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Evaluation of Maize Accessions for Nutrients Composition, Forage and Silage Yields

J. T. Amodu[1], T. T. Akpensuen[2], D. D. Dung[1], R. J. Tanko[1], A. Musa[3], S. A. Abubakar[1], M. R. Hassan[2], J. O. Jegede[1] & I. Sani[2]

[1] National Animal Production Research Institute, Ahmadu Bello University, Shika, Zaria, Nigeria

[2] Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Samaru, Zaria, Nigeria

[3] International Livestock Research Institute, Kano, Nigeria

Correspondence: J. T. Amodu, National Animal Production Research Institute, Ahmadu Bello University, Shika, Zaria, Nigeria. E-mail: jtamodu2000@yahoo.com

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Abstract

An experiment was conducted to evaluate the yield of forage, silage and nutrients composition of two maize accessions: West Atlantic Seed Alliance 1 (WASA1) and an accession from Shika tagged (SHIMAZ). The maize seeds were planted in plots of 5 m x 5 m (25 m^2) size with four replicates for each accession. The results showed that, there was no significant ($P > 0.05$) difference between the accessions for plant height and number of leaves at 4, 6, 8 and 10 weeks after sowing (WAS), but leaf area index (LAI) was significantly ($P < 0.05$) higher in SHIMAZ accession at 6 and 10 WAS. The number of leaves per plant, green leaves, leaf area and forage yield at 91, 105 and 119 days after sowing (DAS) were not significant ($P > 0.05$) in the two accessions of maize, but leaf area and LAI were significantly ($P < 0.05$) higher in WASA1 accession.. The percentage dry-matter (DM) content was significantly ($P < 0.05$) lower in WASA1, although leaf, and stem ratios were significantly ($P < 0.01$) higher at various stages of harvest. The crude protein (CP) and nitrogen free-extract (NFE) were significantly ($P < 0.01$) higher in WASA1 accession while crude fibre (CF) was significantly ($P < 0.01$) higher in SHIMAZ. The proximate components (ash, EE and CP) and NDF were significantly ($P < 0.01$) higher in WASA1 silage, but NFE and ADF were higher ($P < 0.05$) in SHIMAZ accession.

Keywords: maize, accession, forage, silage, yield, nutrient

1. Introduction

Maize (*Zea mays*. L) ranks after wheat (*Triticum durum*) and rice (*Oryza sativa*) as the third most important crop in the world (Bilal et al., 2005). Maize is widely grown in all the continents of the world. In Nigeria, maize is grown in most ecological zones of the country, making it available to be used as livestock feed. The grain is used for pigs, cattle and poultry feed, while the plant materials, either fresh or dry are important as forage feeds (NRC, 1998). Forage maize can be utilized by animals in many ways. It can provide high quality yields of palatable forage (Karsten et al., 2003). Amodu and Abubakar (2004) stated that maize is by far the most extensively used cereal crop as silage in Nigeria, followed by Guinea corn (*Sorghum bicolor*). In addition to silage maize having a high forage yield, digestible energy per hectare is by far greater than any other crop when land and climate are favourable (Staples, 2010).

Maize has higher potential yield (t DM/ha/cut) than all the grasses, legumes and crops used as silage material. Griffiths et al. (2004) stated that the potential forage yields of forage maize varieties should be between 12 to 15t/ha and many research works have shown forage dry matter yields above this range. Yilmag et al. (1997) examined genotype and plant density of forage maize yield and reported the values of 27.0, 23.6, 21.8, 22.5, 21.6 and 22.2t/ha for *Dracma, P-3223, P-3335, DK-711, DK-626* and *Arifiye,* respectively.

The proximate and mineral compositions of maize depend on the stage of harvest of the silage material. Roth (2001) stated the ranges of 7.2-10.0, 23.6-33.2 and 41.0-54.1% for crude protein (CP), acid detergent fibre (ADF) and neutral detergent fibre (NDF) contents, respectively in maize silage. Mc Donald *et al* (1998) reported the values of 23.3, 5.7 and 10.0% for crude fibre (CF), ether extract (EE) and ash, respectively.

