Tropical and Subtropical Agroecosystems

CHEMICAL COMPOSITION AND FERMENTATIVE QUALITY OF FODDER GRASSES ENSILED WITH DERINDED FRESH SUGARCANE CRUSH.

[COMPOSICIÓN QUÍMICA Y CALIDAD DEL ENSILAGE DE PASTO CON CAÑA DE AZÚCAR DESCORTEZADA]

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SUMMARY

An experiment was carried out to test the effectiveness of derinded fresh sugarcane crush (FSC) as a source of water-soluble carbohydrates (WSC) for making fodder grass silage in place of sugarcane molasses. Elephant grass (*Pennisetum purpureum*) and guatemala grass (*Tripsacum laxum*), were harvested at eight-weeks regrowth. One portion of grass was wilted for 24 hours prior to ensiling while other portion was ensiled unwilted. Before ensiling each portion was chopped into 2 cm particle length and treated with the WSC additives. The treatments on percentage fresh weight basis were: CON (Control with no additive), MOL5 (5% molasses), FSC5 (5% FSC), FSC10 (10% FSC), and FSC15 (15% FSC). The additives were mixed with chopped forage material and ensiled in polyvinyl chloride (PVC) laboratory pot silos measuring 17cm in diameter and 85 cm tall for 50 days. Treatments were assigned to a randomized factorial design (2x2x5) as, 2 fodder grasses, 2 processing techniques (wilted and unwilted) and 5 additives levels. The dry matter (DM) of the silages ranged from 168 g/kg DM in unwilted CON to 203 g/kg DM in wilted MOL5 for elephant grass and from 258 g/kg DM in unwilted CON to 295 g/kg DM for wilted MOL5 for guatemala grass. Regardless of wilting the silages of elephant grass had high CP contents (91 - 105 g/kg DM) than those of guatemala grass (68 - 78 g/kg DM). The NDF content decreased from 700 g/kg DM in CON to 620 g/kg DM in FSC15 of wilted elephant grass silage and 680 g/kg DM in FSC15 of unwilted guatemala silage. Only control silages of both grasses and the wilted FSC5 and FSC10 silages of guatemala grass had pH values > 4. The NH_4 –N values of both grasses silages were rather high ranging from 25 to 42 g/kg. In vitro dry matter digestibility of the silage was significantly improved by addition of WSC regardless of the source, and was above 600 g/kg DM as compared to the control, that was between 510 to 560 g/kg DM. The study showed that addition of at least 10% FSC was sufficient for making good quality elephant and guatemala grasses silage. It was therefore concluded that FSC could be used for making grass silage instead of molasses.

Key words: Chewing sugarcane, Fodder grass silage, Smallholder dairy farmers, and Water-soluble carbohydrate additive.

RESUMEN

Se realizó una prueba para evaluar el uso de caña de azúcar descortezada (DSC), en reemplazo de la melaza, como fuente de carbohidratos solubles para la elaboración de ensilaje. Se empleó pasto elefante (*Pennisetum purpureum*) y pasto guatemala (*Tripsacum laxum*), cosechados a 8 semanas de rebrote. La mitad del pasto fue presecada previo al ensilaje, la mitad restante se ensilo sin presecado. Previo al ensilaje el pasto fue reducido a particulas de 2 cm y adicionado con los aditivos (en % del peso fresco): CON (Control sin aditivo), MOL5 (5% melaza), FSC5 (5% DSC), FSC10 (10% FSC), y FSC15 (15% DSC). Los aditivos fueron mezclados con el material picado y ensilado en frasco de polivinilo (PVC) (17 cm diámetro, 85 cm altura) por 50 días. Se empleó un diseño factorial 2x2x5; 2 pastos, 2 técnicas de procesado (con y sin presecado) y 5 niveles de niveles de aditivo. Sin importar el presecado, los ensilajes de pasto guatemala tuvieron mayor contenido de PC (91-105 vs. 68-78 g/kg MS). El contenido de FDN disminuyó de 700 g/kg MS en CON a 620 g/kg MS en FSC15 con pasto elefante presecado y 680 g/kg MS en FSC15 pasto guatemala sin presecado. Unicamente el tratamiento control (ambos pastos) y aquellos presecados FSC5 y FSC10 del pasto Guatemala tuvieron valores de pH > 4. El NH_4 –N fluctuaron de 25 a 42 g/kg. La digestibilidad In vitro de la MS mejoró con la adición de carbohidratos solubles. El estudio mostró que la adición de al menos 10% FSC fue suficiente para obtener ensilaje de buena calidad del pasto elefante y guatemala. Se concluyó que FSC, puede ser empleado para la elaboración de ensilaje en reemplazo de la melaza.

