Cassava Tops Ensiled With or Without Molasses as Additive Effects on Quality, Feed Intake and Digestibility by Heifers

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ABSTRACT : Two experiments on the effects of molasses additive on cassava tops silage quality to its feed intake and digestibility by growing Holstein×local crossbred heifers were carried out. Sixteen plastic bags of one meter diameter and two meters length were allocated in a 2×2 factorial design with four replicates in the ensiling study, with and without the molasses additive and with two storage times (2 and 3 months). The silage produced in the first experiment was used in the feed intake and digestibility study. Six crossbred Holstein heifers, 160-180 kg live weight, were randomly allocated in a 3× 2 change-over design to three treatments: Guinea grass ad libitum, 70% of grass ad libitum with a supplement of non-molasses cassava silage *ad libitum*, and 70% of grass *ad libitum* with a supplement of molasses cassava silage *ad libitum*. Ensiling was shown to be a satisfactory method for preservation of cassava tops. The HCN content was significantly reduced from 840 mg kg^{-1} to 300 or 130 mg kg^{-1}, depending on storage period. The tannin content was not significantly changed. Molasses additive resulted in lower pH, Crude Protein (CP), NDF and higher DM content but did not otherwise affect chemical composition. The voluntary feed intake per 100 kg live weight of the heifers was 2.59, 2.65 and 2.91 kg DM of Guinea grass, non-molasses cassava tops silage and molasses cassava tops silage diet, respectively. Crude protein intake was significantly improved in the cassava tops silage diets. The apparent digestibility of DM, OM, CP, NDF and ADF decreased with the silage supplement diets. No significant difference in digestibility was found between the non-molasses and molasses silage diets. The digestibility coefficient of DM, OM, CP, NDF, ADF in non-molasses cassava tops silage and molasses cassava tops silage was 49.4, 52.1, 45.81, 36.6, 27.7 and 49.7, 51.9, 47.55, 28.1, 19.5, respectively. It is concluded that cassava tops can be preserved successfully by ensiling and that cassava tops silage is a good feed resource for cattle. *(**Asian-Aust. J. Anim. Sci. 2001. Vol. 14, No. 5 : 624-630**)*

Key Words : Cassava Top Silage, Chemical Composition, Feed Intake, Digestibility, Crossbred Heifer, Molasses

INTRODUCTION

Cassava or tapioca (*Manihot esculenta*, Crantz) is an annual tuber crop grown widely in the tropical regions of Africa, Asia and Latin America. It thrives in sandy-loam soils with low organic matter, and climate characterized by low rainfall and high temperature (Wanapat et al., 1997). In Vietnam cassava is cultivated on an area of 231,700 hectares of a total arable land area of 5.7 millions hectares (FAOSTAT, 1998). It is the third food crop after rice and maize and is mainly being cultivated by small-holder farmers in the poorer areas of Vietnam. Besides the main product of the tubers, which contain high levels of energy and 2-3 % crude protein, cassava also supplies a valuable source of leaf protein to animals. Ravindran and Rajaguru (1988) reported the yield of cassava leaves to be as much as 4.6 tons dry matter per hectare taken as a by- product at root harvesting. High contents of crude protein in the cassava leaf have been reported, varying from 16.7% to 39.9% (Allen, 1984), with an average of 21%. FAO (1998) reported that with practices directed toward foliage harvesting, 6 tons of crude protein can be obtained per hectare per year. In Vietnam lower yields of cassava leaf residue were reported by Liem et al. (1998) and this crop residue has been evaluated as a protein source in several experiments with mono-gastric animals. Focussing on the root production, many new high yielding varieties of cassava have been introduced, of which many have a high HCN content (Kim, 1999), and this leaf toxicity is a limiting factor in using a high level of cassava leaf in mono-gastric animals diets. However, ruminants can limit the harmful effects of HCN through the reactions of rumen microbes and therefore utilize the leaves more efficiently. In Tropical Feeds (FAO, 1998), it is stated that cassava leaf meal can be mixed in lactating cow concentrates up to a level of 35% without any harmful effects. Hay of cassava leaf and stem showed a good resource for ruminant feed with a high voluntary feed intake (3.1% LW) and dry matter digestibility (71%) (Wanapat et al., 1997).