Different values have also been reported for mineral content in maize silages. Roth (2001) reported the values of 0.25, 0.23, 0.18, 0.20 and 0.13 for calcium (Ca), phosphorus (P), magnesium (Mg), potassium (K) and sulphur (S), respectively, while Ballard et al. (2001) stated the ranges of 0.14-0.22, 0.19-0.22, 0.10-1.15 for Ca, P, Mg, K and S, respectively.

The present research reports the results of experiments performed to evaluate the forage and silage yield potential of two accessions of maize in the Northern Guinea Savanna of Nigeria.

2. Materials and Methods

2.1 Location of the Study

The study was conducted at the National Animal Production Research Institute experimental farm at Shika located within the grid (11°-11°13′ N, 6°55′-7° 33′ E) in the sub-humid zone of Nigeria.

2.2 Site Characteristics

Approximately 95 percent of the rainfall occurs during May-October. The highest mean maximum temperature of 36°C is recorded in April while the highest mean temperature of about 11.5°C occurs in December-January (Kowal & Knabe, 1972). Table 1 shows the temperature, relative humidity and rainfall distribution for the year of trial and medium-term means (2002-2012) for Shika and Samaru.

Table 1. Temperature, relative humidity and rainfall distribution for (2011) and medium-term means (2001-2011) for Shika and Samaru

Month	Max. Temp (°C)[a]		R. H. (°C)[a]		Rainfall (mm)[b]	
	2011	(2001-2011)	2011	(2001-2011)	2011	(2001-2011)
April	37.8	38.0	20.7	22.8	4.6	11.5
May	35.3	35.2	47.2	51.5	11.2	12.8
June	32.3	31.8	61.1	63.3	13.5	12.4
July	30.2	30.5	70.8	69.5	15.9	15.3
August	30.3	29.6	72.2	73.9	14.9	15.8
September	31.9	31.3	68.2	67.1	9.5	13.6
October	34.0	32.9	64.4	51.6	11.5	11.1
	Mean 33.1	32.8	Mean 57.8	57.1	Total	

Sources: [a]Samaru (Lat. 11°11′N, Long. 07°38′E, Altit. 687 m).

[b]Shika (Lat. 11°12'N, Long. 07°38′E, Altit. 667 m).

2.3 Accessions and Experimental Design

Two maize accessions: West Atlantic seed Alliance (WASA1) obtained from the International Livestock Research Institute (ILRI), sub-station, Kano, Nigeria and a local variety from Shika tagged (SHIMAZ) obtained from the Forage and Crop Residue Research Programme of the National Animal Production Research Institute, Shika, Nigeria were examined for various production parameters in a completely randomized design.

The plot size used for planting was 5 m x 5 m (25 m^2), with four replicates for each of the two maize accession. Planting of the maize accessions was carried out on each replicate at the seed rate of 15 kg/ha on 12th June, 2012 when the rains were well established. Two seeds were planted per hole in a depth of 3cm and at a spacing of 75 cm inter-row and 25 cm intra-row to produce a plant of population of 53 000 plants/ha.

2.4 Weeding and Fertilization of Experimental Plots

Weeding of experimental plots was carried out manually using locally made hoes. First weeding was carried out at three weeks after planting (WAP) while two additional weeding were carried out at 6 and 9 weeks after planting. Prior to planting, single phosphate (18% P_2O_5) fertilizer was broadcast over all plots, at the rate of 30 kg/ha and the soil disc ploughed. Thereafter, two doses of NPK (20:10:10) fertilizer were drilled into the soil at the rate of 150 kg/ha, at 3 and 6 weeks after planting.

2.5 Measurement of Growth Parameters

Three plant stands of the middle rows of each replicate were tagged and used for determining the following agronomic parameters: plant height, number of leaves per plant and leaf area index (LAI). These were determined at 4, 5, 6 and 10 weeks after planting. The number of tillers were determined at 7 WAP.

Plant height: The height of the tagged plants was measured from ground level to the top of the last leaf (flag leaf) using a meter rule and the mean values computed.

Number of tillers: The number of tillers per plants within each row was counted for the two maize accessions and also the number of leaves of the tagged plants was counted for two maize accessions. The leaf area index (LAI), a dimensionless ratio of the leaf area over the area of land subtended by sampled plants was also determined.