Palabras clave: caña de azucar, ensilaje de pasto**,** pequeños productores, carbohidratos solubles.

INTRODUCTION

Scarcity of feed for animals due to the scarcity of land to grow forages has been a major constraint for smallholder dairy production in the high-populated highland areas of East Africa (Urio, 1987; Kayongo, 1991). Elephant grass (*Pennisetum purpureum*) and guatemala (*Tripsacum laxum*) grasses are the two high-yielding fodder species, that the smallholder dairy producers have been encouraged to grow for fodder production (Muyoya and Mukurasi, 1988; Boonman, 1993). In these high potential areas annual dry matter yield of elephant grass and guatemala grasses has been reported to range from 30 to 50 t DM ha^{-1} (Mtengeti *et al*., 2001) and most of the yield normally realized during the wet season. The surplus yield from these fodder grasses during the wet season is wasted if not conserved. The surplus yields of elephant and guatemala grasses during the wet season can be carried over into the dry season through silage making. However, like most other tropical forages the two grasses are low in WSC concentrations, ranging from 3 to 9 % (Sarwartt *et al*., 1992). In addition ensiled materials of tropical grasses are susceptible to large losses of sugar under high ambient temperatures due to respiration and aerobic decomposition during the first few days in the silo (Wilson and Webster 1980). In most cases therefore, tropical grasses silage fermentation does not result in high concentrations of lactic acid, which is responsible for low pH, and long storage stability of the silage. Molasses is one of the widely used WSC additives to stimulate rapid increase or dominance of lactic acid bacteria (Humphreys, 1991). Maeda *et al* (1997) reported lactic acid concentrations of 37 g/kg DM in elephant grass silage ensiled with 3% molasses as compared with 15 g/kg DM without molasses. However, molasses is not easily available to smallholder dairy farmers due to its high price or due to remoteness of the farmer's farm from the sugar processing industries. For this reason therefore, research to find an alternative WSC additive sources to ensure that is within rich to the farmers is necessary.

Sugarcane (*Saccarum officinarum*) is one of the main sources of sugar for domestic and industrial use (Skerman and Riveros 1990) and yet is one of the most important tropical forage resource (Schmidt et al., 2005). In Tanzania, The chewing sugarcane verities are widely distributed in Tanzania. Most home garden plots in high potential areas have some plants of chewing sugar cane. However, the rural farmers can only manage to feed sugarcane tops to their animals and they do not have ability to crush large quantities of the stem to feed their animals. The rural farmers however crush small quantities of derinded sugarcane stems to squeeze juice for brewing alcohol or just drink with coffee. It would be possible therefore that derinded fresh sugarcane crush could be one of the potential alternative fermentative stimulants for making grass silage in rural areas of the tropics where other sources of WSC is limited.

Ensiling forage material with high moisture content can adversely affect fermentation quality of the silage (McDonald *et al*. 1991) and also lead to high effluent production, which drain away silage nutrients. Therefore, wilting may be necessary for high moisture forage material before ensiling. When combined with chopping treatment, wilting may increase readily available WSC for the fermenting microbes (Lavezzo *et al*., 1989).

The aim of this study was therefore to investigate the effectiveness of derinded fresh sugar cane crush as a WSC additive for ensiling elephant and guatemala grasses.

MATERIAL AND METHODS

Study area

The study was conducted at Magadu dairy farm of the Sokoine University of Agriculture at Morogoro in Tanzania. The area is about 500 m above sea level and receives short rains from November to January that is rather not very reliable and rather more reliable long rains from March to May in normal years. Mean annual rainfall is 860 mm and mean minimum and maximum temperature is 19 and 30 ^{o}C, respectively.

Grasses and their management

Four years, one plot (20 m x 20 m) each of elephant and Guatemala grasses established in the same field side by side were used in this study. The grasses were cut at 15 cm above the ground so as to allow uniform regrowth. The plots were then weeded by using a hand hoe and applied with farmyard manure at a rate of 10 t DM ha^{-1}. The grasses were harvested for silage making when their regrowths were still vegetative at 8 weeks old and 0.8 to 1 m in height. This is the normal harvesting time and height of these fodder grasses under smallhoder farmers' fodder plots in East Africa.

