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**The effects of sowing methods on growth components, yield chemical composition and silage quality of sunflower forage**

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**Abstract**

*The aim of this experiment was to determine the chemical composition of sunflower forage at different ages of harvest under three sowing methods. The experiment was set up in a 3x3 factorial arrangement and laid out in a Completely Randomized Design (CRD) with 12 plots, each measuring 3x3 m. The treatments were sowing method (dibbling, drilling, and broadcasting) and cutting age (2, 4, 6, and 8 weeks after sowing (WAS)). Each treatment was replicated four times, and data were collected at 6, 8, and 10 weeks after sowing to analyze dry matter, moisture content, crude protein, ether extract, crude fiber, ash content, nitrogen-free extract, neutral detergent fiber, and anti-nutrients such as tannin, oxalate, and phytate. Furthermore, four different treatments were ensiled using the following proportions: T1 = 95% sunflower forage + 0 Napier grass + 5% molasses; T2 = 80% sunflower forage + 15% Napier grass + 5% molasses; T3 = 60% sunflower + 35% Napier grass + 5% molasses; T4 = 40% sunflower + 55% Napier grass + 5% molasses. The silage was left un-opened for 21 days to ferment. The chemical composition of these treatments was also analyzed. The results indicated that chemical composition of sunflower forage for C.P(9.53%), C.F(15.58%), and Ash (1.39%) were significantly ( $P<0.05$ ) higher for sunflower planted in drilling method and harvested 10 weeks after sowing, NDF (18.35%) and ADF (13.97%) were significantly ( $P<0.05$ ) higher in dibbling at 6 weeks after sowing. NFE (77.88%) was significantly ( $P<0.05$ ) higher in broadcasting also at 6 weeks after sowing, while DM, MC and EE were not significantly ( $P<0.05$ ) affected by sowing method. The results showed that anti-nutritional composition of sunflower was significantly ( $P<0.05$ ) affected by sowing method. Tannin (2.69%) and Oxalate (0.33%) were significantly ( $P<0.05$ ) lower in broadcasting while Phytate (1.56%) was least in dibbling. The results of growth components showed that plant height (81.44 cm), leaf length (13.59 cm), leaf width (10.33 cm) and leaf number (32.36) were significantly ( $P<0.05$ ) higher in broadcasting, while number of tillers was not significantly affected ( $P<0.05$ ) by sowing method. Varying sowing methods significantly ( $P<0.05$ ) affected fresh and dry forage yield of sunflower with the highest values (23320.30kg/ha and 5677.67kg/ha) recorded for drilling method. This study provides valuable insights into the chemical composition of sunflower forage under different sowing methods and at various cutting ages. These findings could have practical implications for improving forage quality and yield in livestock production.*

**Keywords:** Forage Yield, Chemical Composition, Sowing Method, Ensiled Sunflower

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**Introduction**

Sunflower (*Helianthus annuus* L.) is primarily cultivated as an oil crop, but its residues such as heads and leftover stalks are also popular roughage for livestock and have

been used for this purpose since the early 20th century (Gaines and Nevens, 1925; Ray, 1919). Sunflower forage can be a valuable alternative option under drought conditions, which can limit seed production potential, or

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in areas with a shortage of roughage (Garcia, 2006). Sunflower forage is usually fed as silage, and the threshed heads are a valuable feed, provided they are properly dried before threshing (depending on the climate) (Suttie, 2000). The dry heads can also be made into a meal (Göhl, 1982) or mixed with other residues of sunflower harvest and oil extraction to make sunflower screenings (Lardy *et al.*, 2009).