2.6 Harvesting of Maize Materials and Biomass Measurement

Each accession of maize was harvested at 91, 105 and 119 days after sowing. At each stage, the plants were cut at a height of 10cm above the ground. Two tagged plant stands were cut from each replicate at each harvest time to determine the forage dry matter yield components and forage yield of the two maize accessions. Yield components determined include number of leaves per plant, number of green or dead leaves per plant number of green leaf and leaf area index (LAI). After determination of these various components of yield, they were immediately weighed to obtain fresh weight and then oven-dried at a temperature of 70°C for 48 hours to obtain the dry weight which was used to determine the dry-matter for various components and for a whole plant stand from where the fresh forage and forage DM yields per hectare were obtained.

2.7 Ensiling of Maize Materials

The uninterrupted growth of two maize accessions were harvested at 91, 105 and 119 days, respectively to determine both the forage yield and yield components. Forage materials from both accessions of maize were allowed to wilt in the sun for 4 hours before ensiling at every corresponding date of harvest. Each maize accession material was immediately placed in transparent silage polythene bags (0.6 m x 1.8 m) and put in silage pit at each harvesting time. The pits were then covered with soil for an incubation period of 21 days. Physical characteristics of the silages: temperature, colour, aroma and pH of the silages were determined immediately the silage polythene bags were opened. (Table 2 shows the physical characteristics of silages made from the two accessions of maize at 21 days of ensiling). Sub-samples of the silage materials were also taken, oven-dried and milled for proximate and mineral analysis (Table 3 shows the proximate composition of two maize accessions at three stages of harvest, while Table 4 shows the mineral contents of the two maize accessions at the same stages of harvest).

Table 2. Physical characteristics of silage made from two maize accessions at 21 days after ensiling

	Maize accession	
Parameter	WASA 1	SHIMAZ
Appearance	Leafy	Leafy
Texture	Soft	Soft
Colour	Light yellowish brown	Light yellowish brown
Aroma	Mild pleasant sour milk smell	Mild pleasant sour milk smell
pH	3.9	4.1
Temperature (°C)	29.0	31.0

Table 3. Forage yield and yield components of two maize accessions harvested at various days after sowing

Yield component	Maize accession	Days after sowing		
		91	105	119
No. of leaves/plant	WASA1	15.9 ± 0.43	16.3 ± 0.25	14.8 ± 0.63
	SHIMAZ	15.2 ± 0.63	16.5 ± 0.29	16.0 ± 0.82
		NS	NS	NS
Dead leaves (no./plant)	WASA1	3.5 ± 0.68	4.6 ± 0.33	5.1 ± 0.43
	SHIMAZ	3.0 ± 0.41	8.6 ± 1.53	10.0 ± 0.41
		NS	*	**
Green leaves (no./plant)	WASA1	13.3 ± 0.32	12.3 ± 0.24	10.0 ± 1.02
	SHIMAZ	12.3 ± 0.75	9.1 ± 1.82	6.0 ± 0.71
		NS	NS	**
Leaf area index (LAI)	WASA1	5.1 ± 0.27	2.9 ± 0.21	1.8 ± 0.06
	SHIMAZ	3.7 ± 0.43	1.8 ± 0.36	0.9 ± 0.25
		*	*	*
Fresh forage yield (t/ha)	WASA1	100.7 ± 5.25	83.3 ± 7.44	58.5 ± 0.06
	SHIMAZ	104.4 ± 4.22	75.45 ± 3.14	53.9 ± 8.77
		NS	NS	NS
For age DM yield (t/ha)	WASA1	25.1 ± 3.34	25.5 ± 4.15	27.1 ± 1.25
	SHIMAZ	26.3 ± 3.99	29.3 ± 4.14	31.0 ± 4.14
		NS	NS	NS

* Significant ($P < 0.05$), ** Highly significant ($P < 0.01$),

S.E.M = Standard Error of Means.

2.8 Chemical Analysis

The dried samples of the feeds (silage and fresh materials) were ground through 1mm sieve and further dried at 105^{o}C for one hour to determine the dry matter. The proximate constituents of the dried samples of the feeds were determined according to Kjeldahl Procedures (AOAC, 1984), while the neutral detergent fibre (NDF) and acid detergent fibre (ADF) of feeds were determined according to the Procedures of Goering and Vansoest (1970).

2.9 Statistical Analysis

The General Linear Model Procedure of SAS (SAS Institute Inc, 1985) was used for the analysis of variance of the data. Duncan's Multiple Range Test Steele and Torrie 1980) was used to compare treatment effects.

