CROP RESIDUES WITH FODDER TREES TO PRODUCE GOOD QUALITY SILAGE

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ABSTRACT: *Silage is the compressed and fermented green forage crops under anaerobic condition, usually in a silo. Crop residues can be used as feed for cattle during the dry season by ensiling them as silage. The aim of this study is to identify the combination of various crop residues to produce good quality silage. Samples of silage produced from individual crop residues and different combinations of crop residues were collected from farmers who produced silage in the Northern Province of Sri Lanka from January to March 2017. Twenty samples of silage from ten different individual and combinations of crop residues with fodder trees in two replicates were analyzed for sensory evaluation, pH, ammonium-N, lactic acid and total acidity of silage in the field itself using silage quality detection field test kit and the crude protein content was measured using standard procedure in the laboratory. Based on the results, though the silage made from the combination of Sorghum bicolor (sugargraze) + Oryza sativa (paddy) straw + Gliricidia sepium (gliricidia) leaves showed the highest percentage of crude protein of 21%, the fermentation quality was reported to be low. When considering fermentation quality, the silage made from Pennisetum purpureum (hybrid napier grass (co-3)), Zea mays (maize), Sorghum bicolor (sugargraze), and from the combinations of Sorghum bicolor (sugargraze)+ Borassus flabellifer (palmyra) leaves, Sorghum bicolor (sugargraze) + Oriza sativa (paddy) straw + Gliricidia sepium (gliricidia) leaves, Sorghum bicolor (sugargraze) + Thespesia populnea leaves + Borassus flabellifer (palmyra) leaves+ Gliricidia sepium (gliricidia) leaves and Zea mays (maize) + Gliricidia sepium (gliricidia) leaves showed the excellent quality while the silage made from Oriza sativa (paddy) straw+ urea with poor quality. The highest lactic acid concentration was recorded in the silage made from the combinations of Sorghum bicolor (sugargraze) + Borassus flabellifer (palmyra) leaves and Sorghum bicolor (sugargraze) + Thespesia populnea leaves+ Borassus flabellifer (palmyra) leaves + Gliricidia sepium (gliricidia) leaves. The results revealed that the silage produced with the combinations of crop residues consisting of Borassus flabellifer (palmyra) leaves was with excellent fermentation quality. Further investigation is recommended to find out the quantified proportion of Barassus flabellifer (palmyra) leaves with other crop residues and fodder trees that could yield the best quality of silage.*

Key words: Crop residues, Fodder trees, Lactic acid, Silage,

1. INTRODUCTION

Crop residues are fed to domestic animals in various forms ranging from traditional stubble grazing of harvested grain fields with chopped residues mixtures made with more palatable and nutritious by adding nitrogen rich compounds. However, a large portion of the crop residues left in the fields as unutilized.

Crop residues can be used as a feed during the dry season by ensiling them and the silage production is less weather dependent and well adapted to wide range of crops. Silage is one of the feed supplements for ruminants. Ensiling is regarded as good forage preservation method widely used for many years, since fermentation by some microbes is an effective way to improve the digestibility, palatability and nutritive value of straw (Santoso *et al*, 2012). Babayemi (2009) described that silage production in the tropics was a

sustainable means of supplementary feed for ruminants in the dry season. Silage is a feed that has been preserved by acidification. The objective of this study was to identify the nutritional status of silage produced using different combinations of crop residues and its quality.

2. MATERIALS AND METHODS

2.1 Sampling

Samples of silage produced using different types of crop residues and fodder trees by the farmers in Northern province as given in Table 1 were collected for this study. The parameters such as pH, ammonium nitrogen, total acidity and lactic acid concentration were analyzed, and the sensory evaluation was done to study the characteristics of colour, smell, texture and the presence of mold

Table 1. Combinations of crop residues to produce silage

Treatment no	Combination of crop residues
01	*Pennisetum purpureum* (Hybrid Napier grass (CO-3)) only
02	*Zea mays* (Maize) only
03	*Sorghum bicolor* (Sugargraze) only
04	*Sorghum bicolor* (Sugargraze)+ *Borassus flabellifer* (Palmyra leaves)
05	*Sorghum bicolor* (Sugargraze) + *Oryza sativa* (Paddy) straw + *Gliricidia sepium* (Gliricidia) leaves
06	*Oryza sativa* (Paddy) straw + Urea
07	*Sorghum bicolor* (Sugargraze) + *Thespesia populnea* leaves + *Borassus flabellifer* (Palmyra) leaves + *Gliricidia sepium* (Gliricidia) leaves
08	*Oryza sativa* (Paddy) straw + *Pennisetum purpureum* (Hybrid Napier grass (CO – 3)) + *Gliricidia sepium* (Gliricidia) leaves + *Musa sp*.(Banana) leaves
09	*Oryza sativa* (Paddy) straw + *Musa sp*.(Banana) leaves
10	*Zea mays* (Maize) + *Gliricidia sepium* (Gliricidia) leaves

Silage quality detection field test kit was used to test pH, ammonium nitrogen, lactic acid and total acidity of silage in the field itself. Filtered juice made from silage and the distilled water were used for each indicator separately and the colour changes for indicators were measured for each parameter.