Preparation of fresh derinded sugarcane crush

The sugar cane used in this experiment was a local chewing variety characterized by a reddish rind. This was purchased from smallholder farmers around the university campus. Nine internodes from the base of the canes were derinded and crushed to give fresh sugar cane crush. On average the sugarcanes length were 2 m with mean internode length of about 7 cm.

The crusher was made of a piece of aluminum sheet perforated using a nail of 6 mm so as to form an abrasive surface required for crushing derinded sugarcanes. The perforated piece of aluminum sheet was mounted on two pieces of timber, which gave support to withstand force during the process of crushing the derinded sugar cane.

Ensiling procedures

The harvested grasses were divided into two portions; one portion was ensiled on the same day while the other portion was left to wilt for one day in the field. The weather was however, cloudy, warm and humid. Before ensiling the fodder grasses they were chopped to about 2 cm by a tractor driven chopper and treated with water-soluble additives. The treatments were; CON = no additive (control), MOL5 = 5% molasses, FSC5 = 5 % Fresh Sugarcane Crush, FSC10 = 10 % Fresh Sugarcane Crush and FSC15 = 15% Fresh Sugarcane Crush. The level of molasses used was as recommended for ensiling tropical grasses (Humphreys, 1991). Different levels of FSC were considered so as to establish an optimum level of inclusion analogous to that of molasses. The additives were mixed thoroughly with chopped grass material before ensiling in laboratory silos made of PVC pipes open at one end. The mean diameter and height of the pipes were 17 cm and 85 cm, respectively. Two samples (each weighing 250 g) of each treatment and the water-soluble carbohydrates used in this study were taken for chemical composition analysis before ensiling. The number of silos per treatment was two. Four kilograms of the treated material were ensiled in each silo. A polyethylene bag containing 4 kg of sand was inserted in each silo immediately after ensiling so as to compact and compress the ensiled material throughout the ensiling period of 50 days. Immediately after ensiling, the open end of each pipe was sealed by a polythene sheet held securely by a strong rubber band. The silos were stored in one of the laboratory at room temperature.

Determination of silage quality

The dry matter contents (DM) of the ensiling material and silages were determined by freeze-drying. The ash, Crude Protein (CP), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), water soluble carbohydrates (WSC) and *in vitro* dry matter digestibility (IVDMD) were analysed from the freeze dried samples while the ammonia –nitrogen (NH_3-N) was analysed from fresh silage samples. The ash, CP and NH_3-N were analysed according to AOAC (1990) procedures. Water-soluble carbohydrate was determined according to Thomas (1977). The NDF and ADF were analysed according to Van Soest (1991). A pH meter (model 219-Mk 2; Pye Unicam) was used to measure the pH of the silage. Samples of 40g from each silo were soaked in 200 ml of cool distilled water for 12 hours. The mixtures were then filtered and the supernatant used for the determination of the pH. The silages were analysed for lactic acid and volatile fatty acid (VFA) contents according to Playne (1985). The *in vitro* dry matter digestibility was determined according to Tilley and Terry (1963). Two cannulated Friesian x Ayrshire steers fed on a mixture of fresh elephant and guatemala grasses were used to provide the inoculums for the determination of *in vitro* dry matter digestibility.

Experimental design and statistical analysis

The experimental schedule comprised of two grass species, two pre-ensiling treatments (wilted or unwilted) and five additive treatments (untreated, MOL5, FSC5, FSC10, FSC15) which were arranged in a 2 x 2 x 5 factorial arrangement of treatments with two replicates. The General linear Model (GLM) procedure of statistical analysis system (SAS, 1988) with SSI option for analysis of variance was used in analysing the data. The statistical model used was as follows: - $Y_{ijkl} = \mu + A_i + B_j + C_k + AB_{ij} + AC_{ik} + BC_{jk} + ABC_{ijk} + e_{ijkl}$ Where:- Y_{ijkl} = quality attributes of grass species, pre-ensiling process and additives, μ = fixed general effect, A_i = effect of i^{th} grass species, B_j = effect of j^{th} pre-ensiling process (unwilted or wilted), C_k = effect of k^{th} additive, AB_{ij} = interaction of i^{th} species and j^{th} pre-ensiling process, AC_{ik} = interaction of i^{th} species and k^{th} additive, BC_{jk} = interaction of j^{th} pre-ensiling process and k^{th} additive, ABC_{ijk} = interaction of i^{th} species, j^{th} pre-ensiling process and k^{th} additive and e_{ijkl} = error term. Least Significance Difference (LSD) for all statistically analysed data were used to record the difference between treatment means.