3. Results

3.1 Yield Components

The forage yield components of two maize accessions harvested at 91,105 and 119 days after sowing (DAS) are presented in Table 3. There was no significant difference ($P > 0.05$) between the two maize accessions in number of leaves per plant at each stage of harvest. It was also observed that the number of dead leaves recorded in the two accessions of maize was not significant ($P > 0.05$) at 91 DAS, while SHIMAZ had higher and significant ($P < 0.05$) number of dead leaves, than WASA1 accession when harvested at 105 and 119 DAS. A corresponding 8.6 and 10.0 dead leaves were recorded from WASA1 accession and 4.6 and 5.1 dead leaves from SHIMAZ accession at 105 and 119DAS, respectively. Number of green leaves per plant which decreased with the stage of maturity ranged from 13.3-10.0 and 12.3-6.0 in WASA1 and SHIMAZ accession, respectively and were only statistically significant between the two accessions at 119 DAS. There was also a small significant difference ($P < 0.05$) in leaf area index (LAI) of the two maize accessions at all the three stages of harvest. The highest leaf area index (LAI) of 5.1 and 3.7 was produced by WASA1 and SHIMAZ accession, respectively at 91 DAS. Generally the leaf area index (LAI) of the two maize accessions decreased with the increase in stage of maturity.

3.2 Fresh Forage and Forage Drymatter Yields

Fresh forage drymatter yield or production ranged from 25.1-27.1 tha^{-1} and 26.3-31.0 tha^{-1} on WASA1 and SHIMAZ accession, respectively. Fresh forage yield was not statistically significant in all the three periods of harvest of 91,105 and 119 DAS, respectively (Table 3).

Although, both fresh forage and drymatter yield were not statistically significant at the three various stages of harvest, but their yields followed a different trend. While the forage DM yield increase with the stage of maturity, the fresh forage yield decreased with an increase in maturity stage. A range of 25.1-27.1 tha^{-1} and 26.3-31.0 tha^{-1} drymatter yield were obtained across the three periods of harvest in WASA1 and SHIMAZ accession, respectively. Comparing the dry matter yield of the two maize accessions, it was observed that the results obtained from this experiment were not statistically significant ($P > 0.05$).

3.3 Forage Proximate Composition

Table 4 shows the proximate analysis of the two maize accessions harvested at 91,105 and 119 days after sowing. The result showed that at 91 and 105 days there were significant differences ($P < 0.05$) in ash content of the two maize accessions which ranged between 4.9-4.5% in WASA1 and 5.1-4.0% in SHIMAZ, respectively. However, the ash content of WASA1 at 119 DAS (4.5%) was statistically significant ($P < 0.05$), when compared with SHIMAZ accession at the same period of harvest (4.0%). There was a consistent decrease in all the proximate composition of two accessions of maize from 91 to 119 DAS. The results obtained from this trial showed that there was no significant difference ($P > 0.05$) in ether-extract content (EE) of the two maize accessions at all the three stages of harvest. Harvesting the two maize accession at 91 DAS indicated that there were significant differences ($P < 0.05$) in both crude fibre (CF) and crude protein (CP) contents of the maize accessions while harvesting at 105 and 119 DAS resulted in a high significant ($P < 0.01$) and slightly significant ($P < 0.05$) in level of crude fibre (CF) and crude protein (CP), respectively. Crude fibre increased from 23.0% to 31.0% and 27.8% to 36.5% in WASA1 and SHIMAZ accession, respectively from the first period of harvest (91DAS) to the third period of harvest (119 DAS). The CP decreased from 7.8% to 6.5% and 6.6% to 5.2% for the same three periods of harvest in WASA1 and SHIMAZ accession, respectively. The NFE content was highly significant ($P < 0.01$) at 119 DAS period of harvest with 51.7% and 48.1% level in WASA1 and SHIMAZ accession, respectively.