Sunflower forage typically contains 10-20% CP, which is considered moderate to high compared to other forage crops. However, the nutritional value of sunflower forage can be influenced by various factors, such as sowing method and cutting age. Therefore, it is important to study the chemical composition and nutritional value of sunflower forage under different growing conditions to optimize its use as a forage crop. In addition, ensiling is a common method used to preserve forage crops for later use and can also improve the nutritional quality of the forage. By combining sunflower forage with other forage crops such as Napier grass and molasses, the resulting silage can have improved digestibility and nutrient content. This study was designed to investigate the chemical composition of sunflower forage under different sowing methods and cutting ages, as well as the effects of ensiling with Napier grass and molasses on the nutritional quality of the resulting silage. The findings of this study could have practical implications for livestock production, particularly in areas where there is a shortage of roughage or drought conditions that limit seed production potential.

## Materials and Method

### Location of the Study

The experiment was carried out at the Pasture Unit of the Livestock Teaching and Research Farm of the Animal Science Department, Faculty of Agriculture, University of Maiduguri, Borno State, Nigeria. The area

falls under the Sahel zone of West Africa which is noted for its high climatic and seasonal variations (Alaku and Moruppa, 1983). The city practically experiences two distinct seasons yearly. These are: a short rainy season usually from the month of June to September and a long dry season from October to May. March, April and May being the hottest months of the year with a temperature between 30°C and 43°C and a fall is experienced during the rains with temperatures ranging from 25°C - 30 °C. There is a serious decrease in temperature during the harmattan months, which extends from October to February. In June, extreme temperatures of 43°C and 20°C have been recorded. Relative humidity is about 45% in August and decreases to about 5% in the drier months of December and January. Day length varies from 11–12 hours (Alaku and Moruppa, 1983).

### Land Preparation and Sources of Seeds

The land was cleared of weeds and debris with hoe, axe and cutlass, and then cultivated using hoe. The seeds of sunflower (*Helianthus annuus*) were obtained from National Animal Production Research Institute (NAPRI), Shika, Zaria, Kaduna state.

### Experimental Design and Treatments

The experiment was set up in a 3x3 factorial arrangement laid out in a Completely Randomized Design (CRD) consisting of three treatments replicated four times. The experimental layout contained 12 plots and measured 11 x 15 m, with each plot measuring 3 x 3m each and 1m interval between the plots. The treatments used for the experiment were dibbling, drilling and broadcasting (T1, T2 and T3, respectively) with a spacing of 50 x 40 cm inter and intra row spacing for dibbling and drilling and sowing depth of 2 cm. Three seeds were planted per hole making a total of 90 seeds per plot.

### Data Collection on Sunflower Forage for Chemical and Nutritional Factor Analysis

Seedling emergence was monitored at 5 days after sowing and germination percentage was taken at 14 days after sowing. Data on growth components and forage Yield at 12 weeks after sowing were taken at 2, 4, 6, 8, 10 and 12 weeks after sowing. Plant stands from 2 middle rows were tagged from each plot for measurements of various agronomic parameters using the standard procedure (Tarawali *et al.*, 1995).

Growth Parameters : Plant height, Number of leaves per plant, Leaf length (cm), Leaf width (cm), Forage yield were measured.

Dry matter production was calculated as: Dry matter kg/ha = (Total FW x (DWss/FWss)) x 10

Where: Total FW = Total fresh weight from 1 m<sup>2</sup> in (g) DWss = Dry weight of the sub-sample in (g) FWss = Fresh weight of the sub-sample in (g) (Tarawali *et al.*, 1995)

### Measurement of Seedling Emergence

Seedling emergence is typically calculated as a percentage using the following formula by John doe, 2021).

$$\text{Seedling Emergence Rate (\%)} = \frac{\text{number of emerged seedling}}{\text{total number of planted seeds}} \times 100$$

Forage Yield (kg/ha) = (Average biomass of harvested forage per sample plot) x (10,000 / Area of the sample plot). Growth Parameters were measured. Forages were harvested at 2, 4, 6, 8 and 10 weeks of age for chemical and nutritional factor, each harvest from all replicates of each treatment for example T1 was pooled together and shade dried, a sub sample was collected for the analysis of chemical and anti-nutritional factor in the laboratory. This was done for each treatment at the stipulated weeks of evaluation:

### Procedure for Silage Making

Sunflower forage was harvested at flowering stage and Napier grass at blooming stage both from the Pasture field. Sunflower forage and Napier grass were chopped into smaller sizes (3cm) and allowed to wilt for three (3) days separately. Cane sugar molasses was purchased at the Gomboru market, Maiduguri and used as additive.