However such cassava tops need good weather for drying and special techniques to limit the loss of dry leaves. Ensiling could be a suitable way of preserving the leaves, but with high content of N and low content of water soluble carbohydrates (WSC) green

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fodder material like cassava tops, silage additives should be added to ensure successful fermentation (Petersson, 1988). Sugarcane molasses, a common feed ingredient in the tropics, is commonly used as an additive for ensiling low WSC tropical forages and improving silage quality. The present study was aimed at determining the influence of molasses in making cassava tops silage and evaluating its feed intake and digestibility by crossbred Holstein heifers.

MATERIALS AND METHODS

Ensiling study

The experiment was carried out in 1998-1999 at the University of Agriculture and Forestry Experimental Farm, Ho Chi Minh City, Vietnam. Cassava tops were evaluated in ensiling studies with or without additives. Sugarcane molasses (640 g DM kg^{-1} and 375 g WSC kg^{-1}) was used as an additive at 60 kg per ton of fresh material. Treatments with or without molasses and two storage periods (two and three months) were allocated in a 2 by 2 factorial combination in a randomized complete block. Each treatment was replicated four times using a total of 16 plastic bags of 1.0 m diameter. Cassava tops were collected in the field immediately after root harvesting in February, 1999. Only the tops with the green stem and its leaf canopy were taken. The green cassava tops were on average 40 to 60 cm long with a DM content of 28.2%. Approximately 3000 to 4000 kg of green top residues were collected per hectare. The cassava tops were chopped into pieces of 3-4 cm length and placed in plastic bags in layers up to 1 m thick in total. Molasses was mixed with the chopped pieces at the time of filling and the materials were compacted by two people standing on the bags. After filling the tops of the bags were bound by plastic string and pressed by placing 5 of 8 kg sand bags on top. Approximately 260 kg of chopped cassava top was ensiled in each bag. The bags were stored in shade under a roof.

Samples were collected for chemical analysis immediately before ensiling and on two later occasions, two and three months after ensiling. The following determinations was made: toluene dry matter (dried and corrected for volatiles according to Lingvall & Ericson, (1981), pH (pH-ORION model 420 A), WSC, tannin, HCN, CP, ash, and ether extract (EE), analyzed using procedures described by AOAC (1984). ADF, Ash-free NDF and permanganate lignin were analyzed according to Van Soest and Robertson (1980).

Feed intake and digestibility study

The experimental conditions: The silage prepared in the ensiling study was used in the experiment to evaluate the feed intake and digestibility of cassava tops silage. The time arrangement of the two studies is shown in table 1. Six crossbred Holstein heifers, 8-10 months of age and 160-180 kg live weight, were randomly allocated in a 3×2 change-over design (Patterson and Lucas, 1962) to three treatments: I: control grass diet; II: grass diet with a supplement of 0-molasses silage (0MS); and III: grass diet with a supplement of 6%-molasses silage (6%MS). Each period included a preliminary period of 14 days for adaptation, 5 days for feed intake measurement, 2 days for digestibility diet adaptation, and 7 days for digestibility measurement. At the beginning of the experiment a 5-day preliminary testing was done to measure the voluntary dry matter intake of the grass diet of each animal in order to determine the ratio of cassava tops silage in the experimental diets (around 30% in DM of cassava tops silage in the diet). During the feed intake measurement the grass supply was restricted to 70% of the *ad libitum* intake (on a DM basis) on the treatments 0MS and 6%MS and cassava silage was supplied *ad libitum*. For the digestibility determinations the diet was limited to 85% of mean DM intake measured during the 5 days of intake studies. During the 9 days of digestibility study the daily amount of feed was constant.

The animals were confined in individual stalls under roof one month before the trial to accustom them to the experimental conditions and treated against internal and external parasites. During the experiment the animals were fed 4 times per day: 8:30, 11:00, 16:00 h, and the remainder given at 20:00 h.

Fresh Guinea grass (*Panicum maximum* 280), cut at six weeks of age was used as the basal feed. Cassava tops silage with or without molasses additives was taken from the plastic bags once per day, weighed and put into a small plastic bag for feeding the whole day. A mineral supplement, produced by the Department of Animal Nutrition (University of Agriculture and Forestry), was used in the experiment. It contained salt, dicalcium phosphate, $MgSO_4$, $CuSO_4$, $CoCl_2$, K_2SO_4, Casein Iodine, $MnSO_4$ and Selenium and was fed at 84 g/150-200 kg live weight/day. Water was freely available.