Table 4. Proximate composition of two accessions of maize at different days of harvest

Parameter (%)	Maize accession	91 DAS Mean ±S.e	105 DAS Mean ±S.e	119 DAS Mean ±S.e
Ash	WASA1	4.9 ± 0.15	4.5 ± 0.10	4.5 ± 3.28
	SHIMAZ	5.1 ± 0.54	4.7 ± 0.51	4.0 ± 4.66
		NS	NS	*
Ether-extract	WASA1	7.6 ± 0.06	7.2 ± 0.33	6.2 ± 0.50
	SHIMAZ	6.8 ± 0.20	6.6 ± 0.21	6.0 ± 0.21
		NS	NS	NS
Crude fibre	WASA1	23.0 ± 0.61	28.5 ± 0.73	31.0 ± 0.98
	SHIMAZ	27.8 ± 0.89	33.2 ± 0.62	36.5 ± 0.21
		NS	**	**
Crude protein	WASA1	7.8 ± 0.41	7.4 ± 0.41	6.5 ± 0.43
	SHIMAZ	6.6 ± 0.99	6.1 ± 0.15	5.2 ± 0.12
		NS	*	*
Nitrogen free extract	WASA1	56.6 ± 0.70	52.1 ± 1.42	51.7 ± 0.11
	SHIMAZ	53.6 ± 1.29	49.1 ± 0.44	48.1 ± 0.55
		*	*	**

* Significant ($P < 0.05$), ** Highly significant ($P < 0.01$).

NS = Not significant, S.e = standard error of means.

DAS = days after sowing, WASA1 = West Atlantic Seed Alliance.

SHIMAZ = Shika maize.

3.4 Forage and Silage Proximate and Mineral Composition

Table 5 shows the forage and silage proximate and mineral composition. The ash content was higher ($P < 0.01$) in silage for both maize accessions. The EE (9.4%) in silage was higher ($P < 0.01$) than in forage with 7.2% for WASA1, but there was no significant differences ($P > 0.05$) between forage and silage of the SHIMAZ. There was no significant difference ($P < 0.05$) in CF contents of silage and forage for both maize accessions. The CP content was higher ($P < 0.01$) in silage than the forage of WASA1 accession, while there was no significance differences ($P > 0.05$) between the forage and silage in SHIMAZ crude protein content.

The NFE was higher ($P < 0.05$) in silage of the two accessions of maize. There was also no significant differences ($P > 0.05$) in NDF of WASA1 accession. However, silage value (58.3%) was higher ($P < 0.01$) than in forage of SHIMAZ with 51.5%. There were no significant differences ($P < 0.05$) in the phosphorus (P) and Magnesium (Mg) contents of the forage and silage of the two accessions of maize. The silage of WASA1 was higher ($P < 0.01$) in Ca, but there was no significant differences ($P < 0.05$) in Ca content of the forage and silage of SHIMAZ accession. Similarly, there was no significant difference ($P > 0.05$) in Mg content of both forage and silage of the two accessions.

Table 5. Proximate, detergent, fibre and mineral composition of forage and silage of the two maize accessions (%DM)

	WASA 1			SHIMAZ		
Parameters	Forage mean ± se	Silage mean ± se	LOS mean ± se	Forage mean ± se	Silage mean ± se	LOS
Ash	4.5 ± 0.10	10.8 ± 0.41	**	5.1 ± 0.54	7.6 ± 0.37	**
EE	7.2 ± 0.33	9.4 ± 0.43	**	6.8 ± 0.20	6.8 ± 0.38	NS
CF	28.6 ± 0.72	28.8 ± 0.44	NS	27.8 ± 0.89	29.5 ± 0.43	NS
CP	6.9 ± 0.17	8.6 ± 0.32	**	6.6 ± 0.89	7.5 ± 0.43	NS
NFE	52.4 ± 1.38	42.4 ± 1.41	*	53.6 ± 1.29	48.7 ± 0.94	*
NDF	58.3 ± 0.69	55.3 ± 0.8	NS	58.2 ± 0.80	51.5 ± 0.41	**
ADF	30.8 ± 0.80	33.9 ± 0.79	*	24.7 ± 0.82	30.6 ± 0.96	**
P	0.1 ± 0.01	0.12 ± 0.04	NS	0.1 ± 0.22	0.3 ± 0.21	NS
Ca	0.4 ± 0.04	1.1 ± 0.05	**	0.6 ± 0.02	0.6 ± 0.02	NS
Mg	0.7 ± 0.16	1.05 ± 0.03	NS	0.4 ± 0.04	0.4 ± 0.03	NS
K	1.0 ± 0.05	1.2 ± 0.41	NS	1.5 ± 0.77	1.1 ± 0.01	*
Na	0.5 ± 0.906	0.3 ± 0.10	NS	0.4 ± 0.02	0.5 ± 0.04	*
ME(MJ/kgDM)	9.2 ± 0.43	11.32±0.39	**	9.2 ± 0.39	9.9 ± 0.49	NS

** Highly significant ($P < 0.01$), * Significant ($P < 0.05$), NS= Not significant.

S.E.M = Standard Error of Means, LOS= Level of significant.

