Effect of Variety on Proportion of Botanical Fractions and Nutritive Value of Different Napiergrass (*Pennisetum purpureum*) and Relationship between Botanical Fractions and Nutritive Value

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ABSTRACT : Five varieties of napiergrasses (*Pennisetum purpureum*) were fractionated botanically into leaf blade, leaf sheath, stem and head. Chemical composition of each of whole napiergrass and their botanical fractions were determined. Correlation, linear and multiple regressions between botanical fractions and nutritive value of varieties of napiergrass were also estimated. All botanical fractions differed due to the effect of variety. Napier Pusha contained the highest proportion of leaf blade and internode, but the lowest proportion of leaf sheath. Napier Hybrid contained the lowest proportion of leaf blade, but highest proportion of node. Consequently, napier Pusha contained the highest (p<0.01) crude protein (CP, 9.0%), but Napier Hybrid had the lowest CP (7.0%). Chemical composition of whole plant differed significantly (p<0.01; except NFE, p>0.05) due to the variety. Not only the whole plant, chemical composition of most botanical fractions of whole plant differed (p<0.05 to 0.01) due to the variety. The intrarelationships between leaf blade and leaf sheath was negative (r=-0.43). Leaf sheath was also negatively correlated to CP, but positively correlated to ash of whole Napier or their botanical fractions. Leaf blade, on the other hand, increases CP but decreases ash content of whole plant or their fractions. These results, therefore, suggest that napiergrass varieties differ widely in terms of botanical fractions and nutritive value, which may have important implications on intake and productivity of animals. Furthermore, napiergrass varieties should be selected for leaf blade only for a better response. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 6 : 837-842)***

Key Words : Napier, Variety, Botanical Fractions, Leaf Blade, Selection

INTRODUCTION

Although biomass yield is the single most important criteria to select a fodder, there are other criterias like proportion of botanical fractions (e.g. leaf and stem), nitrogen and energy content of fodder are very important to be considered in selecting a fodder. The proportions of botanical fractions and their internal structure determine the nutritive value and intake of forages. Ruminants particularly small ruminants naturally select leaf against stem because the former is more nutritious than the latter (Wahed et al., 1990). It was reported that botanical fractions of straw might differ widely and has a significant effect on their chemical composition, physical characteristics and digestibility (Poppi et al., 1981). Factors affecting proportions of botanical fractions and their nutritive value therefore may have important implications to manipulate nutritive value and intake of forages by animals (Islam et al., 1996). Islam et al. (1997a) reported that the proportion of leaf in forages can be increased by both agronomic factors or by selecting variety, the latter is often considered as one of the most significant factors influencing the proportions of botanical fractions of straw.

Among non-legume perennial fodder, the yield potential of napiergrass (*Pennisetum purpureum*) varieties was higher than other forages in Bangladesh (Kibria et al., 1993). At present, five varieties of napiergrass (Arusha, Hybrid, Pusha, 17 and Bazra) present in the country and their cuttings have also been distributed among the interested farmers those who want to cultivate napiergrass. No research has been carried out on which of these five varieties are better over others in respect of their botanical fractions and nutritive value. This research may be valuable to animal scientist and the plant breeders in selecting the suitable varieties and to improve the economic characteristics of those plant parts.

Therefore, the present study was undertaken to know the proportion of different botanical fractions and chemical composition of five varieties of napiergrass. Another objective of the study was to investigate the potential of botanical fractions in estimating nutritive value of napiergrass.

MATERIALS AND METHODS

Five varieties of napiergrass (*Pennisetum purpureum*) grass taking 10 kg from each plot and each variety namely; Arusha, Hybrid, Pusha, 17 and Bazra were collected from the fodder experimental plots of Bangladesh Livestock Research Institute. Grasses were sown on mid-May 1998 in a Completely Randomized Design having 3 replications (plot) for each grass. Size of each plot was 6×4 m^2. During sampling, grasses were in second year of establishment. During the first year, grasses were first cut on 90 days after

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Table 1. Proportion (%DM) of different botanical fractions of different varieties of napiergrass