### Treatment and Ensiling

Four different treatments were ensiled using the following proportions:

T1 = 95% sunflower forage + 0 Napier grass + 5% molasses

T2= 80% sunflower forage +15 Napier grass + 5% molasses

T3= 60% sunflower + 35% Napier grass + 5% molasses

T4= 40% sunflower + 55% Napier grass + 5% molasses

Each treatment was mixed with 5% cane sugar molasses. The mixture was thoroughly mixed and packed into 100 kg polythene silo bags, compressed, and made air tight to prevent entry of air. The silage was left unopened for 21 days to ferment. After which it was opened and immediately evaluated for physical characteristics (pH, colour, smell, texture, appearance and temperature) and a sub-sample taken to the laboratory for analysis of chemical composition. The appearance, smell, texture and PH of silage were scored on a 0-4 scale as presented.

### Data Analysis

Data generated from the experiment was subjected to analysis of variance (ANOVA) in a 3 x 3 factorial arrangement laid out in a Completely Randomized Design (SAS, 2005). The significant differences among treatment means were separated using Duncan's Multiple Range Tests at 5% level of significance using the SAS software package

### Results and Discussion

#### Composition of Sunflower Forage

The results of the proximate composition of sunflower are presented in Table 1. The data showed that dry matter and moisture content were not significantly ( $P>0.05$ ) affected by sowing method, but crude protein differed significantly ( $P<0.05$ ) at varying methods of sowing. Significantly ( $P<0.05$ ) higher crude protein was recorded at dibbling (9.53%), though statistically similar to drilling (9.27%), while the lowest was recorded at broadcasting (8.53%). Crude fibre was higher at drilling (15.58%), followed by dibbling (14.88%), and then least at broadcasting (9.48%). The highest ash content was recorded at broadcasting (1.56%), which was statistically similar to drilling (1.39%), but significantly ( $P<0.05$ ) higher than the value recorded for dibbling (0.94%). The nitrogen-free extract also showed significant differences ( $P<0.05$ ), with broadcasting (77.88%) being the highest, followed by dibbling (72.43%), and drilling (71.32%) being the lowest. The neutral detergent fibre showed significant difference at varying sowing methods which is significantly highest at dibbling (18.35%), followed by drilling (18.03%) and the lowest being broadcasting (17.79%). The acid detergent fibre showed significant difference in the same manner as neutral detergent fibre (13.97%, 13.73% and 13.54%) for dibbling, drilling and broadcasting respectively.

Age of cutting significantly ( $P<0.05$ ) affected the proximate composition at 6, 8 and 10 weeks after sowing (WAS). The higher dry matter was recorded at 6 weeks (94.30% and 94.12%), the highest crude protein (10.55%), neutral detergent fibre (19.00%), acid detergent fibre (14.46%) was recorded 6 WAS. Crude fibre (17.26%) was highest at week 10. Ether extract, and ash were not significantly affected by age of planting. The lowest crude protein, neutral detergent fibre and acid detergent fibre were significantly ( $P<0.05$ ) lowest at week 8 (7.64%, 17.20%

and 13.10%) respectively. nitrogen free extract was highest at week 6 (77.03%), followed by week 8 (74.60%) and lowest at week 10 (69.99%).

