ENSILING CHARACTERISTICS AND NUTRITIVE VALUE OF GUINEA GRASS (*Panicum maximum*, Jacq.) AS AFFECTED BY GROWTH STAGE

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Summary

An experiment was conducted to study the effect of frequency of defoliation on the ensiling characteristics and nutritive value of Guineaecotype 'A' (*Panicum maximum* Jacq) grass. Guinea grass harvested at 2, 3, 4, 5, 6, 7, 8, 9, 10 and 12-week cutting intervals was chopped (2 cm) and ensiled alone or with the addition of coconut (*Cocos nucifera* L.) meal (w/w-fresh weight basis), for periods of 6, 7 or 8 weeks in 2-litre laboratory silos. Dry matter, water soluble carbohydrates, lactic acid, pH, ash, nitrogen and digestibility *in vitro* were measured in representative samples of preensiled and ensiled material.

Dry matter content of silages prepared from herbage harvested at 2 and 3 weeks intervals was lower ($P < 0.05$) compared to longer defoliation intervals. The pH of silage prepared from herbage over 8 weeks old were higher ($P < 0.05$) than those harvested below 8 weeks. The water soluble carbohydrate content of silage prepared from 3-weekly defoliated herbage was higher ($P < 0.05$) than those prepared from longer periods. Lengthened growth period decreased ($P < 0.001$) the crude protein content of the ensiled material, whereas the addition of coconut meal resulted in marginal increases. *In vitro* organic matter digestibility of the silages decreased ($P < 0.05$) with the increase in forage maturity.

(Key Words: Ensiling, Nutritive Value, Guinea Grass, Growth Stage)

Introduction

Considerable amount of research has been done to study the effect of frequency of defoliation on the yield and nutritive value of Guinea grass (*Panicum maximum* Jacq.). In general, it is accepted that the dry matter yields increase (Panditharatne, et al., 1978; Pathirana et al., 1980; Peiris, 1985) while the crude protein and digestibility decrease with longer interval between defoliations. Generally, tropical forages are low in water soluble carbohydrates which are important for the ensiling process. Information regarding the effect of frequency of defoliation on water soluble carbohydrate contents and their subsequent effect on ensiling characteristics is lacking.

The objective of the study reported here was to investigate the effect of frequency of defoliation on the ensiling characteristics and nutritive value of Guinea grass.

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Materials and Methods

Preparation of silage:

The materials used in this study were obtained from an ongoing field experiment at the Veterinary Research Institute, Peradeniya (wet zone), Sri Lanka. The above experiment (randomised block with 4 replicates) was designed to study the effect of frequency of defoliation (2 to 12 week cycle) on the yield and nutritive value of unfertilized Guinea grass.

Sampling of herbage was done on clear, sunny morning (07:00 H).Samples harvested at 2, 3, 4, 5, 6, 7, 8, 9, 10 and 12 week cutting intervals were used to prepare silage. At harvest, the herbage was chopped (2 cm) and ensiled alone or with the addition of 5 % coconut (*Cocos nucifera* L.) meal (fresh weight basis) for periods of 6, 7 or 8 weeks. The chopped material was firmly packed into 2 litre cardboard cylinders double lined with polyethylene bags and the open end was folded and sealed using rubber bands. Sample size of 750 g was used and each treatment was replicated 4 times. As such, at each defoliation 24 silos (12 without coconut meal and 12 with) were prepared, and at each duration of ensiling (6, 7 or 8 weeks)

8 silos were opened. Until such time the silos were opened, they were stored in a temperature controlled room at 24 °C.

Laboratory analysis:

The dry matter content of the fresh herbage (pre-ensiled) was determined by drying samples at 70 °C for 30 hours in a force draft unitherm oven. Water extracts of the pre-ensiled and ensiled mixtures were prepared by homogenizing 25 g with 225 ml of distilled water in a Waring blender for 2 minutes. The homogenate was filtered through 4 layers of cheese cloth and the pH of the filterate was immediately measured. The water extracts of the silage prepared from the 3, 4, 6, 9 and 12 weeks defoliated herbage were analysed for lactic acid (Pennington and Sutherland, 1956) and water soluble carbohydrates (Johnson et al., 1966).

