

The effect of molasses on quality, feed intake and digestibility by heifers of silage made from cassava tops

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Abstract

The present study was therefore aimed at determining the influence of molasses in making silage from cassava tops and evaluating the feed intake and digestibility when the silage was fed to growing crossbred Holstein heifers.

Materials and methods

Ensiling cassava tops

Silage making

Four levels of sugarcane molasses (0, 30, 60 and 90 kg per tonne of fresh cassava foliage), and two storage periods (2 and 4 months) were evaluated according to a 4*2 factorial randomized complete block design with 3 replicates. A total of 24 plastic bags with 10 kg each of fresh cassava foliage were prepared. Cassava tops were collected in the field immediately after root harvesting in January 1999. Only the tops (leaves, petioles and 40-60 cm of green stem) were taken. The molasses contained 640 g dry matter and 375 g sugars per kg. The tops were chopped into pieces that were 3 to 4 cm in length. The chopped material was mixed with the molasses and placed in the plastic bags. The contents of the bags were compacted by hand, bound with a string and pressed by placing one sand bag (2 kg) on top of each bag.

Data collection and laboratory analysis

Samples were collected for chemical analysis on two occasions, two and four months after ensiling. The characteristics of the silages; colour, fungal contamination and smell were evaluated. Determinations were made of toluene dry matter (dried and corrected for volatiles according to Lingvall and Ericson 1981), pH (pH-ORION model 420 A), water soluble carbohydrates (WSC), tannins, HCN, N, ash, and EE using the procedures described by AOAC (1984). ADF and ash-free NDF were analyzed according to Van Soest and Robertson (1980). Acetic, butyric and lactic acids were determined by the HPLC technique (Shimadzu, Japan 3081-09202-20ATD-E).

Feed intake and digestibility study

Silage preparation

Approximately 4000 kg of cassava top residues were collected in the field immediately after root harvesting in February, 1999. Sixteen plastic bags (1.0 m diameter), containing about 260 kg of chopped cassava tops each, were used to make the silages. The cassava tops were chopped into pieces 3 to 4 cm in length and placed in plastic bags in layers of 1.0 - 1.4 m deep. Molasses was mixed with the chopped material at the time of filling and the mixed materials were compacted by two people standing in the bags. After filling, the tops of the bags were bound by plastic string and pressed by placing five 8 kg sand bags on top. After 4 months of storage, the silage was used in the intake and digestibility experiment.

Animals and experimental management

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:

- C: control grass diet
- 0MS: Grass with a supplement of silage (ensiled without molasses)
- 6MS: Grass with a supplement of 6% molasses-silage

Each period included 14 days for adaptation, 5 days for measurement of feed intake, 2 more days 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 by each animal in order to determine the ratio of cassava top silage in the experimental diets (planned to be 70: 30 grass: silage on dry matter basis). During the feed intake measurement the grass supply on the treatments 0MS and 6MS was restricted to 70% of the ad libitum intake (on a DM basis) and cassava silage was supplied ad libitum. For the digestibility determinations the total diet was limited to 85% of the mean DM intake measured during the 5 days of intake studies. During the 9 days of the digestibility study the daily amount of feed was maintained constant.

The animals were confined in individual stalls in a covered shed open at the sides. They were kept for one month in this location prior to starting the experiment in order to adapt them to the experimental conditions. They were treated against internal and external parasites. During the experiment the animals were fed 4 times per day: at 8:30, 11:00, 16:00 and 20:00 h. Fresh Guinea grass (*Panicum maximum* 280), cut at six weeks of re-growth was used as the basal feed. Cassava tops silage with or without the molasses additive 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 (containing salt, dicalcium phosphate, MgSO₄, CuSO₄, CoCl₂, K₂SO₄, Casein Iodine, MnSO₄ and Selenium) was fed at 84g/150-200kg 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. Samples of feeds offered and refused were collected every 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, feces from each animal were collected immediately after defecation throughout the day, and placed in weighed plastic basins until 8:30 h the following morning. The 24-hour fecal output

was weighed, mixed and a sub-sample (10% of the daily output) from each individual heifer was stored in a freezer (-20 °C). The seven samples from each animal during the collection week were de-frosted, mixed, sampled and dried in a forced oven at 60°C for 72 hours for laboratory analysis. Samples were prepared using procedures described by Goering and Van Soest (1970). Feed, refusals and feces samples after oven drying were ground using a laboratory hammer mill with 1mm screen. Dry matter, ash, crude protein, ether extract, ADF, ash-free NDF and permanganate lignin were analyzed using the same methods as described in the ensiling study. Gross energy contents of feed and fecal 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), Tukey's test for paired comparisons was used (Minitab 1998).

