
		MM 50: MO 50	4.43 ^c	2.02 ^d	2.20 ^{ab}	12.16 ^c	1.31 ^a	2.60 ^c	3.16 ^e	4.43 ^{hi}
SEM		MM 100: MO 0	0.14	0.13	0.07	0.57	0.01	0.23	0.04	0.11
P-value			< .0001	< .0001	< .0001	< .0001	< .0001	< .0001	< .0001	< .0001

^{a,b,c} means on the same column with different superscripts are significantly different ($P < 0.05$), SEM = standard error of means. MM 100: MO 0 = *M. maximus* 100: *M. oleifera* 0; MM 75: MO 25 = *M. maximus* 75: *M. oleifera* 25; MM 50: MO 50 = *M. maximus* 50: *M. oleifera* 50. V = Vegetative, R = Reproductive, T = Tannin, S = Saponin.

The silage with 50% *M. oleifera* seed at reproductive stage ensiled for 30 days (4.15 g kg⁻¹) had the highest value of tannin content while the highest value of saponin content was recorded for 50% *M. oleifera* seed at vegetative stage ensiled for 30 days. The tannin and saponin contents increased as the proportion of the seed in the silage increased at both phenological stages while they decreased with increased ensiling period. This might be due to heat produced during the ensiling process which is normal in relation to silage temperature even in a well-managed silo (Adesogan & Newman, 2014). Production of heat during the process of conservation might have been responsible for the reduction in tannin and saponin contents as the ensiling period increased.

Conclusion

It can be concluded from this study that silages made from both phenological stages containing *M. oleifera* seeds improved CP, EE and ash contents and also reduced the NDF, tannin and saponin contents as the ensiling length prolonged. This shows that the higher yield of grass at reproductive stage can be ensiled and enhanced with browse seeds for animal consumption especially during the dry season when high quality is rare for animals.

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