The highest CP (9.53%) obtained at dibbling is lower than that reported by NRC (2001) which stated that sunflower forage typically contains around 10-20% crude protein, it is also lower than (17.20%) reported by Okedu *et al.* (2019). It is also lower than (18.4%) reported by Farinu *et al.* (1999). This might be attributed to varietal difference and crop management. However, crude protein value obtained in this study is within the range of 7-12% CP as requirement for ruminants reported by NRC (2001). The crude fibre composition highest result obtained at dibbling is higher than (12.50%) obtained by Okedu *et al.* (2019) and is also higher than (12.50%) which was reported by Farinu *et al.* (1999). However, results of crude fibre in this study concurred with standard range of 15-17% crude fibre recommended for small ruminants (NRC 2001). The ash content obtained was higher at broadcasting and drilling but lowest at dibbling. This result is lower than that (14.0%) reported by Okedu *et al.* (2019). It is also lower than that (5.0%) reported in an article by Farinu *et al.* (1999). The nitrogen free extract in this study is higher than 50.05% which was reported by Okedu *et al.* (2019) and it is also higher than 41.82% which was reported by Odedire *et al.* (2014). Similarly, Olayemi *et al.* (2006) reported NFE of 51.40% for dried sunflower leaf, and the difference might be attributed to varietal differences. The neutral detergent fibre was lower at drilling, and the values obtained were higher than 14% reported by Farinu *et al.* (1999). The results are lower when compared to those (40-60%) reported by Lardy *et al.* (2007) for sunflower forage. Acid detergent fibre represents the less digestible fiber fraction in forage; acid

detergent fibre levels indicate higher lignin content, which can reduce digestibility.

**Table 1: Proximate composition of sunflower forage (*Helianthus annuus L.*)**

TREATMENT	DM	MC	CP	EE	CF	ASH	NFE	NDF	ADF
<b>SOWING</b>									
DIBBLING	92.18	8.03	9.53 <sup>a</sup>	2.22	14.88 <sup>b</sup>	0.94 <sup>b</sup>	72.43 <sup>b</sup>	18.35 <sup>a</sup>	13.97 <sup>a</sup>
DRILLING	92.90	7.81	9.27 <sup>a</sup>	2.44	15.58 <sup>a</sup>	1.39 <sup>a</sup>	71.32 <sup>c</sup>	18.03 <sup>b</sup>	13.73 <sup>b</sup>
BROADCASTING	91.97	7.10	8.53 <sup>b</sup>	2.56	9.48 <sup>c</sup>	1.56 <sup>a</sup>	77.88 <sup>a</sup>	17.79 <sup>c</sup>	13.54 <sup>c</sup>
SEM	0.46 <sup>NS</sup>	0.46 <sup>NS</sup>	0.18 <sup>*</sup>	0.24 <sup>NS</sup>	0.28 <sup>*</sup>	0.16 <sup>*</sup>	0.46 <sup>*</sup>	0.097 <sup>*</sup>	0.007 <sup>*</sup>
<b>WEEK</b>									
6	93.16 <sup>a</sup>	6.84 <sup>b</sup>	10.55 <sup>a</sup>	2.67	8.26 <sup>c</sup>	1.50	77.03 <sup>a</sup>	19.00 <sup>a</sup>	14.46 <sup>a</sup>
8	93.10 <sup>a</sup>	6.90 <sup>b</sup>	7.64 <sup>c</sup>	2.11	14.42 <sup>b</sup>	1.22	74.60 <sup>b</sup>	17.20 <sup>c</sup>	13.10 <sup>c</sup>
10	90.80 <sup>b</sup>	9.20 <sup>a</sup>	9.15 <sup>b</sup>	2.44	17.26 <sup>a</sup>	1.17	69.99	17.97 <sup>b</sup>	13.69 <sup>b</sup>
SEM	0.46 <sup>*</sup>	0.46 <sup>*</sup>	0.18 <sup>*</sup>	0.24 <sup>NS</sup>	0.28 <sup>*</sup>	0.16 <sup>NS</sup>	0.46 <sup>*</sup>	0.097 <sup>*</sup>	0.007 <sup>*</sup>
<b>INTERACTION</b>									
SXW	0.007	0.007	0.005	0.663	<0.0001	0.007	<0.0001	<0.0001	<0.0001

