Production of Silage Using Sugarcane Tops and Testing Nutritional Quality

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ABSTRACT

Shortage of good quality cattle feed is one of the main problems in the dairy industry in the Dry Zone of Sri Lanka and it is further worsened during the dry season. Hence, the objectives of this experiment were to: (a) produce quality improved cattle feed using sugarcane tops as an alternative to the fodder of Guinea "A" (Panicum maximum) and (b) evaluate ensiling characteristics and nutritive value of preserved sugarcane tops based cattle feed. Sugarcane tops and Guinea grass were preserved by mixing rice bran, coconut poonac, molasses, urea, and minerals, and silage were prepared. Physical characteristics and nutritional quality of silage were analysed and compared with Guinea grass. Sugarcane tops silage had an olive green colour, fruity aroma, moist texture, and good fermentation characteristics with a low pH value (4.5 - 6.2). Adding urea or urea with rice bran increased crude protein in sugarcane tops silage. The lactic acid content ranged from 14.8% to 15.4% in sugarcane tops silage. The silage samples made with only sugarcane tops recorded significantly high soluble carbohydrate content than Guinea grass silage. Ensiling sugarcane tops with molasses, rice bran, urea, and coconut poonac could produce nutritive silage for feeding cattle in sugarcane growing areas of Sri Lanka.

Key words: Cattle feed, Guinea grass, Silage, Sugarcane tops

INTRODUCTION

Lack of good quality feed year round is a major constraint to profitable smallholder dairy production in Sri Lanka (Ibrahim *et al.*, 1999*)*. Most of cattle are reared in Dry Zone traditional Village System where indigenous cattle are maintained on common grazing lands with minimal inputs (Abeygunawardena *et al*., 1997). As low returns from the low yielding indigenous cattle, farmers in Dry Zone of Sri Lanka reluctant to feed cattle on concentrates. Direct feeding of fresh fodder and Guinea grass is limited to the shorter wet season in Dry Zone. There is a little scope for feeding cattle using hay in the dry season, but it is not popular due to its low nutrient content and less palatability (Preston, 1977). Therefore, the introduction of good quality animal feed produced from locally available fodder would enhance the productivity and profitability of the dairy industry in the Dry Zone of Sri Lanka. The preservation of fodder by fermenting with molasses (silage) increases the nutrient contents and the palatability of the fodder (Stewart, 2011). The unavailability of enough fodder materials, particularly in the dry season in the Dry Zone of Sri Lanka, restricts the production of silage. Sugarcane cultivation which is the main livelihood of rural communities in Monaragala and Ampara districts, is harvested mainly during the dry season (Mettananda, 1990). Sugarcane plantation of 10,000 ha produces about 50,000 - 75,000 tons per annum (Anonymous 2013). Kirk and Crown (1942) reported that (sugarcane tops) SCT could be fed to cattle as fresh and ensiled materials. In addition, the integration of cattle with sugarcane cultivation improves productivity as a more sustainable system of farming (Smith *et al*., 1997). However, farmers in the Dry Zone of Sri Lanka do not pay enough attention to the integration of sugarcane cultivation and cattle management. They do not get a substantial benefit from using SCT as a cattle food, neither fresh nor ensiled forms though it has a nutritional value than rice and wheat straw (Preston, 1977). Ensiling and preservation further improve the nutritive value and the palatability of the SCT (Bui Van Chinh *et al*., 2000). Therefore, a study was conducted to produce silage using SCT and testing the nutritive values of prepared SCT silage.

METHODOLOGY

Production of SCT silage was done at the research farm, Sugarcane Research Institute (SRI), Udawalawe. The laboratory analysis was conducted at the Veterinary Research Institute (VRI), Gannoruwa, Peradeniya, and the Department of Animal Science, Faculty of Agriculture, University of Peradeniya, to investigate the ensiling characteristics of green cane tops. The sugarcane tops of 12 months age crop of the variety Co 775 cultivated under rain-fed condition at the research farm of SRI was used for the study. Guinea grass (*Panicum maximum*) collected from the research farm was used as the control treatment. The experimental design was Completely Randomized Design (CRD) with eight treatments (Table 1) and three replicates. Two types of green fodders (SCTs and Guinea grass) and four levels of additives mixed into SCT and Guinea grass were tested.

Table 01: Treatments used for the study

Treatment	Percentage of ingredients used				
	SCT	Guinea grass	Urea	Rice bran	Molasses
T1	100	-	-	-	-
T2	99	-	1	-	-
T3	96.5	-	1	2.5	-
T4	98	-	-	-	2
T5	-	100	-	-	-
T6	-	99	1	-	-
T7	-	96.5	1	2.5	-
T8	-	98	-	-	2

Note SCT: sugarcane tops

Silage preparation

Chopped sugarcane tops and Guinea grass samples were ensiled with additives, as mentioned in Table 01. Then, the mixtures were filled into transparent polyethylene bags (lab silos), pressed to remove trapped air, sealed, and stored for up to 35 days for ensiling. The silos were put into black colour polyethylene bags to prevent the exposition of light and stored at room temperature.