RESULTS

Chemical composition of grasses and WSC additives before ensiling

The chemical composition of the grasses and WSC additives used in the preparation of the silages is shown in Table 1. Guatemala grass had relatively higher DM but rather lower CP and ash contents than elephant grass. The two grasses had however, nearly similar WSC and NDF contents. Molasses had four times the amount of WSC as compared to derinded fresh sugarcane crush but the latter had three times higher WSC content than the grasses.

Table 1. Chemical composition of the grasses and water soluble carbohydrates additives used in the present study

Component	Elephant grass		Guatemala grass		Derinded fresh sugarcane crush	Molasses
	Unwilted	Wilted	Unwilted	Wilted		
DM %	19.3	20.6	27.7	30.9	24.7	65.3
CP %	9.6	10.6	8.0	8.9	1.9	2.1
WSC %	3.1	3.2	3.3	3.5	10.5	44.2
Ash %	12.8	12.9	9.2	9.0	25.6	10.6
NDF %	74.6	69.9	74.0	73.0	46.4	Nd*
ADF %	46.3	46.4	41.2	40.7	27.2	Nd

DM = Dry matter, CP= Crude protein, WSC = Water Soluble Carbohydrate, NDF= Neutral Detergent Fiber, ADF = Acid Detergent Fiber. *Nd = Not determined.

Quality of elephant grass silage

The results of the effect of the WSC additive treatments on the chemical composition and digestibility of elephant grass silage are shown in Table 2. The DM content was highest in molasses treated wilted silage and lowest in unwilted control silage. The wilted silages had significantly ($P \leq 0.5$) higher CP content than unwilted silages. However, there was rather little difference between molasses and FSC treated silages in terms of crude protein content for both unwilted and wilted elephant grass silages. Molasses treated silages had the highest WSC content followed by FSC silages and the least were the controls for both unwilted and wilted silages. On average unwilted silage had relatively higher WSC contents than wilted silage. The control silages had the highest NDF contents and were less digestible than all treated silages. In both unwilted and wilted silages the NDF content decreased and digestibility increased from 5 to 15 % FSC. Water Soluble Carbohydrate additives had rather little affect on the silages ADF content.

The results of the effect of WSC additive treatments on the fermentation characteristics of both unwilted and wilted elephant grass silages are shown in Table 3. The pH values of treated silages were about 3.9 and those of the control > 4.0. On average wilted elephant grass silages had higher NH_3N values than unwilted silages. The control treatment of wilted silages had the highest NH_3N. Generally the control treatments had the lowest lactate values. On average, however, the wilted silages had higher lactate values than the unwilted silages. Lactate content increased with increased FSC levels from 5 to 15 % FSC in both unwilted and wilted silages. The molasses and 15 % FSC treated silages had higher lactate content than all other silages. Acetate values were higher in control treatments and tended to increase from 5 to 15 % FSC treatments for both unwilted and wilted silages. Butyrate was negligible and only recorded in unwilted silages.

Quality of guatemala grass silage

The results of the effect of WSC additives on the chemical composition and digestibility of unwilted and wilted guatemala grass silages are shown in Table 2. The wilted silages had on average slightly higher DM content than unwilted silages. The CP content was highest in wilted molasses treated silage and lowest in unwilted control treatment silage. The WSC content was generally higher in molasses than FSC treated silages and increased with increasing FSC levels. The NDF content decreased from 5 to 15 % FSC in both unwilted and wilted silages. The digestibility of all guatemala silages were greater than 60 %. The digestibility was highest in unwilted and lowest in wilted molasses treated silages.

The results of the effects of the WSC additive treatments on the fermentation characteristics of the guatemala silages are shown in Table 3. The pH and NH_3N values were highest in control treatments. On average the wilted silages had relatively higher pH values than unwilted silages. However, both unwilted and wilted silages treated with 15 % FSC had pH values lower than 4. The NH_3N values tended to decrease from 5 to 15 % FSC in both unwilted and wilted silages. The control treatments had the lowest lactate values. On average, however, the wilted silages had higher lactate values than the unwilted silages. The highest values of acetate and butyrate were recorded in control treatments.