Variety	Fractions (%DM)			
	Leaf blade	Leaf sheath	Internode	Node
Arusha	28.8	20.9	34.0	14.4
Hybrid	25.7	22.3	34.9	17.1
Pusha	29.6	18.5	37.0	14.8
17	29.1	23.3	34.0	13.5
Bazra	25.8	21.8	35.4	17.0

planting and then regularly between 60 and 65 days of interval after each cutting. Therefore, grasses were first cut on mid-August. The samples for botanical fractions and chemical analysis used in this study were taken after 60 days of second year establishment i.e. 415 days after planting. In other words, the parameters used in this experiment were taken from the 6-th cut of all varieties of napiergrasses and hence all grasses were on the same stage of growth. All of these grasses were fertilized with 23.5 kg fertilizer N/ha after each cutting (i.e. harvest). Irrigation was made available when necessary. Mean annual temperature of the area ranged from 25.5 to 26.3°C and average rainfall ranged from 1,424 to 2,471 mm per annum. The soil color was brown and contain on an average 22% clay, 64% silt, 12.5% sand and 1.5% organic materials in top 10 cm layer.

To determine the proportion of botanical fractions, grasses from each variety were cut at 5-6 cm height. Triplicates of 1-kg from each variety were fractionated into four fractions namely; leaf blade, leaf sheath, internode and node. The fractions of each variety were then weighed individually, dried (60°C for 48 h) and divided by total weight and multiplied by 100 to determine the proportion of each fraction. Then the botanical fractions of each variety and the sample of whole plant were sun dried and grounded through 1 mm sieve by Willy Mill for chemical analysis. The dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), nitrogen free extract (NFE) and ash were determined following AOAC (1984).

Data on chemical composition were analyzed by Completely Randomized Design (Steel and Torrie, 1980) using SAS (1988). The relationship (r), linear and multiple relationships between botanical fractions and nutritive value were estimated by using SAS (1988).

Table 2. Chemical composition (%DM or otherwise stated) of different botanical fractions of napiergrass varieties

Parameter	Botanical fractions	Napier varieties					Mean	F value	Level of significance
		Arusha	Hybrid	Pusha	17	Bazra			
DM%	Leaf blade	24.9	23.8	23.0	24.2	30.7	25.3	12.21	**
	Leaf sheath	14.8	18.1	15.0	15.5	23.5	17.4	65.70	**
	Internode	13.6	14.5	13.4	9.9	14.9	13.2	5.43	**
	Node	15.3	16.9	13.7	13.1	16.6	15.1	3.98	*
	Whole plant	19.0	16.5	17.0	19.2	28.2	20.0	39.19	**
CP	Leaf blade	11.7	11.7	11.7	10.1	9.6	11.0	497.25	**
	Leaf sheath	5.7	4.3	6.0	5.3	4.0	5.1	832.99	**
	Internode	6.8	3.3	6.5	6.6	6.9	6.0	943.81	**
	Node	8.0	6.1	9.3	9.9	9.0	8.5	236.84	**
	Whole plant	8.9	7.0	9.0	8.6	8.2	8.4	332.09	**
CF	Leaf blade	22.5	24.2	23.2	23.5	24.1	23.5	2.71	*
	Leaf sheath	28.6	28.3	30.3	30.6	28.5	29.3	4.87	**
	Internode	29.2	29.8	28.9	31.5	29.6	29.8	14.16	**
	Node	33.9	34.5	33.6	34.6	34.6	34.3	1.36	NS
	Whole plant	29.8	32.6	30.4	32.6	30.0	31.1	12.16	**
EE	Leaf blade	1.5	1.6	1.6	1.5	1.4	1.5	70.29	**
	Leaf sheath	1.6	1.6	1.3	1.3	1.4	1.4	75.09	**
	Internode	2.7	2.6	1.9	1.8	1.8	2.1	185.12	**
	Node	2.7	2.4	1.8	1.8	1.8	2.1	496.79	**
	Whole plant	2.0	2.0	1.7	1.8	1.5	1.8	21.93	**
NFE	Leaf blade	55.2	52.6	54.4	53.1	53.4	53.7	1.29	NS
	Leaf sheath	55.6	55.9	54.2	47.9	50.9	52.9	8.26	**
	Internode	55.0	56.5	55.5	50.2	51.7	53.8	6.68	**
	Node	45.6	46.6	45.6	42.2	39.5	43.6	17.65	**
	Whole plant	47.5	46.1	46.0	45.8	48.0	46.9	2.05	NS
Ash	Leaf blade	9.2	9.7	8.3	11.8	11.5	9.8	8.42	**
	Leaf sheath	8.6	9.8	8.2	14.9	15.3	10.4	19.59	**
	Internode	6.4	9.8	6.7	9.9	10.0	8.2	6.71	**
	Node	9.8	10.3	9.5	11.6	15.2	10.3	77.64	**
	Whole plant	12.7	12.3	10.0	12.0	12.3	11.8	10.79	**