Results

Cassava tops ensiled with or without molasses additive

Physical quality of silage

Observations at 2 and 4 months after ensiling (Table 1) showed that the silage colour was pale green to brown yellow at 2 months after ensiling and changed to a yellow to brown colour after 4 months of storage. The molasses additive increased the degree of brown colour in the silage. Moulds were not seen 2 months after ensiling, but increased with the amount of molasses additive and the time of storage. The smell was good for all treatments. Based on the colour, smell and mould appearance, the silages were considered to be acceptable without or with the low level of molasses additive for the shorter storage period, and to be acceptable, but with a proportion spoiled after the long-term storage and with the high level of molasses additive.

Table 1. Classification of cassava tops silage with different amounts of molasses additive and 2 or 4 months storage

Storage mae	Molasses level							
	0%		3%		6%		9%	
	2	4	2	4	2	4	2	4
Colour	Gy	Yb	Gy	Yb	By	Yb	By	Yb
Moulds	Abs	Ot1- 2	Abs	Ot1- 2	Abs	Ot3- 4	Abs	Ot3- 4
Acceptable	A	A	A	A	A	A +sp	A	A +sp

mae: Months after ensiling.

Gy: Greenish yellow; Yb: yellowish brown; By: browish yellow; Pg: Pale green;

Abs: absent; Ot+number: only on top with cm in thickness

A: Acceptable; A+sp: Acceptable with spoiled portions;

Chemical composition of cassava top silage

The dry matter of the fresh cassava was 25.8% and only small changes were noted during ensiling on all treatments (Table 2). There were trends towards increased DM content at higher levels of molasses, and to reduced DM content with storage time. The crude protein content of the cassava tops was around 21% of DM, and in the non-additive silages did not change after ensiling. As was to be expected, incorporation of molasses (contains less than 4% crude protein in dry matter) in the silage led to reduced crude protein content, especially at the higher levels of molasses added. Storage time reduced the crude protein of the silage somewhat, but the changes were non-significant. The NDF concentration was decreased 8% after ensiling for the cassava tops silage without added molasses. The NDF content was reduced with storage time.

Table 2a. The effect of molasses and storage period on the quality of cassava top silage (g/kg DM except for DM content which is on fresh basis)

	pH	DM	CP	EE	NDF	ADF	Ash
Fresh tops		258	21.1	10.4	56.1	37.0	6.76
Silage (molasses level)							
0	4.39	267	21.6 ^a	11.8	51.4	37.1	7.21
30	4.21	266	19.8 ^{ab}	12.5	47.4	37.0	6.72
60	4.29	274	19.3 ^b	13.6	45.8	38.4	7.04
90	4.28	277	18.2 ^b	12.6	47.3	37.0	6.71
Probability	0.10	0.41	0.00	0.26	0.09	0.77	0.64
Storage time							
2 months	4.38 ^a	280	19.9	12.5	37.3		6.62
4 months	4.21 ^b	264	19.5	13.8	46.0 ^b	37.4	7.22
Probability	0.01	0.08	0.32	0.66	0.02	0.94	0.10

Table 2b. The effect of molasses and storage period on the quality of cassava top silage (mg/100g DM)

	A. lactic	A. acetic	WSC	Tannin	HCN
Fresh tops			6.34	3.83	97.7
Silage (molasses level)					
0	0.97	0.23	0.65 ^a	2.87	28.1
30	0.95	0.24	1.16 ^b	2.84	27.1
60	0.99	0.23	1.44 ^c	3.07	27.1
90	0.99	0.23	1.35 ^c	2.66	26.5
Probability	0.13	0.36	0.00	0.95	0.77
Storage time					
2 months	0.96	0.23	1.14	2.83	30.9 ^a
4 months	0.99	0.24	1.16	2.89	23.5 ^b
Probability	0.06	0.13	0.10	0.89	0.00