Laboratory analysis of silage samples

After 35 days, silos were opened, and visual observation was made for colour, odour, texture, and presence or absence of mould. Water extracts of the ensiled mixtures were used to measure the pH value of each treatment. For this, 25 g of sample mixing with 225 ml of distilled water was blended using a blender, and the mixture was filtered using filter paper. Then, the pH of the filtrate was measured immediately using a pH meter. Dry matter (DM) contents of the silage samples were determined by drying in an oven at 60 °C to a constant weight. Water-soluble carbohydrate (SC) content was determined using the Anthrone test (AFIA, 2011). Lactic acid (LA) and ammonia nitrogen (AN) were analysed using a spectrophotometer according to the Barnett (1951) and Parsons *et al.* (1984) methods, respectively.

RESULTS AND DISCUSSION

Physical characteristics of silage

Table 02 presents the colour of silage samples after four weeks from the date of preparation. The T1 (SCT only) had an olive green colour, and T5 (Guinea grass only) had a green colour. The silage prepared by adding only urea (T2) was darker than the silage prepared with urea and rice bran (T3). The T1 and the T4 (SCT+ Molasses) had a pleasant fruity odour compared to T2 and T3. Guinea grass ensiled with urea (T6) had a slightly bad smell, but it was not spoilt. This conformed to the results reported by Tuah *et al.,* (1979). The uniformity and texture of all the samples were at a satisfactory level, and they were free from moulds. Overall acceptability of all the silage samples prepared with SCT was better than that of Guinea grass silage.

Nutritional values of silage

Table 02 describes the nutritional value of SCT silage and guinea grass silage samples compared to different treatments with DM, CP, CF, pH, LA, AN, and SC content.

Dry matter content

The DM content of silage samples ranged from 33.88% to 35.84% (Table 02). The DM content of SCT silage was not significantly changed due to the addition of urea, rice bran, and molasses. However, the addition of 2% molasses to Guinea grass significantly increased the DM content ($P<0.05$). According to McDonald (1981), the addition of molasses caused to addition of more soluble carbohydrates for lactic acid bacteria (LAB) and prevented the breakdown of sugars and organic acids in the grass and may have reduced the DM losses. Also, the addition of rice bran to SCT did not increase the DM content. This may be due to the loss of DM during the fermentation process.

Crude protein

The addition of urea at the time of ensiling significantly ($P<0.05$) increased the crude protein content of the silage. However, the crude protein content of the silage did not change on the type of forage (Table 02). For SCT ensiled with urea and rice bran (T2, and T3) had higher crude protein content than T1 (Only SCT). Also, Guinea grass ensiled with urea and rice bran (T6 and T7) had higher crude protein content than T5 (Only Guinea grass). According to Alcantara *et al.* (1989), the addition of urea increased the pH of ensiled forages, and it had shown positive effects in the preservation of nutrients in SCT silage. Several types of research have shown that SCT ensiled with urea remarkably increased its crude protein content (Noroozy and Alemzadeh, 2006a; 2006b; Alemayehu *et al*., 2014). Rangnekar (1988) reported that SCT silage ensiled with 0.5% urea contained 8.1% crude protein. In the present study, crude protein content in silage prepared with 1% urea was 12.72%. This may be due to the differences in urea percentage used, sugarcane crop maturity, variety, and climatic condition of the sugarcane growing area. However, the addition of molasses when preparing SCT silage increases the crude protein content. According to McDonald (1981), the addition of molasses increases the soluble carbohydrates, and it can act as a substrate for LAB to produce lactic acid, which will decrease the pH. Therefore, molasses reduced the breakdown of protein and nitrogenous compounds in forage samples, and this resulted in the preservation of nutrients during ensiling (Carpintero *et al*., 1969).

pH value of silage

The pH value of silage prepared from only SCT (T1) was significantly lower ($P<0.05$) compared to Guinea grass silage (T5) (Table 02). Ensiling both sugarcane tops and Guinea grass with urea or urea with rice bran significantly ($P<0.05$) increased the pH compared to other treatments (Table 02). According to the literature, SCT ensiled for 45 days with 2% molasses had recorded a pH value of 4.8 (Bui Van Chinh *et al*., 2000). In this study, the lowest pH was recorded when SCT are ensiled with 2% molasses (T4). Because SCT contains more soluble sugars than the other type of grasses, and fermentation process may take place more efficiently. Preston *et.al*, (1976) reported that most forages present complications in ensuring adequate fermentation when they are ensiled due to low soluble sugar content. Therefore, molasses has to be added.