Data collection and laboratory analysis: The animals were weighed prior to and after the 5-day feed intake period in the morning, before feeding and watering. The mean weight of the heifer was used in calculating the feed intake per kg live weight (LW). Feed samples and the refusals were collected every

Table 1. Time table of the experiments

Months	0	1	2	3	4	5	6
	↑		↑	↑	↑		↑
Activities	Ensiling		Sampling		Starting		Ending
Experiments	----------- I ------------				--------- II ---------		

day for laboratory analysis. During the collection period, refusals were collected at 8:00 h, weighed, mixed, sub-sampled and bulked in bags, one for each animal. During the digestibility study, faeces from each animal were collected immediately after defecation throughout the day, and placed in pre-tared plastic basins until 8:30 h the following morning. The 24-hour faecal output was weighed, mixed and sub-sampled, and 10% of daily output was sampled from each individual heifer and stored in a deep freezer. The seven samples from each animal during the collection week were de-frosted, mixed, sampled and dried in a forced oven at 60℃ for 72 hours for laboratory analysis. Samples were prepared using procedures described by Goering and Van Soest (1970). Feed, refusals and faeces samples after oven drying were ground using a laboratory hammer mill with 1 mm screen. The following determinations were made: Dry matter, ash, crude protein, ether extract, ADF, ash-free NDF and permanganate lignin were analyzed using the same methods described in the ensiling study. Gross energy contents of feed and faecal samples were determined by means of an adiabatic bomb calorimeter and digestible energy was calculated from these results.

Statistical analysis

The data were subjected to an analysis of variance (ANOVA) by using the General Linear Model (GLM) procedure of Minitab (1998). When the F test was significant ($p<0.05$), Tukeytest for paired comparison was used (Minitab, 1998).

RESULTS

Ensiling cassava tops with and without molasses additive

In the ensiling study, the effects of molasses additive and time of storage on the chemical composition and the quality of the silage are summarized in table 2. The dry matter of the fresh cassava tops was 29%, and this increased after ensiling. Use of molasses additive increased the silage dry matter content significantly. The pH values of the silage were significantly lower when molasses were added (4.18 compared to 4.30). Mean pH of the silages fell significantly from 4.30 to 4.19, 2 to 3 months after ensiling. HCN content in the fresh cassava tops was reduced significantly by the ensiling process, by 56% after 2 months and 70% after 3 months of ensiling. The time of storage significantly affected the loss of HCN, while there was no effect of molasses additive. Soluble tannin content was 4.3 to 4.6 % in the DM and did not change significantly with storage time or by adding molasses. The CP and NDF contents of silage were reduced significantly by the molasses additive, while there was no change with time of storage.

Chemical composition of diet ingredients used in the feed intake and digestibility study

The chemical composition of the diet ingredients collected during the feed intake and digestibility experimental periods are presented in table 3. The CP, EE and lignin contents of Guinea grass 280 were lower than in cassava tops silage, but the NDF and ADF contents were higher. There was a slight decrease in CP, EE, NDF, ADF and ash with addition of molasses, while the opposite was found for DM and WSC. The HCN content in the silages was on average 132 mg kg^{-1} during the second experiment (four to six months after ensiling) which thus showed a continuous reduction in the mean HCN content, from 251 mg kg^{-1} observed in the cassava tops silages at 3 months of storage.

Table 2. Chemical composition of fresh cassava tops and cassava tops silage

	FCT*	Molasses treatment			Storage treatment		
		0 M*	6% M		2 MAE*	3 MAE	
No.	4	8	8	p**	8	8	p
pH		4.30	4.18	0.01	4.30	4.19	0.01
DM g kg^{-1}	292	310	324	0.03	320	314	0.86
% in DM							
CP	18.8	21.5	18.8	0.00	19.5	20.8	0.32
EE	9.6	10.4	10.4	0.07	9.6	11.2	0.01
ADF	34.2	34.6	35.1	0.14	35.0	34.7	0.40
NDF	51.8	51.2	49.9	0.01	50.3	50.7	0.64
Ash	6.3	5.8	6.0	0.49	5.9	6.0	0.97
Tannin	4.3	4.5	4.3	0.21	4.3	4.6	0.64
HCN mg kg^{-1} #	840	292	329	0.24	369	251	0.00

* FCT: Fresh cassava tops; M: molasses; MAE: Months after ensiling.

** p: p value: Probability of a larger F value for the treatment.

in fresh material.