The dry matter content of the ensiled materials was determined by drying 200 g in a force draft oven at 60 °C for 30 hours. These dried samples were ground to pass through a 1 mm sieve and analysed for total ash (AOAC, 1980) and *in vitro* organic matter digestibility using a commercial cellulase enzyme preparation (Onosuka 3 S) and the method of McLeod and Minson (1978). Kjeldhal nitrogen (AOAC, 1980) was determined on silage samples prepared from 3, 4, 6, 9 and 12 week defoliation treatments. The coconut meal used in this study was also analysed for crude protein and *in vitro* organic matter digestibility using the above mentioned methods.

Statistical analyses:

Statistical analyses were performed using the analyses of variance procedure (Steel and Torrie, 1960) and rectilinear regression (Snedcor and Cochran, 1979). Comparisons were made to test linear and quadratic effects due to: stage of growth, control versus coconut meal: duration of ensiling.

Results

The dry matter content of the pre-ensiled material ranged between 22.9 and 30.1 %. The herbage harvested at 2 and 3 week intervals had lower values (around 23 %), whereas values around 28 – 30 % were recorded for longer defoliation intervals. Similar ranges were found for the ensiled material. Although the duration of ensiling showed no significant effect on the dry matter content of the ensiled herbage, the effects due to stage of maturity were significant ($P < 0.05$).

Influence of stage of maturity, duration of

TABLE 1. EFFECT OF FREQUENCY OF DEFOLIATION, DURATION ON ENSILING AND ADDITION OF COCONUT MEAL ON pH VALUE OF GUINEA GRASS SILAGE (MEAN OF 4 REPLICATES)[1]

Frequency of defoliation (weeks)	Pre-ensiled herbage	Duration of ensiling (weeks)						Mean
		6		7		8		
		Coconut meal		Coconut meal		Coconut meal		
		without	with	without	with	without	with	
2	5.9	5.1	5.2	5.5	5.2	5.7	5.3	5.3c
3	5.9	5.1	5.2	5.0	4.8	5.6	5.1	5.1a
4	5.8	5.1	4.9	5.1	5.2	5.1	5.0	5.1a
5	5.9	5.4	5.4	5.3	5.1	5.4	5.0	5.3c
6	5.9	5.3	5.0	5.3	5.1	5.2	5.3	5.2b
7	5.8	5.1	5.2	5.1	4.9	5.0	5.2	5.1a
8	5.9	5.3	5.3	5.2	5.3	5.3	5.6	5.3c
9	6.2	6.2	5.7	5.2	6.1	5.7	5.7	5.8d
10	6.0	5.8	5.7	5.9	5.7	6.4	5.8	5.9e
12	5.8	7.1	5.2	6.5	7.6	7.0	7.1	6.8f
Mean		5.4 NS[2]		5.5 NS		5.6 NS		

[1]Means within the column with dissimilar letters are different ($P < 0.05$).
[2]NS means non significant.

ensiling and the addition of coconut meal on the pH value of the Guinea grass silage together with those for the pre-ensiled herbage are presented in table 1. Stage of maturity showed less variation in the pH of freshly harvested herbage (5.8 to 6.2). The duration of ensiling and the addition of coconut meal did not produce any significant variation in pH. But, the stage of maturity significantly ($P < 0.05$) affected the pH of the ensiled product. The pH of silage prepared from herbage over 8 weeks old had higher ($P < 0.05$) values than those harvested below 8 weeks (5.8 to 6.8 vs 5.1 to 5.3).

Lengthened growth period significantly ($P < 0.05$) affected both the water soluble carbohydrate (WSC) and the lactic acid content of the ensiled herbage (table 2). The WSC of silage prepared from 3-weekly defoliated herbage (2.1 %) was higher ($P < 0.05$) than those prepared from longer growth periods. Lactic acid contents of silage made from 3-, 4- and 6-weekly defoliated samples were significantly higher ($P < 0.05$) than those prepared from 9 and 12-week old herbage (1.3 to 1.5 % vs 0.9 to 1.0 %). Duration of ensiling had no significant effect on either the WSC or the lactic acid content of the ensiled material. Although the addition of coconut meal resulted in higher concentrations of WSC and lactic acid, the values were not significantly different.