Water soluble carbohydrate content

Table 02 presents the effect of different additives on the water-soluble carbohydrate content of silages. The water-soluble carbohydrate content of the silage of both SCT and Guinea grass increased with the addition of molasses (Table 02). However, the silage made from only SCT (T1) had a significantly high ($P < 0.05$) water-soluble carbohydrate content than the silage made with only Guinea grass (T5) (Table 02). This may be due to the high concentration of total sugars in SCT (Singh and Solomon, 1995). Water-soluble carbohydrates are important for the LAB as a substrate during the ensiling process (McDonald, 1981). According to Pate (1981), sugarcane leaves are also rich in soluble carbohydrates. Therefore, SCT are good forage for the ensiling process. In general, tropical forages are low in water-soluble carbohydrates (Ibrahim *et al*., 1989). Moreover, Catchpole and Hanzel (1971) reported that tropical grasses contain relatively high concentrations of cell wall components and a low level of fermentable carbohydrates. This might be the reason for differences in the chemical properties of silage made out of Guinea grass than SCT.

Lactic acid concentration

In the present study, the lactic acid concentration of SCT and Guinea grass silage ranged from 14.71% to 15.58% (Table 02). Significantly high ($P<0.05$) lactic acid concentrations were recorded in the silage samples prepared with SCT mixed with rice bran and molasses compared to the same treatment prepared with Guinea grass. Lactic acid concentrations in silage samples prepared using only SCT or Guinea grass were significantly high ($P<0.05$) when it was prepared by adding only molasses (Table 02). However, Suzuki (2014) reported that lactic acid content was 1.08% for SCT silage made from 6 months of age SCT without additives. Sudarshan (2000) reported that lactic acid content was 5.24% for ensiled Guinea grass with 5% molasses. The lactic acid concentrations of the silage produced in the present study were higher compared to the above findings.

Table 02: Fermentation qualities and color of sugarcane tops and Guinea grass silage

T	DM (%)	CP (%)	pH	LA (%)	AN (%)	SC (%)	C
T1	34.82 ^{ab}	4.40 ^{e}	4.66 ^{d}	14.77 ^{cd}	1.35 ^{e}	7.34 ^{c}	Olive green
T2	33.88 ^{b}	12.72 ^{b}	6.20 ^{b}	14.76 ^{cd}	9.97 ^{b}	5.60^{d}	Darker than T1
T3	34.06 ^{b}	16.02 ^{a}	6.16 ^{b}	15.35 ^{ab}	10.14 ^{ab}	4.69 ^{e}	Darker than T4
T4	34.52 ^{b}	5.38 ^{d}	4.59 ^{d}	15.22 ^{abc}	1.67 ^{e}	11.59 ^{a}	Brown green
T5	34.26 ^{b}	8.03 ^{c}	5.73 ^{bc}	14.99 ^{bcd}	4.98 ^{c}	6.31 ^{d}	Green
T6	34.21 ^{b}	13.29 ^{b}	8.64 ^{a}	14.71 ^{d}	10.43 ^{a}	7.86 ^{c}	Darker than T5
T7	35.13 ^{ab}	15.59^{a}	9.01 ^{a}	14.76 ^{cd}	9.82 ^{b}	7.27 ^{c}	Darker than T8
T8	35.84 ^{a}	8.82 ^{c}	5.24 ^{c}	15.58 ^{a}	3.11 ^{d}	8.90^{b}	Brown green
CV %	2.01	5.19	4.71	1.68	3.23	6.56	

Note T: Treatment, DM: Dry Matter, CP: Crude Protein, LA: Lactic Acid, AN: Ammonium Nitrogen, SC: Soluble Carbohydrates, C: Colour

*Means within a column with the same letters are not significantly different ($P>0.05$)

Ammonia nitrogen level

Ammonia nitrogen levels of silage made with urea or urea with rice bran were significantly higher ($P<0.05$) than those silage prepared with or without molasses, regardless of the type of forage (Table 02). Ammonia nitrogen is a good indicator of the quality of silage, and it is closely related to the silage pH (Carpintero *et al*,, 1969). According to Chaudhary *et al*,. (2012), tropical forage silage of good quality had a pH of less than 5.0 and less than 15% of ammonia nitrogen of the total dry matter. Ammonia nitrogen levels in all silages prepared in the present study were in agreement with the results of Chaudhary *et al*, (2012). In general, 5% ammonia nitrogen content is excellent, whereas 5 - 10 % is good in quality. Therefore, the silage prepared with only SCT or only guinea grass and the silage prepared with SCT + molasses in the present study were excellent in quality (Table 02).

CONCLUSION

Fermentation characteristics of silage depend on the type of forage and the additives mixed during silage preparation. The addition of molasses has a positive effect, whereas the inclusion of urea leads to develop a negative effect on the fermentation characteristics of silage. According to this study, sugarcane tops can improve the fermentation characteristics in the silage-making process compared to the guinea grass silage, and the addition of molasses can enhance the fermentation characteristics of silage. Therefore, sugarcane tops can be recommended as an optional feed material for making good-quality silage under local conditions.

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