Table 2. Chemical composition and digestibility of elephant and gutemala grasses ensiled after different treatments

Treatments		DM%	WSC	CP %	Ash %	NDF %	ADF %	IVDMD %
				Elephant grass				
Unwilted	Control	16.8^{e}	1.35^{f}	9.1^{f}	14.2^{b}	70.2^{a}	43.3^{a}	52.4^{g}
	MOL5	17.7^{cd}	2.09^{b}	9.4^{d}	14.2^{b}	64.0^{e}	39.1^{d}	59.4^{c}
	FSC5	17.2^{d}	1.78^{d}	9.2^{e}	13.1^{c}	67.6^{b}	40.9^{cd}	56.5^{e}
	FSC10	17.9^{c}	1.79^{d}	9.3^{de}	12.0^{d}	66.4^{c}	41.7^{c}	62.1^{b}
	FSC15	18.9^{b}	1.89^{c}	9.3^{de}	14.2^{b}	64.5^{de}	41.6^{c}	63.5^{b}
Wilted	Control	18.1^{c}	1.25^{e}	9.8^{c}	13.8^{b}	69.7^{a}	43.7^{a}	54.5^{f}
	MOL5	20.3^{a}	2.38^{a}	10.3^{b}	15.5^{a}	65.7^{c}	38.7^{d}	62.6^{b}
	FSC5	18.3^{b}	1.35^{f}	10.3^{b}	13.2^{c}	66.3^{c}	42.0^{b}	57.5^{d}
	FSC10	18.8^{b}	1.55^{e}	10.5^{a}	11.4^{e}	65.6^{cd}	40.2^{d}	58.6^{cd}
	FSC15	19.1^{b}	1.86^{c}	10.4^{ab}	13.1^{c}	62.7^{f}	39.6^{d}	66.1^{a}
	SEM	2.62	0.017	0.032	0.124	1.65	1.02	0.29
				Guatemala grass				
Unwilted	Control	25.8^{e}	1.02^{d}	6.8^{c}	9.4^{c}	70.2^{a}	42.5^{a}	64.0^{d}
	MOL5	27.3^{d}	2.15^{a}	7.6^{ab}	9.5^{c}	63.6^{e}	38.4^{d}	68.4^{a}
	FSC5	26.9^{d}	1.05^{d}	7.5^{b}	9.0^{cd}	69.5^{ab}	40.3^{c}	65.4^{b}
	FSC10	27.1^{d}	1.53^{c}	7.8^{a}	8.7^{d}	68.3^{bc}	42.3^{a}	64.6^{c}
	FSC15	27.5^{cd}	1.74^{b}	7.6^{ab}	8.0^{e}	68.0^{cd}	42.4^{a}	65.0^{b}
Wilted	Control	28.2^{bc}	1.72^{bc}	7.3^{b}	12.3^{a}	69.9^{a}	43.4^{a}	60.5^{e}
	MOL5	29.5^{a}	2.39^{a}	7.8^{a}	10.4^{b}	58.5^{e}	39.0^{d}	60.8^{e}
	FSC5	28.6^{b}	1.79^{b}	7.5^{b}	9.6^{c}	66.8^{d}	42.3^{ab}	63.8^{d}
	FSC10	30.0^{a}	2.10^{ab}	7.7^{a}	9.6^{c}	66.8^{d}	41.3^{bc}	64.5^{cd}
	FSC15	30.2^{a}	2.21^{a}	7.8^{a}	8.7^{d}	66.7^{d}	41.6^{b}	64.8^{bc}
	SEM	2.56	0.154	0.067	0.18	1.32	0.34	0.22

IVDMD – In Vitro Dry Matter Digestibility,
Control = no additive, MOL5= 5 % Molasses,
FSC5 = 5 % Fresh Sugar Cane Crush,
FSC10 = 10 % Fresh Sugar Cane Crush,
FSC15 = 15 % Fresh Sugar Cane Crush.
Values in the same column followed by different superscripts are significantly ($P < 0.05$) different.