Lengthened growth period decreased ($P < 0.001$) the crude protein content of the post-ensiled material (table 3), and showed a linear relationship. Addition of coconut meal increased the protein content of the silage, but the duration of ensiling had no significant effect.

The *in vitro* organic matter digestibility (IVOMD) showed a linear relationship with growth period (table 4). Lengthened growth period decreased ($P < 0.001$) the IVOMD of the ensiled product. Duration of ensiling had no significant effect on IVOMD, however the addition of coconut meal increased the IVOMD of the ensiled material by 6 – 8 digestibility units.

Discussion

In the study reported here, the fermentation characteristics of Guinea 'A' forage harvested at different growth stages and ensiled with or without the addition of coconut meal were different from temperate forages. In general, the quality of silage is assessed by chemical standards and

TABLE 2. EFFECT OF FREQUENCY OF DEFOLIATION, DURATION OF ENSILING AND ADDITION OF COCONUT MEAL ON WATER SOLUBLE CARBOHYDRATE AND LACTIC ACID CONTENTS (% DRY MATTER) OF GUINEA GRASS SILAGE (MEAN OF 2 REPLICATES)[1]

Frequency of defoliation (weeks)	Coconut meal (without/with)	Soluble carbohydrate				Lactic acid			
		Duration of ensiling (wks)			Mean	Duration of ensiling (wks)			Mean
		6	7	8		6	7	8	
3	without	2.3	1.8	2.1		1.3	1.5	1.9	
	with	2.6	2.1	1.7	2.1b	1.3	1.3	1.6	1.5a
4	without	1.0	0.9	1.0		1.1	1.2	1.7	
	with	1.6	0.4	1.7	1.1a	1.2	1.4	1.1	1.3ac
6	without	1.2	1.0	1.1		1.5	2.0	1.7	
	with	1.5	1.4	1.4	1.3a	1.0	1.8	1.0	1.5a
9	without	1.0	1.1	0.9		1.3	0.9	1.0	
	with	1.0	0.9	1.0	1.0a	1.0	0.9	1.1	1.0bc
12	without	0.7	1.2	0.7		0.6	0.9	0.8	
	with	1.1	1.3	1.2	1.0a	1.0	0.8	1.0	0.9b
Mean		1.4	1.2	1.3		1.1	1.3	1.3	

[1]Means within a column with dissimilar letters are significantly different ($P < 0.05$).

TABLE 3. EFFECT OF FREQUENCY OF DEFOLIATION, DURATION OF ENSILING AND ADDITION OF COCONUT MEAL ON THE CRUDE PROTEIN CONTENT (% DRY MATTER) OF GUINEA GRASS SILAGE (MEAN OF 2 REPLICATES)

Duration of ensiling (weeks)	Coconut meal (without/ with)	Frequency of defoliation (weeks)					Regression[1]		Correlation coefficient
		3	4	6	9	12	a	b	
6	without	10.8	9.3	8.0	6.1	4.8	12.21	0.6477	−0.9730***
	with	10.7	13.1	8.9	9.0	7.5	12.98	−0.4632	−0.7700**
	Mean	10.7	11.2	8.4	7.5	6.1			
8	without	11.1	9.8	7.1	5.8	4.9	12.32	−0.6770	−0.9430***
	with	11.1	12.2	8.1	8.4	6.8	12.92	−0.5300	−0.7990***
	Mean	11.1	11.0	7.6	7.1	5.8			

[1] Rectilinear regression equation; $y = a + bx$
($P < 0.01$); * ($P < 0.001$)

TABLE 4. EFFECT OF FREQUENCY OF DEFOLIATION, DURATION OF ENSILING AND ADDITION OF COCONUT MEAL ON THE *IN VITRO* ORGANIC MATTER DIGESTIBILITY (%) OF GUINEA GRASS SILAGE (MEAN OF 4 REPLICATES)