Quality of silage was determined by ranking them with assigned points for each level of parameters and points were given in Table 2.

Table 2: Assigned points for ranking of silage quality with different parameters

pH		
Parameter	Quality	Point
Low	3.4 - 3.7	05
Moderate	3.8 - 4.2	15
High	4.3- 4.6	05
Very high	> 4.6	00
Lactic acid		
High	High quality	12
Moderate	Moderate quality	08
Low	Low quality	05
Ammonium – N		
Very low	High quality	10
Low	Good quality	08
Moderate	Medium quality	05
High	Low quality	02
Very high	very low quality	00
Acidity		
Very high	very good quality	10
High	good quality	08
Moderate	good quality	05
Low	low quality	02
Very low	Very low quality	00

Table 3. Quality of silage based on assigned points

Range of point obtained	Quality of silage
00-14	Low quality
15-29	Moderate quality
30-45	Excellent quality

Samples were oven dried for 48 hours at 55^0C until they get constant weight and dry matter content of samples were measured. Then the samples were

ground, and fine sample were obtained and the total nitrogen content in each sample was measured by using Kjeldhal method. The total nitrogen percentage was multiplied by the factor 6.25 and obtained the level of crude protein.

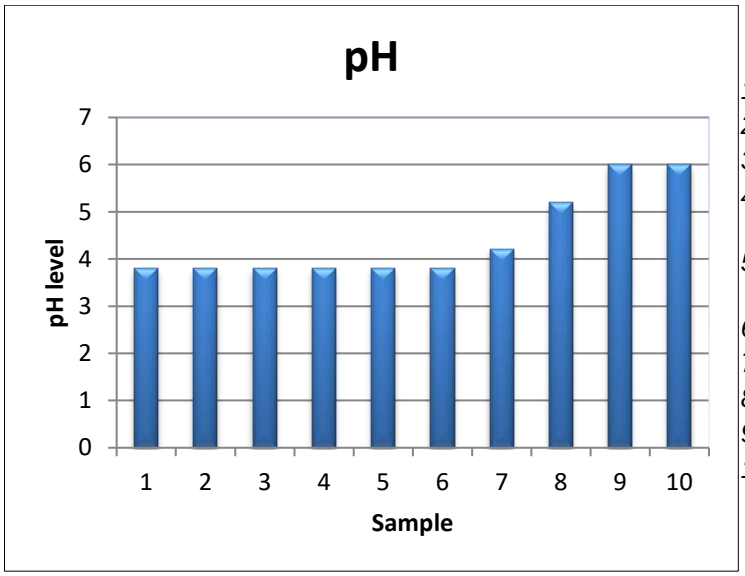
3. RESULTS AND DISCUSSION

The sensory evaluation was done for the sample silage produced using different combination of crop residues and the fodder trees for texture, colour and odour and presented in Table 4. The absence of molds in the silage indicated that proper fermentation occurred in the silage.

Table 4. The sensory analysis of texture, colour and odour of silage made from individual crop residue and the combinations of crop residues and fodder trees

	Combinations of crop residues and fodder trees used to make silage	Texture	Colour	Odour
01	*Pennisetum purpureum* (Hybrid napier (CO-3)) only	Leafy soft	Light green	Sweet aroma
02	*Zea mays* (Maize) only	Leafy soft	Light green	Sweet aroma
03	*Sorghum bicolor* (Sugargraze) only	Leafy soft, seed head present	Light green	Sweet aroma
04	*Sorghum bicolor* (Sugargraze) + *Borassus flabellifer* (Palmyra) leaves	Leafy soft	Olive green	Sweet aroma
05	*Sorghum bicolor* (Sugargraze) + *Oryza sativa* (Paddy) straw + *Gliricidia sepium* (Gliricidia) leaves	Leafy soft fibrous	Light brown	Sweet aroma
06	*Oryza sativa* (Paddy) straw + Urea	Soft fibrous	Straw yellow	Fruity smell with lightly ammonium smell
07	*Sorghum bicolor* (Sugargraze) + *Thespesia populnea* leaves + *Borassus flabellifer* (Palmyra) leaves + *Gliricidia sepium* (Gliricidia) leaves	Leafy soft	Light green	Fruity smell
08	*Oryza sativa* (Paddy) straw + *Pennisetum purpureum* (Hybrid napier (CO-3)) + *Gliricidia sepium* (Gliricidia) leaves+ *Musa sp.* (Banana) leaves	Leafy soft fibrous	Straw yellow	Fruity smell

