CHEMICAL COMPOSITION AND FERMENTATION CHARACTERISTICS OF MIXED MAIZE COB (*Zea mays*) AND SWEET POTATO VINE (*Ipomoea batatas*) SILAGE

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ABSTRACT

The study was conducted to assess the effect of dry matter levels on silage characteristics of maize cob and sweet potatoes vine mixtures. Maize cob (MC) and sweet potato vine (SPV) were chopped and mixed to provide dry matter levels of 70 %, 65 %, 60 % and 55 %, thus each level was considered as treatment T1, T2, T3 and T4, respectively. The materials were ensiled for 45 days in a ziploc polyethene bags and then placed in plastic containers. Each container carried one treatment with five replicates. There was significant ($p < 0.05$) difference in dry matter (902.40±0.40 – 975.55±2.74 g/kg), crude protein (39.70±5.25 – 69.40±1.44 g/kg), neutral detergent fibre (525.55±1.07 – 661.70±30.48 g/kg), and hemicellulose (163.45±2.34 – 302.30±4.04 g/kg) across the treatments. A linear decrease ($p < 0.05$) was observed in crude protein (CP) content, but dry matter (DM) and neutral detergent fibre (NDF) increased ($p<0.05$) across the treatments. Similarly, total volatile fatty acids (8.00±0.58 – 10.67±1.33 µmol/L) showed a numerical decrease ($p>0.05$) at lower DM levels. However, pH (4.22±0.13 – 4.73±0.06) increased ($p<0.05$) linearly across the treatments. It was concluded that low dry matter levels encourage formation of high quality silage. It was further deduced that microbial activities increased with a decrease in dry matter levels. Hence, for good quality silage using maize cob and sweet potato vine, 55 % DM level is recommended.

Keywords: fermentation, silage material, rumen ammonia-nitrogen, volatile fatty acids, nutrients.

INTRODUCTION

Silage is a product of anaerobic fermentation of plant materials. It is a way of preserving organic matter content of a silage material. Lactic acid (LA) is the main preservative acid in silage process, the higher the LA the better the silage quality. However, butyric acid (BA) has a negative correlation to silage quality. Other important organic acids that ensure quality of silage are acetic acid (AA) and propionic acid (PA). Maize cob and sweet potato vine are by-products of maize and sweet potato, respectively. Maize cob contains: hemicelluloses (20% -25%), lignin (20% to 30%) and cellulose (45% -55%) (Deutschmann *et al*., 2012; Menon *et al*., 2012). Sweet potato vines have nutrient content of 13.5% CP, 30% NDF, 33.9% acid detergent fibre (ADF) and 46. 8% water soluble carbohydrate (Li *et al*., 2017).

In the savannah grasslands, ruminants have little access to forages during the dry season. Hence, feed shortages could be alleviated by ensiling dry and green feedstuff. Maize cob and sweet potatoes vine ensiled together have little research information thus the need for the current research. The present study is aimed at determining the chemical content and fermentation characteristics of mixed maize cob and sweet potato vine silage.

METHODOLOGY

The experiment was carried at the Animal Science Laboratory, Department of Animal science, Kaduna State University, Kafanchan Campus. Chemical analysis was carried out at National Animal Production Research Institute, Shika. Materials used in this study were sweet potato vines, maize cob, vacuum machine, zip-lock polyethene bags, plastic buckets, pH meter, distilled water, sulphuric acid, 50ml sample bottles, blender, knife, sand, and oven. Maize cob (MC) and sweet potato vine (SPV) were chopped and mixed to dry matter levels of 70 %, 65 %, 60 % and 55 %, thus each level was considered as treatment

T1, T2, T3 and T4, respectively. The materials were ensiled for 45 days in a Ziploc polyethene bags and then placed in plastic containers then covered with sand to remove air. Samples collected were analysed for proximate constituents, cell wall components, pH, ammonia-nitrogen and total volatile acids.

Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) using a General Linear Model (GLM) of Statistical Analysis System (SAS) software version 9.4 (SAS, 2011). The model of the analysis was $Y_{ij}= \mu + t_i+ e_{ij}$. Where: Y_{ij}= dependant variable/observation, μ = overall population mean, t_i = effect of i^{th} treatment (1=1, 2, 3, 4) and e_{ij} = random error/residual. Means were separated using Duncan multiple range tests (Duncan, 1955)

RESULTS AND DISCUSSIONS

Chemical content of maize cob-sweet potato vine silage

Proximate and fibre fraction of sweet potato vine and maize cob mixture ensiled at different dry matter levels are presented in Table 1. The results showed there was a significant difference ($p<0.05$) across the treatments in dry matter, ash, CP, NDF and hemicelluloses (HC). From Table 1, ether extract (EE), crude fibre (CF) and acid detergent fibre (ADF) showed no significant difference across the treatment. The increase in dry matter across the treatments may be as a result of proportion of maize cob to sweet potatoes vine in the silage. It may also be due to the portion of soluble plant materials fermented by the anaerobic microbes present in the silage process. The difference observed in CP across the treatments may be as a result of sweet potato vine proportion in the silage, sweet potato vine recorded higher CP in the proximate analysis compared to maize cob. In a similar silage experiment conducted using *Luecaena* and sorghum, CP content of the silage was high, ranging from 7.2 to 23.6% with the inclusion of *Leucaena* (Weudes *et al.*, 2017). The amount of NDF in the present study increased across the treatments. The increase could be associated with microbial activities which ferment soluble carbohydrates and crude protein before hemicellulose and cellulose. Previous research reported that NDF and ADF are not much affected at ensiling (Panyasak *et al*., 2014). Nevertheless, in an experiment conducted on maize waste, NDF increased from 789.8 g/kg DM to 825.2 g/kg DM (Panyasak *et al*., 2014). The present work deduced that the increase in NDF across the treatments was probably due to high fermentation activities at higher moisture levels across the treatments.