Daily feed intake

The results for daily feed intake are summarized in table 4. The reduction in grass intake in the silage supplement diets as compared to the grass diet followed the plan determined in the experimental design. The total DM intakes and DM intakes per 100 kg LW of the silage supplement diets were higher compared with the control grass diet, but there was only a significant difference in DM intake per 100kg LW between the 6%MS diet and the grass diet. Due to considerably higher CP content in cassava top silages v.s. grass, CP intake of the 0MS and 6%MS diet increased significantly compared with the grass diet. The daily NDF intake of the grass diet was 4.06 kg and supplementing the cassava top silage reduced NDF intakes in the 0MS and 6%MS diets, as compared to the grass diet.

Digestibility of the experimental diet and the dietary ingredients

The results for apparent digestibility of the diet and dietary ingredients are summarized in table 5, 6 and 7. The cassava top silage supplement decreased the organic matter digestibility (OMD) and crude protein digestibility (CPD) of the silage diets by around 5 and 10 percent units, respectively, as compared to the pure grass diet. There was no difference in OMD and CPD between the 0MS and 6%MS diets. The digestibility of the fiber fractions in the diets, expressed as NDF digestibility (NDFD) and ADF digestibility (ADFD), were also significantly lower in the cassava tops silage diets. The differences were 7-11 percent units for NDFD and 11-14 percent units for ADF. No significant difference could be found between the 0MS and 6%MS diets (table 5).

Table 3. The chemical composition of the dietary ingredients, Experiment 2

Chemical composition	Guinea grass 280	Cassava tops silage	
		0 M*	6% M
No.	4	4	4
DM g kg^{-1}	204	329	363
% in DM			
CP	9.6	21.1	19.9
EE	3.5	11.6	10.7
NDF	76.6	49.9	44.1
ADF	41.6	36.7	33.3
Lignin	9.5	16.0	15.2
Ash	5.2	6.9	6.4
Tannin	nd**	3.9	4.2
WSC	nd	1.8	3.9
HCN mg kg^{-1} #	nd	144	121

* Molasses.
** nd: not determined.
\# in fresh material.

Table 4. Daily dry matter feed intake

Dry matter intake	Guinea grass 280 diet	Silage supplement diets		p**
		0 M*	6% M	
Roughage (kg DM/ animal)				
Grass	5.29^{a}	3.37^{b}	3.34^{b}	0.00
Silage	0.00^{a}	2.06^{b}	2.39^{b}	0.00
Total	5.29	5.43	5.73	0.80
Roughage (kg DM/100 kglw)				
Grass	2.59^{a}	1.63^{b}	1.70^{b}	0.00
Silage	0.00^{a}	1.02^{b}	1.21^{b}	0.00
Total	2.59^{a}	2.65^{ab}	2.91^{b}	0.02
Crude protein (kg/ animal)	0.51^{a}	0.73^{ab}	0.83^{b}	0.01
NDF (kg/animal)	4.06	3.06	3.11	0.15
Live weight (kg)	203.00	210.50	201.90	0.85

* Molasses.
** p: p value: Probability of a larger F value for the treatment.
a,b,c Means within rows with differing superscript letters are significantly different ($p<0.05$).

The energy digestibility (ED) of the silage supplement diets was also lower by around 5 percent units compared to the grass diet.

Guinea grass 280 with 6-week cutting frequency was significantly higher in OMD and CPD than the two cassava tops silages. The differences were around 12-13 and 17-16 percent units compared to the 0MS and 6%MS silages, respectively, and there was no difference between the two cassava tops silages. The silages were significantly lower in NDFD and ADFD compared to grass (table 6). The differences were

Table 5. Digestibility of the treatment diets (%)

Digestibility	Guinea grass 280 diet	Silage supplement diet		p**
		0 M *	6% M	
Dry matter	61.61^{a}	57.08^{b}	56.67^{b}	0.002
Organic matter	64.55^{a}	59.99^{b}	59.12^{b}	0.001
Crude protein	63.02^{a}	53.01^{b}	53.12^{b}	0.001
Ether extract	62.25	56.57	53.48	0.145
Ash	22.85	18.99	20.64	0.101
ADF	60.07^{a}	48.76^{b}	45.51^{b}	0.001
NDF	66.20^{a}	59.27^{b}	55.11^{b}	0.002
Energy#	62.60	57.68	56.99	0.075

* Molasses.
** p: p value: Probability of a larger F value for the treatment.
\# Determined by adiabatic bomb calorimeter.
a,b,c Means within rows with different superscript letters are significantly different ($p<0.05$).