Comparison of the elephant and guatemala grass silages

The results of the chemical composition and *in vitro* dry matter digestibility of elephant and guatemala grass silages are shown in Table 4. The guatemala silage had significantly ($P < 0.05$) higher DM, WSC and NDF contents than elephant grass silage. The CP and ash contents were however significantly ($P < 0.05$) lower in guatemala than in elephant grass silage. The two grass silages did not differ significantly ($P > 0.05$) in terms of ADF content. The guatemala silage was slightly more digestible than elephant grass silage. The results of fermentation products of elephant and guatemala grass silages are shown in Table 4. The pH, NH_3N and lactate contents of elephant and guatemala silages were not significantly ($P > 0.05$) different. Acetic and butyric acids were significantly higher ($P < 0.05$) in guatemala than in elephant grass silage.

DISCUSSION

Wilting the forage before ensiling is recommended as a means of increasing dry matter content, the WSC on fresh weight basis and reducing losses from effluent and undesired fermentation (Humphreys, 1991, Nussio, 2005). The effluent observed in this study was rather negligible; however, wilting for 24 hours increased slightly the DM contents of both grasses. The increase was rather lower in elephant grass than in guatemala grass. The results are in agreement with the observations made by Henderson (1993) who reported that under humid and wet conditions a significant increase in DM content of wilting forages could take several days. The fodder grasses were harvested during the short rains. It rained two days before the harvesting date and the ambient temperature and humidity were 26 ^{o}C and 70 %, respectively. If the wilting period is however, extended over several days, the water-soluble carbohydrates may be lost and protein nitrogen contents may be reduced and deamination of amino acids will increase (Henderson, 1993). Increased deamination of amino acid will also increase the production of NH_3N during silage fermentation. However, wilting increased the CP and WSC contents and slightly decreased NDF and ADF contents of grasses. The CP content of guatemala was rather lower than that of elephant grass and this was in agreement with the results reported by Mngulwi (1985) in the same area of study

Table 3. Fermentation quality of the elephant and Guatemala grasses ensiled after different treatments

Treatments		DM% Loss	PH	NH_3 N (% TN*)	Lactic acid %	Acetic acid %	Butyric acid %
				Elephant grass			
Unwilted	Control	8.35^{c}	4.00^{ab}	2.61^{c}	0.68^{d}	0.15^{b}	0.04
	MOL5	6.84	3.94^{b}	2.22^{c}	2.05^{ab}	0.04^{cd}	0
	FSC5	6.01^{cd}	3.85^{bc}	3.10^{ab}	1.09^{cd}	0.01^{d}	0
	FSC10	7.73^{c}	3.87^{bc}	2.55^{c}	2.19^{ab}	0.03^{cd}	0
	FSC15	12.09^{b}	3.82^{bc}	2.02^{c}	2.74^{a}	0.04^{cd}	0
Wilted	Control	5.24^{d}	4.50^{a}	4.22^{a}	0.60^{d}	0.28^{a}	0
	MOL5	6.88^{cd}	3.97^{ab}	2.81^{c}	2.37^{a}	0.07^{bc}	0
	FSC5	7.08c	3.80^{bc}	3.33^{ab}	1.01^{cd}	0.10^{bc}	0
	FSC10	7.84^{c}	3.80^{bc}	3.36^{ab}	1.47^{c}	0.16^{b}	0
	FSC15	14.64^{a}	3.40^{c}	3.32^{ab}	2.39^{a}	0.20^{ab}	0
	SEM	1.341	0.178	0.345	0.081	0.050	
				Guatemala grass			
Unwilted	Control	11.04^{a}	4.42^{a}	3.9^{a}	0.36^{d}	0.29^{a}	0.021^{c}
	MOL5	11.08^{a}	3.89^{b}	2.6^{b}	1.80^{b}	0.03^{d}	0.002^{e}
	FSC5	8.19^{b}	3.86^{b}	3.0^{ab}	1.15^{c}	0.01^{d}	0.003^{e}
	FSC10	8.45^{b}	3.85^{b}	2.7^{b}	1.68^{b}	0.06^{d}	0.001^{e}
	FSC15	6.14^{c}	3.78^{b}	2.5^{b}	1.78^{b}	0.17^{bc}	0.010^{d}
Wilted	Control	7.54^{bc}	4.26^{a}	4.6^{a}	0.47^{d}	0.22^{ab}	0.030^{b}
	MOL5	6.54^{c}	3.92^{b}	3.7^{a}	2.37^{a}	0.07^{d}	0.010^{d}
	FSC5	4.84^{e}	4.00^{ab}	4.1^{a}	1.09^{c}	0.12^{bc}	0.041^{a}
	FSC10	4.92^{e}	4.00^{ab}	4.0^{a}	1.90^{b}	0.18^{bc}	0.022^{c}
	FSC15	4.92^{e}	3.90^{b}	2.3^{b}	2.45^{a}	0.02^{d}	0.002^{e}
	SEM	1.260	0.150	0.63	0.112	0.025	0.002