Table 1: Proximate and fibre fraction (g/kg) of maize cob and sweet potato vine mixture ensiled at different dry matter levels

	Feedstuff		Treatment				
Nutrient	SPV	MC	T1	T2	T3	T4	p-value
DM	970.85	921.95	902.4±0.40^c	933.9512.79^b	974.05±6.09^a	974.55±2.74^a	0.0003
Ash	117.35	11.55	41.2±1.79^b	56.00±5.77^a	34.50±0.64^b	32.70±2.31b	0.0037
EE	51.45	38.2	36.5±0.40	35.55±2.34	49.70±6.64	32.70±15.07	0.5150
CF	202.80	334.3	314.45±0.20	306.45±3.84	322.65±9.67	332.70±11.26	0.1719
CP	166.90	37.85	66.55±0.89^a	69.40±1.44^a	40.95±5.57^b	39.70±5.25^b	0.0008
NDF	462.40	586.75	525.55±1.07^b	636.45±8.23^a	626.30±5.60^a	661.70±30.48^a	0.0015
ADF	305.75	439.75	362.1±1.27	334.15±4.19	391.75±22.31	371.60±35.91	0.3487

HC	156.65	213.35	163.45 ± 2.34^{b}	302.30 ± 4.04^{a}	234.55 ± 27.91^{a}	290.10 ± 5.42^{a}	0.0005

Values are presented as means ± SEM. $^{a\,b\,c}$ were different ($p<0.05$) across treatments. SPV= sweet potato vine, MC= maize cob, T1= 70 % DM, T2= 65 % DM, T3= 60 % DM and T4= 55 % DM. Dry matter, EE= ether extract, CF= crude fibre, CP= crude protein, NDF= neutral detergent fibre, ADF= acid detergent fibre, HC= hemicellulose.

Fermentation characteristics of maize cob – sweet potato vine silage

Fermentation characteristics of sweet potato vine and maize cob mixture ensiled at different dry matter levels is presented in Table 2. The results showed that there was significant difference ($p<0.05$) across the treatments in pH due to lactic acids, although not determined in the present work. The concentration of ammonia nitrogen (NH_3-N) was not affected by dry matter levels. A good silage has low pH due to lactic acid production by lactic acid bacteria. The values of pH recorded in the present study were within acceptable range of 4.2 – 5.5 reported by Babayemi (2009), Menesses *et al*. (2007) and Kung (2002) for grass, legume and artichoke silages. Although individual short chain fatty acids were not determined in the present study, the increase in pH across treatments could be associated to butyrate concentration due to presence of clostridia. It means that further lowering of dry matter level would increase moisture level thus leading to silage contamination. The TVFA recorded in this work was within the range of 7.6% – 14.1% reported for grass silage (Kung *et al*., 2018). Ammonia nitrogen (NH_3-N) in silage indicates decomposition of protein by clostridia which thrives well in higher moisture silage. An NH_3-N level of 0.2% - 11% was recorded to have negative effect on dry matter intake, higher level of NH_3-N in a silage decreases intake and milk production in cow (Weiss 2015; Huhtanen *et al*. 2003). In the present study, NH_3-N increased across the treatments with values lower than 0.17% g/DM - 10.94 % g/DM reported for alfalfa silage (Sánchez *et al*. 2016).

Table 2: Fermentation characteristics of sweet potato vine and maize cob mixtures ensiled at different dry matter levels

	Treatment				
Parameter	T1	T2	T3	T4	p-value
pH	4.22 ± 0.13^{c}	4.46 ± 0.01^{bc}	4.73 ± 0.06^{a}	4.67 ± 0.05^{ab}	0.0053
NH_3-N (%)	0.03 ± 0.00^{b}	0.05 ± 0.01^{a}	0.03 ± 0.00^{b}	0.03 ± 0.00^{b}	0.0059
TVFA (µmol/L)	10.67±1.33	9.00±0.58	9.33±0.67	8.00±0.58	0.2477

Values are presented as means ± SEM. $^{a\,b\,c}$ were different ($p<0.05$) across treatments. TVFA= total volatile fatty acid. T1= 70 % DM, T2= 65 % DM, T3= 60 % DM and T4= 55 % DM

CONCLUSION

Ensiling of maize cob with sweet potato vine at different dry matter levels had no effect on the ether extract, crude fibre, acid detergent fibre and ammonia nitrogen. However, dry matter levels influenced dry matter, crude protein, neutral detergent fibre, hemicellulose, pH, and total volatile fatty acids. From the results on CP, NDF and TVFA, it was concluded that low dry matter levels (45 % moisture) encourages formation of high quality silage.

RECOMMENDATION

It was deduced that microbial activities increased with a decrease in dry matter levels. Hence, for good quality silage using maize cob and sweet potato vine, 55 % dry matter is recommended. Further research is also recommended at lower dry matter levels.

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