09	*Oryza sativa* (Paddy) straw + *Musa sp. (*Banana) leaves	Leafy soft fibrous	Brown	Sweet aroma
10	*Zea mays* (Maize) + *Gliricidia sepium* (Gliricidia) leaves	Leafy soft	Light yellow	Sweet aroma



Samples of silage – crop residues/ Fodder trees

1. *Maize only*
2. *Sugargraze only*
3. *Sugargraze + Palmyra leaves*
4. *Sugargraze + Paddy straw + Gliricidia leaves*
5. *Sugargraze* + T.populnea *leaves + Palmyra leaves+ Gliricidia leaves*
6. *Maize + Gliricidia leaves*
7. *CO-3*
8. *Paddy straw +Banana leaves*
9. *Paddy straw + Urea*
10. *Paddy straw + CO-3 + Gliricidia leaves + Banana leaves*

Figure. 1. pH of silage

Silage made from *Oriza sativa* (paddy) straw+ *Musa sp*. (banana) leaves, *Oriza sativa* (paddy) straw + urea and *Oriza sativa* (paddy) straw + *Pennisetum purpureum* (hybrid napier CO-3) + *Gliricidia sepium* (gliciridia) leaves + *Musa sp.* (banana) leaves had pH 5.2, 6.0, 6.0 respectively whereas the other silage samples made by using the combinations of other crop residues and fodder trees showed the pH levels of 3.8 and 4.2. Lactic acid bacteria in the silage decreased the pH of the silage (Ridwan *et al*, 2015) and improved the quality. Reduced pH and increased lactic acid content inhibit the growth of undesirable fungi, Coliform bacteria, and Clostridia (Tohno *et al*, 2012).

No	Treatment	pH	Lactic acid	Ammonia –N	Acidity	Total	Grade
01	CO-3 silage	15	08	02	05	30	Excellent quality
02	Maize silage	15	08	05	05	33	Excellent quality
03	Sugar graze silage	15	08	08	05	36	Excellent quality
04	Sugar graze + Palmyra leaves silage	15	12	05	05	37	Excellent quality
05	Sugar graze + Paddy straw + Gliricidia silage	15	08	05	05	33	Excellent quality
06	Paddy straw+ Urea silage	00	05	02	00	07	Low quality
07	Sugar graze + *T.populenea* leaves + Palmyra leaves+ Gliricidia leave silage	15	12	05	05	37	Excellent quality
08	Paddy straw + CO - 3 + Gliricidia + Banana leaves silage	00	08	05	02	15	Medium quality
09	Paddy straw +Banana leaves silage	15	05	08	05	18	Medium quality
10	Maize + Gliricidia leaves silage	15	08	05	05	33	Excellent quality

Table 5. Fermentation quality of silage

Table: 6.. Fermentation quality of silage

No	Treatment	pH	Lactic acid	Ammonia -N	Acidity
01	*Pennisetum purpureum* (Hybrid napier (CO-3)) only	4.2	Moderate - Medium quality	High - Low quality	Moderate - Good
02	*Zea mays* (Maize) only	3.8	Moderate - Medium quality	Moderate - Medium quality	Moderate - Good
03	*Sorghum bicolor* (Sugargraze) only	3.8	Moderate - Medium quality	Low - Good quality	Moderate - Good
04	*Sorghum bicolor* (Sugargraze) *Borassus flabellifer* + (Palmyra)leaves	3.8	High - High quality	Moderate - Medium quality	Moderate - Good
05	*Sorghum bicolor* (Sugargraze) + *Oriza sativa* (Paddy) straw + *Gliriidia sepium* (Gliciridia) leaves	3.8	Moderate - Medium quality	Moderate - Medium quality	Moderate - Good quality
06	*Oriza sativa* (Paddy) straw+ Urea	6.0	Low - Low quality	High - Low	Very low -
07	*Sorghum bicolor* (Sugargraze)+ *T.populnea* leaves + *Borassus flabellifer* (Palmyra) leaves+ *Gliricidia sepium* leaves	3.8	High - High quality	Moderate - Medium quality	Moderate - Good quality
08	*Oriza sativa* (Paddy) straw + *Pennisetum purpureum* (Hybrid napier (CO-3)) + *Gliricidia sepium* (Gliricidia)+ *Musa sp*. (Banana) leaves	6.0	Moderate - Medium quality	Moderate - Medium quality	Low - Low quality
09	*Oriza sativa* (Paddy) straw + *Musa sp*.(Banana) leaves	5.2	Low - Low quality	Low - Good quality	Moderate - Good quality
10	*Zea mays* (Maize)+ *Gliricidia sepium* (Gliricidia) leaves	3.8	Moderate - Medium quality	Moderate - Medium quality	Moderate - Good quality