Duration of ensiling (weeks)	Coconut meal (without/ with)	Frequency of defoliation (weeks)							Regression[1]		Correlation coefficient
		2	3	4	6	8	10	12	a	b	
6	without	51.0	42.9	42.5	37.6	33.5	30.7	29.0	57.24	−1.897	−0.90***
	with	59.6	51.7	48.7	43.3	41.2	39.5	38.0	50.75	−2.017	−0.85***
	Mean	55.3	47.3	45.6	40.4	37.3	35.1	33.5			
7	without	51.9	43.8	41.1	37.2	36.0	35.6	31.4	59.24	−2.314	−0.91***
	with	58.7	50.4	49.3	44.3	40.4	37.5	32.0	49.29	−1.583	−0.83***
	Mean	55.3	47.1	45.2	40.7	38.2	36.5	31.7			
8	without	49.8	45.3	40.6	35.3	34.7	31.9	25.4	54.11	1.545	−0.92***
	with	55.3	48.1	47.8	43.6	41.6	40.3	36.8	50.65	−2.057	−0.86***
	Mean	52.5	46.7	44.2	39.4	38.1	36.1	31.1			

[1] Rectilinear regression equation; $y = a + bx$
*** ($P < 0.001$)

feeding trials. Well preserved grass silage is characterised by a pH value of 4.2 or below (Carpintero et al., 1969) and the lactic acid content between 3 and 13 % (Langston et al., 1958). However, the above characteristics were defined for unwilted temperate forages, as such their validity for tropical forages is questionable.

In the present study, pH of silages ranged from 4.8 to 7.6 and the lactic acid concentrations ranged from 0.6 to 2.0 %. Catchpoole (1968) working with silage prepared from *Setaria sphacelata* herbage (WSC less than 6 %) reported pH values above 4.4 and lactic acid contents between 0.2 to 1.5 %. In our investigation, silage prepared from 3 weeks old unfertilized Guinea grass had 2.1 % WSC, and with mature forage it was close to 1.0 % (DM basis). In a laboratory silo study with 3 weeks old fertilized guinea grass (WSC of 8.5 %), Panditharatne (1984) reported pH value of 5.2 and lactic acid concentration of 0.15 %. Even though the above study was also conducted in the mid-country wet zone of Sri Lanka, the lactic acid concentration in the ensiled product was low. However, the *in vitro* dry matter digestibility and intake of the silage with sheep from Panditharatne (1984) were 60.1 % and 540 g DM/day, respecti-

vely, indicating that the silage was of good quality.

Duration of ensiling and the addition of coconut meal did not produce significant changes in the lactic acid content of Guinea grass silages. Nevertheless, the lactic acid content of the control was numerically higher as compared to that where coconut meal was added (1.6 vs 1.4 %). In a similar study, Panditharatne (1984), reported values of 0.1 and 0.4 % for the silage prepared without or with the addition of coconut meal, respectively. Several workers have shown that the fermentation pathways of tropical forage silages was different from temperate silages (Miller et al., 1966; Catchpoole, 1968; Catchpoole and Hanzel, 1971; Tosi, 1973; Xande, 1978; Panditharatne, 1984). According to these workers the factors responsible for preservation are not fully known. There are suggestions to indicate that acetic acid rather than lactic acid may be the main preservative in tropical forage silages.

It is important to note that the stage of maturity of the grass used for ensiling greatly influenced both the fermentation characteristics (pH, lactic acid) and the nutritive value (CP, IVOMD) of the post ensiled product. The effects due to maturity on the crude protein (CP) content and digestibility of fresh Guinea A forage was clearly demonstrated by Peiris (1985). He reported that the CP content and the IVOMD decreased by 8 and 26 digestibility units, respectively, when the growth period was increased from 3 to 12 weeks. With ensiled guinea A herbage, the magnitude of difference in terms of CP (21 %) and IVOMD (87 %) values are in the same order. Due to the high CP and IVOMD of the coconut meal, its addition resulted in marginally higher CP and IVOMD values, but the effects due to herbage maturity was more prominent.

The final evaluation of the nutritive value of the ensiled material should be based on animal feeding experiments in which both the digestibility and intake are measured. In addition, it seems important to measure the volatile fatty acid content of these silages, because acetic acid rather than lactic acid may be the main preservative in tropical forage silages.

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