NS = not significant ($p>0.05$); *, $p<0.05$; **, $p<0.01$.

RESULTS AND DISCUSSION

The proportion of botanical fractions of different varieties of napiergrass is presented in Table 1. Proportion of leaf blade (29.6%) and internode (37.0%) was highest, but leaf sheath was lowest (18.5%) in Pusha variety. On the other hand, leaf sheath (23.3%) was highest, but node (13.5%) was lowest in variety 17. Napier Hybrid had the lowest proportion of leaf blade (25.7%), but highest node (17.1%). These results revealed that the variety clearly affected the proportion of botanical fractions of napiergrass, which agreed with the results of Islam et al. (1996). Differences between varieties in terms of botanical fractions may have important implications on nutritive value and intake by ruminants (Islam et al., 1997a), because sheep and goat are able to select more nutritious leaf against stem. Ørskov (1988) reported that when intake of genotypes of barley straw by steers varied from 3.43 to 5.16 kg the corresponding growth rate varied from 100 to 400 g/d. This increase in growth rate due to the difference in genotype was probably due to the higher intake of more nutritious fractions particularly leaf of straw. Therefore, selection of a variety for leaf may indeed increase animal production substantially.

Table 3. Relationship between botanical fraction and nutritive value indicators of whole napiergrass

Parameter	Proportion of botanical fractions (%DM)			
	Leaf blade	Leaf sheath	Internode	Node
Proportions (% DM)				
Leaf blade	1			
Leaf sheath	-0.43	1		
Internode	0.08	-0.79	1	
Node	-0.93	0.07	0.27	1
Crude protein (% DM)				
Leaf blade	0.27	-0.54	0.19	-0.07
Leaf sheath	0.96	-0.58	0.15	-0.82
Internode	0.55	-0.25	0.03	-0.55
Node	0.60	-0.13	0.16	-0.62
Whole plant	0.84	-0.50	0.14	-0.75
Crude fiber (% DM)				
Leaf blade	-0.80	0.44	0.16	0.74
Leaf sheath	0.78	-0.16	0.22	-0.76
Internode	0.05	0.82	-0.59	-0.37
Node	-0.66	0.92	-0.52	0.36
Whole plant	-0.15	0.63	-0.31	-0.04
Ether extract (% DM)				
Leaf blade	0.27	-0.39	0.35	-0.09
Leaf sheath	-0.46	0.17	-0.44	0.41
Internode	-0.18	0.02	-0.40	0.16
Node	-0.11	0.05	-0.50	0.07
Whole plant	0.12	0.16	-0.51	-0.20
Nitrogen free extract (% DM)				
Leaf blade	0.62	-0.66	0.09	-0.46
Leaf sheath	-0.14	-0.51	0.22	0.36
Internode	-0.09	-0.55	0.35	0.34
Node	0.25	-0.39	0.09	-0.10
Whole plant	-0.39	-0.01	-0.14	0.37
Ash (% DM)				
Leaf blade	-0.58	0.61	-0.42	0.35
Leaf sheath	-0.53	0.26	0.08	0.46
Internode	-0.46	0.81	-0.59	0.15
Node	-0.78	0.61	-0.44	0.61
Whole plant	-0.76	0.75	-0.47	0.51