When considering the fermentation quality, the silage made from individual crop residues of *Pennisetum purpureum* (hybrid napier co-3) only, *Zea mays* (maize) only, *Sorghum bicolor* (sugargraze) only and the combinations of *Sorghum bicolor* (sugargraze) + *Borassus flabellifer* (palmyra) leaves, *Sorghum bicolor* (sugargraze) + *Oriza sativa* (paddy) straw + Gliricidia sepium (gliricidia) leaves, *Sorghum bicolor* (sugargraze) + *T.populnea* leaves + *Borassus flabellifer* (palmyra) leaves+ *Gliricidia sepium* (gliricidia) leaves and *Zea mays* (maize) + Gliricidia sepium (gliricidia) leaves showed the excellent quality and silage made from the combination of *Oriza sativa* (paddy) straw + *Pennisetum purpureum* (hybrid napier co-3) + *Gliricidia sepium* (gliricidia) + *Musa sp*. (banana) leaves and *Oriza sativa* (paddy) straw + (banana) leaves showed the medium quality (Table 5). Further the results also revealed that the silage made from *Oriza sativa* (paddy) straw treated with urea was with the lowest quality (Table 5).

Lactic acid concentration is an important parameter that determines the quality of silage. Lactic acid bacteria converted the free sugars into lactic acid and produced high quality feed and it ensured the reduction in the pH to prevent growth of undesirable microorganisms such as clostridia. (Danner *et al*, 2003). The silage made from the combinations of *Sorghum bicolor* (sugargraze) + *Borassus flabellifer* (palmyra) leaves and *Sorghum bicolor* (sugargraze) + *Thespesia populnea* leaves + *Borassus flabellifer* (palmyra) leaves+ *Gliricidia sepium* (gliricidia) leaves showed the highest lactic acid concentration (Table. 5). Silage with high lactic acid content and low pH improved the performance of the dairy cattle by the probiotic effect of lactic acid bacteria (Ando *et al,* 2006)

Silage made from the combination of *Sorghum bicolor* (sugargraze) + *Oriza sativa* (paddy) straw + *Gliricidia sepium* (gliricidia) leaves showed the highest crude protein level of 21% (Table 6) whereas it was 18.6% in the silage made from the combination of *Oriza sativa* (paddy) straw + urea but it showed the lowest quality when considering fermentation characteristics. Increased crude protein percentage in silage made from *Oriza sativa* (paddy) straw + urea, might be due to impregnation of nitrogen on the particles or pieces of paddy straw.

Table 6: Percentage of Crude protein in the silage

	Silage made from the individual/ combinations of crop residues	Mean CP%	SD
01	*Pennisetum purpureum* (hybrid napier (CO-3))	10.1	±1.283
02	*Zea mays* (Maize)	9.0	±2.582
03	*Sorghum bicolor* (Sugargraze)	13.2	±1.283
04	*Sorghum bicolor* (Sugargraze) + *Borassus flabellifer* (Palmyra) leaves	13.3	±1.192
05	*Sorghum bicolor* (Sugargraze) + *Oriza sativa* (Paddy) straw + *Gliricidia sepium* (Gliricidia) leaves	21	±0.816
06	*Oriza sativa* (Paddy) straw + Urea	18.6	±0.490

07	*Sorghum bicolor* (Sugargraze)+ *Thespesia populnea* leaves + *Borassus flabellifer* (Palmyra) leaves + *Gliricidia sepium* (Gliricidia) leaves	8.2	±0.163
08	*Oriza sativa* (Paddy) straw + *Musa sp*. (Banana) leaves	7.8	±0.566
09	*Oriza sativa* (Paddy) straw+ *Pennisetum purpureum* (hybrid napier CO-3)) + *Gliricidia sepium* (Gliricidia) leaves + *Musa sp*.(Banana) leaves	8.2	±1.021
10	*Zea mays* (Maize) + *Gliricidia sepium* (Gliricidia) leaves	11.6	±1.791

5.CONCLUSION AND RECOMMENDATION

Based on the analysis of the samples of silage made from the combination of *Sorghum bicolor* (sugargraze) + *Oriza sativa* (paddy) straw + *Gliricidia sepium* (gliricidia) leaves showed the highest quality when considering both the fermentation characteristics and the crude protein percentage. However, the combination of *Borassus flabellifer* (palmyra) leaves increased the lactic acid concentration of the silage. Out of all the silage made from ten different crop residues individually and the combinations, the silage made from the combinations of crop residues consisting *Borassus flabellifer* (palmyra) leaves showed a high lactic acid content with excellent quality. Further investigation is recommended to find out the quantified proportion of *Borassus flabellifer* (palmyra) leaves with other crop residues and fodder trees that could yield the best quality of silage.

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