DM= dry matter, MC= moisture content, CP= crude protein, EE= ether extract, CF=crude fibre, NFE= nitrogen free extract, ADF= acid detergent fibre <sup>a,b,c</sup>Means within columns with different superscripts differ significantly (P<0.05). SEM=Standard error of mean, S= sowing, W = weeks after sowing. \* = P<0.05 NS = not significant

**Anti-nutritional composition of sunflower forage**

The results of the anti-nutritional composition of sunflower forage are presented in Table 2. The data showed that the anti-nutrient composition of sunflower forage was significantly (P<0.05) influenced by sowing method and age of cutting. Phytate content was significantly (P<0.05) higher at broadcasting (1.62%), followed by drilling (1.5%), and lowest at dibbling (1.56%). Tannin content was significantly (P<0.05) highest at dibbling (3.61%), followed by drilling (3.30%), and lowest at broadcasting (2.69%). Similarly, phytate content was significantly (P<0.05) highest at drilling (1.50%), followed by dibbling (0.40%), and lowest at broadcasting (0.33%). Furthermore, the age of cutting significantly (P<0.05) affected the anti-nutritional composition of sunflower forage. Phytate content was significantly (P<0.05) highest at week 10 after sowing (1.60%), which was lower and statistically similar at week 8 and week 6 (1.58%). Tannin content was significantly

(P<0.05) highest at week 6 (3.26%) followed by week 8 (3.24%) and lowest at week 10 (3.10%). Oxalate content was significantly (P<0.05) highest at week 8 (1.49%), followed by week 6 (0.37%) and lowest at week 10 (0.36%).

The phytate content of sunflower forage results obtained in this study were higher than the 0.5% of dry matter (DM) reported by Cappai *et al.* (2019) but similar to the range of 1.35-2.57% reported by Greta *et al.* (2015). The results obtained from this research is similar to the range (1.35-2.57%) reported by Greta *et al.* (2015). Tannin content is another group of anti-nutrients that can reduce protein digestibility in ruminants. In this study, values obtained ranged from 2.69% to 3.6%, which is lower than the 5% critical value reported by Makkar *et al.* (2003) but higher than the 1.5% reported by Sosulski *et al.* (1982). The oxalate content of sunflower forage was highest at drilling with 1.5 %, the result obtained is similar to that reported by Saini *et al.* (2017).

**Table 2: Anti-nutrient composition of sunflower forage**

TREATMENT	Phytate	Tannin	Oxalate
<b>SOWING</b>			
DIBBLING	1.56 <sup>c</sup>	3.61 <sup>a</sup>	0.40 <sup>b</sup>
DRILLING	1.58 <sup>b</sup>	3.30 <sup>b</sup>	1.50 <sup>a</sup>
BROADCASTING	1.62 <sup>a</sup>	2.69 <sup>c</sup>	0.33 <sup>c</sup>
SEM	0.003*	0.001*	0.0001*
<b>WEEK</b>			
6	1.58 <sup>b</sup>	3.26 <sup>a</sup>	0.37 <sup>b</sup>
8	1.58 <sup>b</sup>	3.24 <sup>b</sup>	1.49 <sup>a</sup>
10	1.60 <sup>a</sup>	3.10 <sup>c</sup>	0.36 <sup>c</sup>
SEM	0.003*	0.001*	0.0001*
INTERACTION	<0.0001	<0.0001	<0.0001
<b>SXW</b>			

<sup>abc</sup> = Means within columns with different superscripts differed significantly (P<0.05), SEM = Standard error of mean, S= sowing W= Weeks after sowing. \* =P<0.05