The DM content of all fractions and whole plant of Bazra was higher than all other varieties studied (Table 2). The DM content of whole plant of the studied varieties except Bazra ranged from 16-19%, while it was the highest ($p<0.01$) in Bazra (28.2%). The CP content of leaf blade was above 11.0% in Aursha, Hybrid and Pusha varieties, but CP was the lowest ($p<0.01$) in Bazra. In case of leaf sheath, the CP content was higher ($p<0.01$) in Pusha (6.0%) than all other varieties. The higher CP content of whole plant of Pusha is likely to be attributed to not only the higher proportion of leaf blade and lower leaf sheath, but also the higher CP content of all fractions. Interestingly, CP content of leaf sheath was about half of the CP content of leaf blade. In fact, leaf consists of both leaf blade and leaf sheath. Therefore, in selecting forages for leaf, the selectors should be cautious about both of the components of leaf. It is not only the CP content, which differs between leaf blade and leaf sheath, but also the intake response that differ between the fractions. Islam et al. (1997b) reported that 94% of the leaf blade of oat straw supplied to sheep was consumed in contrast to 52% was selected from the leaf sheath. In addition to the lower CP content of leaf sheath, there is a physical barrier where unlike leaf blade, leaf sheath is closely attached to the stem for which leaf sheath is less likely to be selected by animals. These factors in fact outclassed leaf sheath from leaf blade although generally both the components are considered as leaf. The CP content of internode was above 6.0% in all of the varieties mentioned except the hybrid one (3.3%) which was the lowest ($p<0.01$). The same trend as observed in case of node, where the CP content was lowest (6.1%; $p<0.01$) in Hybrid than all other varieties. However, it was observed that the CP content of whole plant was above 8.0% in all cases except Hybrid variety, which was the lowest (7.0%; $p<0.01$). The lower CP of Hybrid is partly due to its lower proportion of leaf blade and higher leaf sheath and partly due to lower CP of leaf sheath and stem (internode plus node) fractions. As expected, leaf particularly leaf blade contains higher CP than other fractions is in line with the literature. Compared with stem, leaf components of oat (Thiago and Kellaway, 1982; Shand et al., 1988), wheat (Åman and Nordkvist, 1983; Shand et al., 1988; Wales et al., 1990), barley (Ramanzin et al., 1986; 1991; Herbert and

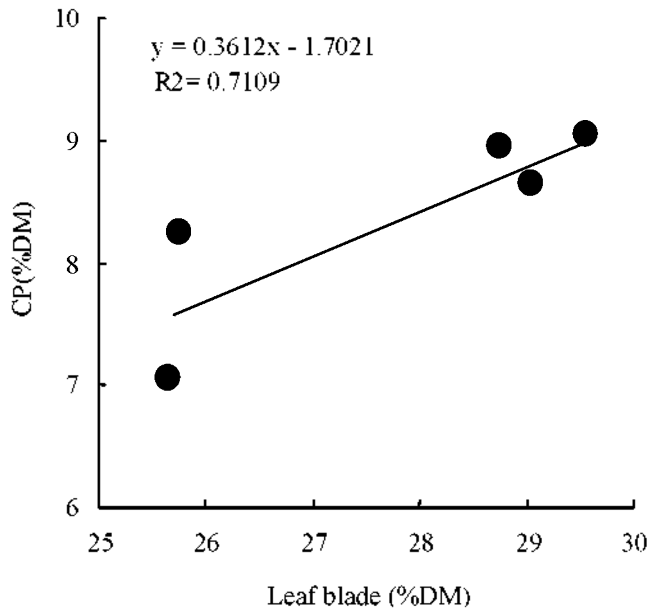

Figure 1. Relationship between proportion of leaf blade and CP content of whole napiergrass