Discussion

Ensiling cassava tops

With DM content between 25 and 35% and pH values below 4.5 the silage quality could be considered to be good (Pettersson 1988). The molasses and storage reduced pH values. Butyric acid is another quality parameter, and silage is considered to be good when the concentration is below 0.1 g/kg fresh material (Lättemäe 1997). No butyric acid

was detected in any of the silage samples. The presence of mould in silage is undesirable because it uses silage nutrients and toxins are sometimes produced. There were increasing problems with moulds and spoiled portions with increasing amount of molasses and longer storage period.

The WSC in herbage is the main substrate for microbial growth. Therefore, concentration of WSC is reduced during fermentation. More variable results were obtained in residual WSC at increased levels of molasses, probably because part of the added sugars was lost in the effluent. It was expected that a higher dose of molasses should result in a higher residual WSC and improve silage quality, as reported by Lättemäe et al (1997), but in our study high levels of molasses resulted in more molasses in the run-off. Haigh and Parker (1985) suggested that a critical WSC concentration in herbage for successful preservation as silage without additives is 30 g/kg DM. In legumes, Zelter (1960) suggested a higher WSC level of 120g/kg DM because of low dry matter content at harvest. In our study the WSC content of cassava tops was in the middle of the range reported by these two authors.

Non-additive silage had nearly the same lactic acid concentration compared to the additive silage treatments, suggesting that WSC was not the sole substrate for lactic acid bacteria. Starch, the main storage carbohydrate in leaf and stem, may be a substrate after the attack of enzymes in the initial ensiling process, although the majority of lactic acid bacteria do not attack starch (McDonald et al 1991). However, the lactic acid concentration, which was in the range of some common tropical herbage silages (Aminah et al 1999), was still low compared to the values for temperate legume silage (Lättemäe et al 1997).

The reduction in HCN content in cassava is due to the action of endogenous linamarase on glucosides following loss of cell integrity or tissue damage. In the ensiling process, chopping and slight wilting during the preparation before sampling, pressing and the initial environment of the aerobic phase resulted in good conditions for reducing the HCN content. When the pH in silage is lowered the enzyme activities are restricted, and the speed of HCN elimination reduced. In this experiment the HCN content of the cassava tops silage was reduced with storage time, but no effect was found of additive level. Similar results were found by Du Thanh Hang (1998) and Bui Nhu Phuc et al (2000) for cassava leaf silage.

The tannin content of the silage materials was in the range of common tropical high-protein leaves (Mahyuddin et al 1988; Ahn et al 1989), and was reduced in the initial period of ensiling. This reduction may have been due to the formation of tannin-protein complexes. Maldonado et al (1995) reported that insoluble tannin and plant leaf protein complexes were established in the pH range 3.5-5.5. In ensiling sorghum with different tannin contents, Rodrigues et al (1998) reported that tannin concentration decreased with increase in the duration of fermentation. No such reduction with the time of storage and level of molasses additive was found in the present study.

Feeding value of cassava top silage

Supplementing cassava top silage to the grass diet tended to increase the feed intake, which could have been a result of a stimulatory effect of silage on intake (Aminah et al 1999), or the effect of the protein in the cassava leaves when added to a low-protein

roughage diet (Merkel et al 1999). In the present study, the supplement increased the crude protein intake by 45 to 63% compared with the grass diet. Molasses addition also improved silage quality, which would also result in a higher feed intake (10%) compared with non additive silage. Similar results have been reported by other authors (Pettersson 1988; Lättemäe 1997).

Using cassava tops hay as the sole feed Wanapat et al (1997) found a DM digestibility of 71%, which is much higher than the value in the present study (50%). Treatment method may explain some of the difference as water soluble components may be lost in the run-off. In one study Clancy et al (1977) reported that making alfalfa hay by drying can improve the digestibility by 7% compared with silage making. In the present study, digestibility of the cassava silage was determined by difference and the actual result for cassava may not be the same when used as a supplement compared with being the sole feed, as found by Madrid et al (1997).

Conclusions

- Cassava tops can be preserved by common ensiling methods with or without molasses.
- Ensiling improves the product by markedly reducing the HCN.

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