**Effects of Sowing Methods on Growth Components of Sunflower (*Helianthus annuus L.*)**

The results of growth components are presented in Table 3. Plant height was significantly (P<0.05) highest at broadcasting (81.44cm), followed by drilling (49.63cm) and then lowest at dibbling (18.81cm) method of sowing. Leaf length, leaf width and leaf number were significantly (P<0.05) affected by sowing method in the same manner. However, number of tillers was not affected significantly by method of sowing. Age of plant had an effect on the growth parameters. Plant height at 8 weeks (64.25cm) differed significantly (P<0.05) from the other weeks being (56.60cm) at 6 weeks, (43.39cm) at 4 weeks and (35.60cm) at 2 weeks after sowing (WAS) respectively. Leaf width was significantly (P<0.05) highest at 8 weeks (9.16cm), but were statistically similar (P<0.05) at 6, 4 and 2 weeks (7.59cm, 6.82cm and 6.66cm) respectively. Leaf length at 8 weeks was recorded highest (12.39cm) while 6, 4 and 2 were lower and statistically similar (10.90cm, 10.01cm and 9.71cm) respectively. Numbers of Leaf at weeks 8 and 6 were significantly (P<0.05) highest and similar

while it was lowest and statistically similar at weeks 4 and 2weeks. There was no significant difference in the number of tillers at different WAS.

**Effects of sowing method on fresh and dry forage yield of Sunflower (*Helianthus annuus L.*)**

The results of sowing method on the yield of sunflower (*Helianthus annuus L.*) are presented in Table 4. Fresh forage yield was significantly (P<0.05) higher at drilling (23320.30 kg/ha) but similar and lower at dibbling and broadcasting (17988.30 and 18016.70 kg/ha, respectively). Dry matter yields were significantly higher at drilling (5677.67 kg/ha), followed by broadcasting (5118.67 kg/ha), and then lowest at dibbling (4751.00 kg/ha) method of sowing. The higher forage yield in drilling may be due to higher tiller numbers that arise from the drilling method of sowing. This result is contrary to what was obtained in the study conducted by Daudu and Nephilim (2017), who reported that the average forage yield of sunflower in Nigeria was observed to be 1.5-2.0 tons/ha (1500-2000 kg/ha). It also disagrees with what was reported by Smith *et*

al. (2018), who suggested that dibbling is associated with potentially higher fresh forage yield compared to broadcasting.

**Table 3. Effects of Sowing Methods on Growth Components of Sunflower (*Helianthus annuus L.*)**

TREATMENT	PH	LW	LL	LN	TN
<b>SOWING</b>					
DIBBLING	18.81 <sup>c</sup>	4.48 <sup>c</sup>	7.19 <sup>c</sup>	14.73 <sup>c</sup>	1.96
DRILLING	49.63 <sup>b</sup>	7.86 <sup>b</sup>	11.48 <sup>b</sup>	28.12 <sup>b</sup>	2.08
BROADCASTING	81.44 <sup>a</sup>	10.33 <sup>a</sup>	13.59 <sup>a</sup>	32.36 <sup>a</sup>	1.75
SEM	4.17*	0.79*	0.76*	2.43*	0.15 <sup>NS</sup>
<b>WEEK</b>					
2	35.60 <sup>d</sup>	6.66 <sup>b</sup>	9.71 <sup>b</sup>	20.25 <sup>b</sup>	2.06
4	43.39 <sup>c</sup>	6.82 <sup>b</sup>	10.01 <sup>b</sup>	23.11 <sup>b</sup>	1.75
6	56.60 <sup>b</sup>	7.59 <sup>b</sup>	10.90 <sup>b</sup>	27.89 <sup>a</sup>	1.92
8	64.25 <sup>a</sup>	9.16 <sup>a</sup>	12.39 <sup>a</sup>	29.02 <sup>a</sup>	2.00
SEM	3.13*	0.59*	0.57*	1.83*	0.11 <sup>NS</sup>
<b>INTERACTION</b>					
SXW	0.015	0.982	0.861	0.002	<0.0001

PH= plant height, LL= leaf length, LW = leaf width, LN= leaf number TN= tiller number S= sowing method, W = weeks after sowing. <sup>a,b,c,d</sup>Means within columns with different superscripts differ significantly (P<0.05). SEM=Standard error of the mean.