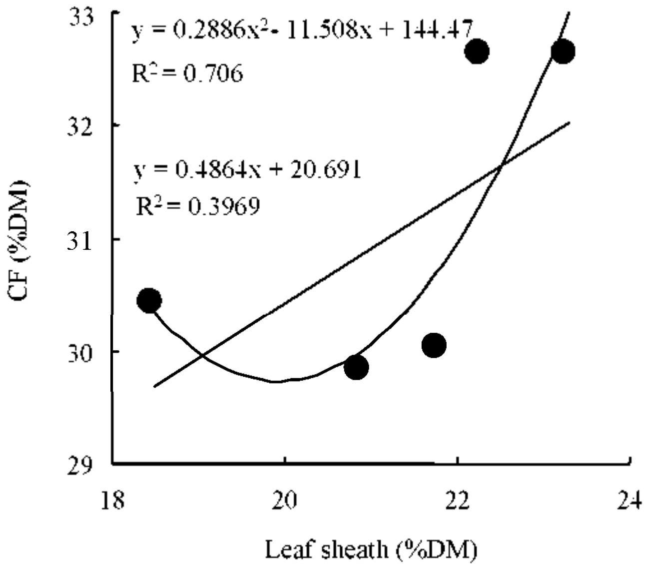

Figure 2. Relationship between proportion of leaf sheath and CF content of whole napiergrass

Thomson, 1992) and grasses (Laredo and Minson, 1973; Poppi et al., 1981) were found to be more digestible. Moreover, the rate and extent of degradation of oat (Shand et al., 1988), wheat (Shand et al., 1988) and barley (Ramanzin et al., 1991; Herbert and Thomson, 1992) leaves were faster than the stem. In contrast, *in situ* DM degradabilities of stem of rice straw was higher than leaf (Walli et al., 1988; Nakashima and Ørskov, 1990).

The CF content of the respective fractions of all varieties was almost similar ($p<0.05$). The CF of the whole plant ranged from 29.8-32.6%. Similar trend was also observed in case of NFE of different fractions of all varieties except the case of NFE content of leaf sheath in variety 17, whose NFE content was highest (47.9%; $p<0.01$) and NFE content of node was the lowest (39.5%) in case of Bazra. The NFE content of the whole plant of the studied varieties was narrow which ranged from 45.8-48.0%. The ash content of different botanical fractions of variety 17 and Bazra was higher ($p<0.01$) compared to others. However, the ash content of whole plant of all varieties mentioned was more or less similar. The EE content of the respective fractions of all varieties was almost similar except the EE content of internode and node

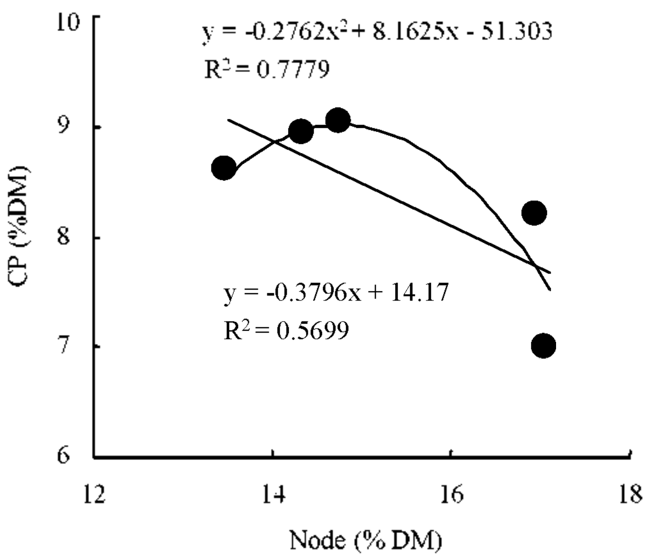

Figure 3. Relationship between proportion of node and CP content of whole napiergrass