*TN = Total Nitrogen

Table 4. Mean chemical composition, *in vitro* dry matter digestibility and fermentation characteristics of elephant and guatemala grass silages regardless of wilting

Component	Elephant grass	Guatemala grass	SEM
DM %	17.8^{b}	27.8^{a}	3.9
CP %	9.8^{a}	7.5^{b}	0.14
WSC %	1.59^{b}	1.73^{a}	0.028
Ash %	13.3^{a}	9.5^{b}	3.25
NDF %	65.6	66.8	6.16
Acid detergent fiber	41.1	41.4	2.45
IVDMD %	59.3^{b}	61.4^{a}	1.86
PH	3.95	3.99	0.026
NH_3-N (% TN)	2.9	3.3	0.14
Lactate	1.64	1.59	0.51
Acetate	0.07^{b}	0.12^{a}	0.011
Butyrate	0.01^{b}	0.09^{a}	0.006

Values in the same row followed by different superscript are significantly ($P < 0.05$) different

Regardless of wilting and grass species the control silages had rather lower DM contents than treated silages showing the importance of addition of WSC additives in ensiling grasses (Humphreys, 1991). Addition of molasses improved the DM contents by 11 and 15 and by 22 and 13 units in unwilted and wilted elephant and guatemala grasses, respectively. Similar results were reported by Yokota *et al.* (1998) who added 4 % molasses to elephant grass (8.6 % DM content) and obtained a silage with 13.4 % DM content. Whether wilted or unwilted the DM content of silages increased with increasing levels of FSC in both grasses. These results are encouraging because silage making in the tropics is likely to occur in the wet season when wilting of the harvested fodder grasses is rather difficult. It is also important that the additive improve the DM content of the silage so as to ensure low effluent, stability for long storage and higher DM intake by the animals (Catchpoole and Henzell, 1971, Tjandraatmadja, *et al*., 1993).

The CP content of the silages varied slightly between the treatments but was higher in elephant grass than in guatemala grass silages. The WSC content of the silages was nearly 50 % lower than the original ensiling grass material. However, addition of the WSC additives increased the residual WSC content and as expected, molasses silages had the highest WSC residual contents. Similar results have been reported by other workers elsewhere (Holm1974; Tjandraatmadja *et al*., 1993). The proportion of NDF declined slightly with increasing levels of FSC. This was expected since FSC had lower proportion of NDF than the grasses. The digestibility of the silages was improved significantly by addition of molasses and also increased with increasing FSC levels. This could be due to increased residual WSC and reduced NDF contents in the silages with addition of molasses and increasing levels of FSC. The results are in agreement with those of Nayigihugu *et al*. (1995) who observed that increasing molasses levels lowered pH, NDF, ADF and increased *in vitro* dry matter digestibility of bermuda grass silage. The results of this study indicate further that, the benefit of WSC additive is not only to improve fermentation of the silage but also in improving the proportion of the silage that is digested by the animal.

Addition of molasses and FSC preserved the silages well as indicated by low pH (≤ 4.00), low content of NH_3N (≤ 4.1 % TN), negligible content of butyrate (≤ 0.6 g/kg DM), and high proportion of lactate (> 50 %) in the total acids produced as recommended by Humphreys (1991) for good quality silage. The control silages of guatemala grass had higher pH values than those of elephant grass possibly due to the higher DM content of the former than the latter grass or due to the differences in buffering capacity. Woodard *et al*. (1991) reported that the ease with which elephant grass was preserved as silage was attributed to it's inherently low buffering capacity. The buffering capacity of the two grasses was however, not determined in this study.

CONCLUSIONS

It can be concluded that the locally chewing sugarcane can be used as a WSC for ensiling grasses when molasses is not available. The results of this study suggest that elephant and guatemala grasses harvested at 8 weeks regrowth do not need to be wilted before ensiling when FSC at a level of 10 to 15 % (w/w) is mixed with the ensiling material.

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