**Table 4: Fresh and dry forage yield of sunflower as influenced by sowing method**

TREATMENT	FRESH FORAGE(kgha <sup>-1</sup> )	DRY FORAGE(kg/ha <sup>-1</sup> )
<b>SOWING</b>		
DIBBLING	17988.30 <sup>b</sup>	4751.00 <sup>c</sup>
DRILLING	23320.30 <sup>a</sup>	5677.67 <sup>a</sup>
BROADCASTING	18016.7 <sup>b</sup>	5118.67 <sup>b</sup>
SEM	131.62*	9.37*

<sup>a,b,c,d</sup>Means with different superscript within column differ significantly (P<0.05). SEM=Standard error of the mean.

### Physical Characteristics of Sunflower-Napier-Molasses Silage

The physical characteristics of sunflower forage ensiled with Napier grass and sugarcane molasses are presented in Table 5. There were some variations in some parameters. The 95:0:5 sunflower-Napier grass-molasses silage appeared olive green in color, while the 80:15:5 sunflower-Napier grass-molasses silage appeared green. The 60:35:5 and 40:55:5 sunflower-Napier grass-molasses silages were brownish in color. Olive green and green colors in silage indicate that the original forage color was

maintained during ensiling. This is in agreement with Mannatje (1999), who stated that when silage appears olive green or green, it means that the silage is well-preserved. These findings are consistent with the results reported by Hladni *et al.* (2011), Aldelaimi *et al.* (2013), Memon *et al.* (2015), Manzoor *et al.* (2016), Mladenovic *et al.* (2017), Lakshman *et al.* (2018), and Kanoosh (2019). The brownish color observed in this study may be due to improper packaging and air penetration. The brownish colour obtained during this present study may be due to improper packaging and air penetration.

Similarly, the odour for 95:0:5, 80:15:5 and 60:35:5 sunflower-napier-molasses silages were pleasant and alcoholic except 40:55:5 sunflower-napier-molasses silage which gave offensive odour. Oduguwa *et al.* (2007) reported that pleasant and alcoholic odours are indicators of good quality silage. Texture for 95:0:5, 80:15:5 and 60:35:5 sunflower-napier-molasses silages in this study were firm and this is in line with the report of Falola *et al.* (2015), who stated that firm texture of silage is a sign of good silage while 40:55:5 sunflower-napier-molasses silage was mouldy which represent bad silage. Temperature was also good; according to McDonald *et al.* (1995). Silage

quality and colour is affected by temperature above 30°C which results to caramelization of sugars in the silage. However, the result for temperature in this study was below 33°C. Similarly, the temperature obtained for 95:0:5, 80:15:5 and 60:35:5 sunflower-napier-molasses silages in this study was within the range of 20-29°C reported by Weinbery *et al.* (2001) and also agree with Babayemi and Igbekoyi (2008). The temperature obtained from this study was high enough to reduce lactic acid concentration and increase pH. Similarly, pH obtained in this study was very good (3.6-5.5) as reported by Menese (2007) and Ibhaze *et al.* (2015).

**Table 5. Physical characteristics of sunflower-napier-molasses silage**

Parameters	<i>Sunflower-Napier-Molasses Silage</i>			
	95:0:5	80:15:5	60:35:5	40:55:5
Colour	Olive green	Green	Brownish	Brownish
Odour	Pleasant	Pleasant	Slightly pleasant	Pungent
Texture	Firm	Firm	Firm	Mouldy
Temperature	19.00	20.00	22.00	32.90
pH	3.6	3.7	4.5	5.3