4. Discussion

4.1 Agronomic Parameters

Number of leaves of the two maize accessions were similar to the results obtained by Turgut et al. (2005) and Carpici et al. (2010) but, higher than the result obtained by Awan et al. (2001) and Hassan (2011). The significant difference found in the leaf area index of the two accessions of maize indicates that, SHIMAZ accession will grow and cover more land area, and has the tendency to produce more forage dry-matter yield. In a study carried out by (Elings, 2000), it was observed that the capacity of a crop to intercept photosynthetically active radiation and synthesis of carbohydrates is a non-linear function of LAI and as the LAI increases, so does photosynthesis (Mannetje, 1999). The LAI obtained in this study at 8 weeks after sowing is in agreement with the result of Yao et al. (2008), who obtained similar value at 7 weeks after sowing in forage maize varieties. The differences in the agronomic parameters can be adduced to variety, environmental and cultural practices.

4.2 Forage Dry-Matter and Components Yields

Considering or using dry-matter as the basis for harvesting, the DM content of WASA1 accession indicated that this accession can be harvested for silage as from 105 to 119 days post-planting, whereas, SHIMAZ accession can be harvested earlier at 91 days post-planting. Mickan and Piltz (2004) also confirmed in a study carried out on maize, that stage of harvest affects both the dry-matter content and dry-matter yield of maize crop.

The significant difference observed in plant component ratios at different stages of harvest was likely due to genetic differences and maturity date of the two accessions of maize. Yilmaz et al. (2007) and Tang et al. (2008) also reported differences in yield component ratios in forage maize varieties. The observation of decrease in leaf ratio in the two maize accessions agreed with Humphreys (1999), who reported that as the plant matures, there is decrease in ratio of leaf to stem and changing proportion of the plant components accounts for the overall differences in cultivar nutritive value. The increase in stem ratio obtained in this trial also agrees with McDonald et al. (1998) that as the plants mature, the stem proportion of the total biomass increased. Furthermore, Russell (1986) reported that as the stem proportion increased, the proportion of leaves decreased with the increasing maturity stage in maize plant.

The forage DM yield of 25.5 and 31.0 t/ha obtained in WASA1 and SHIMAZ accessions, respectively were higher than the range (12.0 to 25.0 t/ha) obtained by Griffith et al. (2004), and Lauer et al. (2004); Yilmag et al. (2007), Iptas and Acar (2008) and Carpici et al. (2010) for various maize varieties. However, the yield of WASA1, was less than variety *C-955* as reported by Turgut et al. (2005) who obtained 28.5 t/ha.

4.3 Forage Proximate Composition

The decrease in contents of ash and ether-extract of the accessions agreed with Kellems and Church, (2002) who reported that as the plant matures, both ash and ether-extract content decreased. The decrease in CP also agreed with (Holecheck et al., 2004; Tang et al., 2011) who stated that as the plant matures, the CP decreases; and structural carbohydrates increased due to accumulation of cellulose and lignin (McDonald et al., 1988). The differences observed in the proximate composition of the two accessions, may be due to the changes in proportion of leaf: stem ratio at various stages of harvest (Humphreys, 1999). The NFE content which was higher in WASA1 accession at every stage of harvest, was likely due to lower content of CF at each stage of harvest and the decline in NFE in each accession as maturity advanced can be adduced to increase in ash, EE and CP.