30-38 percent units for NDFD and 32-41 percent units for ADFD for grass compared to the 0MS and 6%MS silages, respectively. The mean energy digestibility (ED) of grass was highest (62.6%), followed by 6%MS (51.6%) and 0MS (50.4%), but none of these differences was statistically significant.

The digestible energy (DE) per kg DM of grass diet was higher compared to the silage supplement diets, but no difference in the total daily DE intake per animal could be found between the diets (table 7). By calculating the DE differences, the DE of 1kg DM of 0MS and 6%MS were found to be the same (10.2 MJ/kg DM), which was slightly lower compared with the DE value of grass (10.6 MJ/kg DM).

The calculated DCP contents of 1kg DM of 0MS and 6%MS, 91.2 and 100.3 g, were nearly one and half times the DCP of 1kg DM of grass (60.5 g). The total daily digestible crude protein intake was lowest (319 g) for the grass diet followed by the 0MS diet (388 g) and 6%MS diet (438 g).

DISCUSSION

The cassava tops used in this study were lower in CP content and higher in NDF and ADF contents compared to previous data on pure cassava leaves (Hang, 1998; Phuc et al., 2000) or cassava hay harvested as fodder with 3-months cutting frequency (Wanapat et al., 1997). The lower nutritive value of the cassava tops compared to leaves was the result of stem ratio and of differences in stage of maturity compared to the values reported by Wanapat et al. (1997).

Cassava tops silage, with or without molasses additive had a good, typical silage smell and a pH values below 4.5, and thus would be considered as a good quality silage in general terms (Lättemäe, 1997). Fresh cassava tops had a WSC content of around 6% DM^{-1}, which is considered adequates for successful preservation as silage without any additive (Haigh and Parker, 1985). There was no difference in appearance and chemical composition of the cassava top silages with or without molasses additive, except for the high content of WSC in the molasses silage.

The HCN content of fresh cassava tops was higher than data for leaves reported in previous studies (Hang, 1998; Phuc et al., 2000). The variation in plant HCN content has been identified as being due to species, plant part, stage of maturity and fertilizer applied (Elgindi et al., 1971). In this experiment the HCN contents of cassava tops silage were reduced gradually with time after ensiling (tables 2 and 3), but no effect was found of additive level. The same was found by Hang (1998) and Phuc et al. (2000) in cassava leaf silage.

The tannin content of the silage was in the range of some common legume leaves (Balogun et al., 1998). The content was 30% higher compared with the previous harvest at the end of the rainy season two months earlier (Man, unpublished data). The difference may have been due to weather conditions and soil fertility (Barry and Forss, 1983).

The voluntary dry matter intake (table 4) by the heifers of Guinea grass 280 (*Panicum maximum* 280) as the sole forage was higher compared with data reported for other varieties (Jarrige, 1989). Plant variety and cattle breed may be the reasons for the difference. Supplementing cassava tops silage to the grass diet tended to increase the feed intake. This result could be attributable to a stimulatory effect of silage on intake (Aminah et al., 1999) or the effect of the supplementation of protein leaves to low quality roughage diets in the tropics as stated by Merkel et al. (1999). In the present study, the supplement raised

Table 6. Digestibility of the cassava top silages (%) assuming constant digestibility of Guinea grass as determined in the study

Apparent digestibility	Guinea grass 280	Cassava top silage		p**
		0 M*	6% M	
Dry matter	61.61^a	49.37^b	49.66^b	0.00
Organic matter	64.55^a	52.11^b	51.89^b	0.00
Crude protein	63.02^a	45.81^b	47.55^b	0.00
Ether extract	62.25	53.64	49.42	0.09
Ash	22.85	20.99	24.35	0.33
ADF	60.07^a	27.69^b	19.45^b	0.00
NDF	66.20^a	36.59^b	28.10^c	0.00
Energy#	62.60	50.37	51.57	0.28

* Molasses.
** p: p value: Probability of a larger F value for the treatment.
\# Determined by adiabatic bomb calorimeter.
a,b,c Means within rows with differing superscript letters are significantly different (p<0.05).