**Chemical Composition of Sunflower-Napier-Molasses Silage**

The results of the chemical composition of Sunflower-Napier grass mixture silage are shown in Table 6. There was a significant (P<0.05) treatment effect on all parameters measured. Higher (P<0.05) dry matter was recorded in the 80:15:5 sunflower-Napier grass-molasses silage, which was at par with the 95:0:5 sunflower-molasses silage, followed by the 60:35:5 sunflower-Napier grass-molasses silage, while lower (P<0.05) dry matter was obtained in the 40:55:5 sunflower-Napier grass-molasses silage. The dry matter obtained in this study is below the value reported by Saulawa *et al.* (2014). Crude protein was higher (P<0.05) in the 80:15:5 sunflower-Napier grass-molasses silage, followed by the 60:35:5 sunflower-

Napier grass-molasses silage, which was similar to the 95:0:5 sunflower-Napier grass-molasses silage, while lower crude protein content was recorded for the 40:55:5 sunflower-Napier grass-molasses silage. The crude protein value recorded is below the value reported by Narahari and Asha (2003). Similarly, higher (P<0.05) ether extract was obtained for the 80:15:5 silage, followed by the 60:35:5 and 95:0:5 silages, while lower (P<0.05) ether extract was obtained in the 40:55:5 sunflower-Napier grass-molasses silage. The ether extract obtained in this study is consistent with the values reported by Saulawa *et al.* (2014).

**Conclusion**

In conclusion, this study has provided valuable insights into the chemical



composition, sowing method, growth components, and forage yield of sunflower, as well as the effects of ensiling with Napier grass and molasses. The study found that sowing method and age of cutting significantly influenced the chemical composition and anti-nutrient content of sunflower forage. The drilling method of sowing resulted in the highest fresh and dry matter yields of sunflower forage, while dibbling and broadcasting resulted in lower yields. Furthermore, the study found that ensiling sunflower forage with Napier grass and molasses resulted in improved nutritional quality, with the 80:15:5 sunflower-Napier

grass-molasses silage having the highest dry matter, crude protein, and ether extract. The results also showed that the color of the silage was an indication of the preservation quality, with olive green and green colors indicating well-preserved silage. Overall, this study highlights the potential of sunflower as an alternative forage crop, particularly under drought conditions or in areas with a shortage of roughage. The findings could have practical implications for improving forage quality and yield in livestock production and could be useful in developing optimal silage mixtures for improved animal nutrition.

**Table 6: Chemical composition of sunflower-napier-molasses silage**

Parameters	95:0:5	80:15:5	60:35:5	40:55:5	sem
Dry Matter	88.00 <sup>a</sup>	88.10 <sup>a</sup>	81.50 <sup>b</sup>	67.00 <sup>c</sup>	0.79*
Crude Protein	9.45 <sup>b</sup>	12.43 <sup>a</sup>	9.62 <sup>b</sup>	7.52 <sup>c</sup>	0.25*
Ether Extract	13.00 <sup>b</sup>	25.00 <sup>a</sup>	4.00 <sup>c</sup>	2.00 <sup>d</sup>	0.25*
Crude Fibre	24.00 <sup>b</sup>	20.50 <sup>c</sup>	28.50 <sup>a</sup>	24.00 <sup>b</sup>	0.25*
Ash	8.50 <sup>a</sup>	0.83 <sup>d</sup>	6.00 <sup>b</sup>	3.00 <sup>c</sup>	0.23*
Nitrogen Free Extract	54.95 <sup>a</sup>	39.43 <sup>c</sup>	48.12 <sup>b</sup>	48.52 <sup>b</sup>	0.25*
Neutral Detergent Fibre	17.25 <sup>c</sup>	29.58 <sup>a</sup>	17.49 <sup>b</sup>	16.77 <sup>d</sup>	0.01*
Acid Detergent Fibre	19.02 <sup>a</sup>	10.34 <sup>b</sup>	0.73 <sup>d</sup>	2.17 <sup>c</sup>	0.01*

<sup>a,b,c,d</sup>Means within columns with different superscripts differ significantly (P<0.05). SEM=Standard error of the mean.

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