4.4 Silage Physical Characteristics and Nutrients Composition

Kaiser and Blackwood (2004) stated that the good fermented maize silage should be leafy, soft to touch, yellowish-brown, mild pleasant and sour smell, and in addition the silage must be high in CP and metabolisable energy (ME) contents. The pH values obtained in this study is within the recommended range of 3.7-4.2 stated by Kaiser and Blackwood (2004) and Kung and Shaver (2001) for maize silage. In comparison with pearl millet (*Pennisetum americanum*) accessions used for silage in the same environment, Amodu et al. (2001) observed a higher range of (4.3-4.5) pH for three accessions of pearl millet. The results from this trial also agreed with Roth and Heinrichs (2001) who stated that maize silage having a DM of less than 30% should have pH value of 3.9 while those having the DM between 30 to 35% should have pH of 4.0. The temperature obtained from the silage of the two maize accessions agreed with Adesogan and Newman (2008) that silage temperatures should not be more than 37.7^{o}C which encourages good silage fermentation, because higher temperatures reduce the quality of the silage, enhance protein degradation and reduce rapid pH decline for an efficient degradation. The ash and EE contents obtained in this trial were similar to the result reported by Amole et al. (2011). The ash contents in both maize accessions experimented were higher than the result obtained by Ballard et al. (2001) and Hayashi et al. (2009) who reported 2.3 to 3.7% in maize silage varieties. The content of CF and NFE in the two maize accessions were similar to the result obtained by Hayashi et al. (2009) who reported 27.7% and 57.3% for CF and NFE, respectively, but lower than the values obtained by Amole et al. (2011) who reported the value of 36.7% for CF. However, the NFE content in the two accessions of maize is within the range of 23.6 to 33.2% as reported by (Roth & Heirichs, 2001). Comparing the contents of CF and NFE obtained in this trial with the works on three accessions of Pearl millet *(Mokwa, Bunkure and Kankara*) carried out by Amodu et al. (2001, 2007) in the same environment, the NFE content of the millet accessions was similar to those obtained from the two accessions of maize experimented in this trial. The CF content of the three accessions of millet was higher and ranged from 34.2% to 35.6%. The CP content of WASA1 was slightly higher than the range of 4.5 to 8.5 stated by Griffiths *et al* (2004), while that of SHIMAZ was within the range. The two maize accessions cannot be used as sole feed to supply required protein for beef cattle and dairy cattle as their CP contents were lower than 10% and 11.6%, recommended values by Humphreys (1999). The metabolizable energy (ME) values for the two accessions is in-line with the range of 10.0-11.0 MJ/Kg DM stated by (Griffiths et al., 2004) for maize silage. The ME obtained

in this trial of two accession of maize silage will satisfy the energy requirements of sheep and goat for growth, maintenance and pregnancy, but lower than 14.2 to 22.0 MJ energy requirement range for lactating sheep (McDonald et al., 1998).

Ballard et al. (2001) reported increase in ash, EE and CP in fermented maize with a decrease in NDF contents after fermentation. However, the values obtained by these authors were contrary to what was obtained by Phiri et al. (2007) who reported a decrease in CP and ash contents while the decrease in NDF content was quite in-line with their results. It was noted that the CP increment after fermentation may be attributed to microbial synthesis of protein in the rumen during their growth cycle (Mohiedeen et al., 2010) and to loss in carbohydrates. The decrease in NFE content could be attributed to partial hydrolysis of WSCs that provided additional sugar for lactic acid production during fermentation (Muck & Kung, 1997). Darby and Lauer (2002) reported a decrease in NDF content after ensiling, which is also similar to the report in this study. The increase in ADF content after fermentation is in contrast with the report of Phiri et al. (2007) who reported that ensiling had no effect on ADF. On the other hand, Nkosi et al. (2011) reported that ensiling decreased both NDF and ADF contents. The values obtained in this trial for the two maize accessions in CP, ash, ADF and NDF contents were similar to the values obtained by Ballard et al. (2001). Although the Ca, Mg and P contents obtained in this trial were higher than the values obtained by Ballard et al. (2001), but their the mineral contents were lower than those obtained by Kaiser et al. (2004).

5. Conclusion

The differences between the two accessions of maize were relatively small, especially in-terms of plant height, number of leaves produced and leaf area index. The content of ash in silage of WASA1 was higher than in the forage. The crude protein contents in the silages of both accessions were above 7%, while the forage yields were similar for both accessions.

The two accessions can be grown successfully in the Northern Guinea Savanna of Nigeria, although SHIMAZ accession may be preferred due to it's biomass which is slightly higher than WASA1 accession.

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