Table 7. Digestible energy and digestible crude protein of diet and diet ingredients

Component	Guinea grass 280	Cassava top silage	
		0 M *	6% M
Diet			
DE# (MJ/kg DM)	11.6	11.1	10.9
Daily DE intake (MJ/Animal)	61.6	60.0	62.6
Daily DCP intake (g/Animal)	319.2	388.4	438.2
Dietary ingredient			
DE (MJ/kg DM)	11.6	10.2	10.2
DCP (g/kg DM)	60.5	91.2	100.3

* Molasses.
\# Determined by adiabatic bomb calorimeter.

the proportion of cassava tops silages to 38-42% of the dietary dry matter and improved the crude protein intake by 45-63% compared with the grass diet. Molasses addition also improved silage quality, which would also result in higher feed intake (10%) compared with non additive silage. Similar results have been found by other authors (Pettersson, 1988; Lättemäe, 1997). Tannin content in the silage may be another factor affecting the feed intake. Reed et al. (1990) reported that increased tannin intake was associated with decreased dry matter intake. At high levels, tannin may have detrimental effects on the nutritive value of forages by reducing palatability and digestibility (Kumar and DMello, 1995). In the present study no effect of tannin was detected. However, its concentration of around 4.5 % of DM would normally have little effect according to Ravindran (1990).

The apparent digestibility of OM, CP and NDF of Guinea grass 280 is higher compared with values for other varieties reported by Jarrige (1989). Guinea grass 280, a leafy grass, has a higher leaf :stem ratio compared with other varieties, and this may link with fiber components and structure that affect cell wall digestibility (McDonald et al., 1991). The apparent digestibility of cassava tops silage was calculated by the difference in digestibility of the diets in the supplement trial, and was low in OMD, CPD, NDFD compared with Guinea grass in the control treatment. Most of the contribution to the lower OMD came from the low NDFD and CPD (table 6). The decrease is probably related to both lignin level and proanthocyanidin action. The high lignin content in cassava top silage (table 3) may bind cellulose and cell wall protein in strong chemical bonds, which make these compounds undigestible (McDonald, 1991). Cassava tops silage tannin is also a factor in binding with protein and fiber, making them indigestible (Kumar and DMello, 1995). Reed et al. (1990), studying African browse, reported increased fecal NDF-N values, and ascribed these to proanthocyanidins binding irreversibly with protein and forming indigestible complexes. Our finding is supported by the results of Merkel et al. (1999), who showed the association of the low DM, NDF and CP digestibility of tropical legume supplement diets with the higher lignin and soluble tannin intake. Using cassava tops hay as the sole feed in a digestibility trial, Wanapat et al. (1997) found a value of 71% DMD, which is higher compared to the 50% DMD in the cassava silage in the present experiment. Stage of maturity and treatment method may explain the difference. In one conservation method study Clancy et al. (1977) reported that making alfalfa hay by drying can improve the digestibility by 7% compared with silage making. Drying also reduced the free tannin (Ahn et al., 1997) that decreased the binding of protein and fiber, as explained by Reed et al. (1990) and Kuma and D'Mello (1995). In the present study, the high values of CP and NDF in the faces of those silage supplement treatments may be explained by this reaction. In the present study, by-difference digestibility was used to calculate the supplement feed digestibility and the actual result of cassava silage CPD may not be the same when used as supplement or sole feed in a digestibility trial, as found by Madrid et al. (1997), although their results showed there were no differences in DMD and NDFD values between the two digestibility trial methods.

Silage supplement diets tended to improve the feed intake (table 4) but did not affect the total daily DE intake, due to low digestible energy values per kg DM of cassava tops silage compared with Guinea grass (table 7). The values, calculated by the bomb calorimeter method were nearly the same as for DE of Guinea grass, but somewhat lower in cassava top silage when calculated from OMD using Butterworths (1967) equation. VFA lost in drying silage samples for the bomb calorimeter method may be the explanation for this difference. The increased total DCP intake in the cassava silage supplement treatments was a result of the high proportion of cassava silage in the supplement diets and the increase in feed intake of the supplement treatments, although the digestibilities of the two cassava top silages were low compared with Guinea grass. Supplementing the grass diet with cassava top silage in this experiment improved the DCP intake, but had little effect on DE intake.

CONCLUSIONS

The present data indicate that cassava top silage is a good feed resource for cattle. Cassava top silage can be preserved easily by common ensiling methods with or without additives. Ensiling improved the product by markedly reducing the HCN content of the raw materials. Supplementation of cassava top silage, especially with a molasses additive, to a grass diet increased the crude protein and feed intake. Ensiling cassava tops is a good preservation method when harvest coincides with the wet season. Further studies on preservation methods and chemical treatment to limit the tannin protein complexes and to improve the digestibility are needed.

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