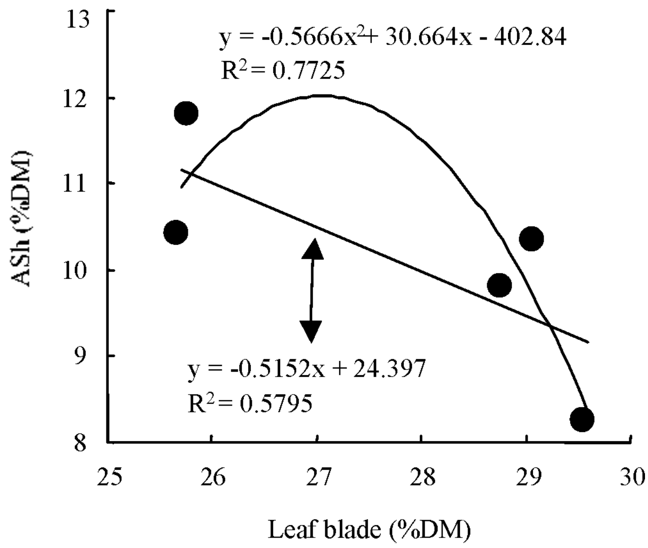

Figure 4. Relationship between proportion of leaf blade and ash content of whole napiergrass

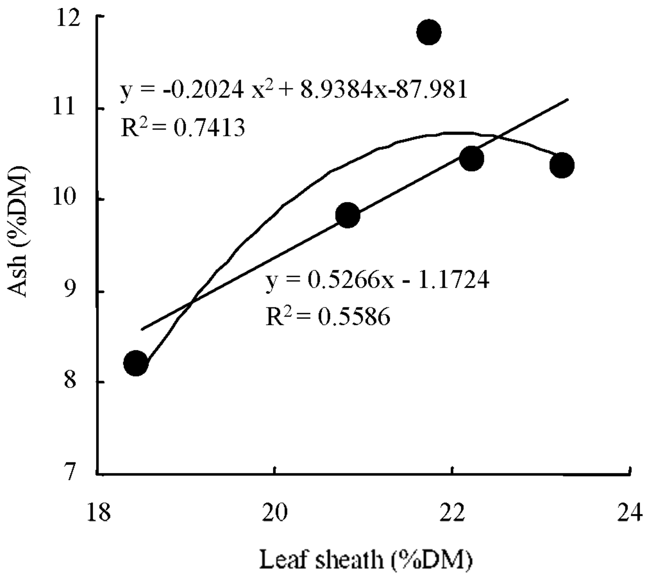

Figure 5. Relationship between proportion of leaf sheath and ash of whole napiergrass

of Arusha and Hybrid where the EE content of those fractions was higher in comparison to other varieties. The EE content of the whole plant of Arusha and Hybrid was also higher than all other varieties.

The intrarelationships between botanical fractions are given in Table 3. The negative relationship between leaf blade and leaf sheath (r= -0.43), or node (r= -0.93) suggest that any improvement of leaf blade of napiergrass likely to occur at the expense of leaf sheath and node. However, leaf blade unlikely to affect on internode since their relationship was low (r= 0.08).

Table 3 also shows that the proportion of leaf blade is highly correlated with CP (r= 0.84) and ash (r= -0.76). Leaf sheath is negatively related to CP (r= -0.50), but positively related to CF (r= 0.63) and ash (r= 0.75). Internode was negatively related to most of the criterias (EE and ash), and node was negatively related to CP but positively related to ash. Unlike some crops (e.g. rice) increase in proportion of leaf blade decreased the ash content (Figure 4) in contrast to the proportion of leaf sheath, which increased the ash content of whole napiergrass (Figure 5). Furthermore, increase in leaf blade linearly increased the CP content of napiergrass (Figure 1). These results suggest that for each % increase in proportion of leaf blade whilst CP% of Napier increases to 0.36% (Figure 1), the ash content likely to be reduced to 0.52% (Figure 3). Therefore, selection of varieties of napiergrass for leaf blade content in fact will increase the quality of forage and ultimately its utilization. On the other hand, leaf sheath increases ash (Figure 5) and CF (Figure 2), but decreases CP content (Table 3) of napiergrasses, which is a complete contrast to leaf blade. Therefore, napiergrasses seem should be selected against leaf sheath, which also supported by the results of intrarelationship between leaf blade and leaf sheath (Table 3). These results, therefore, suggest that the varieties of napiergrss need to be selected for LB only and not for other components. Moreover, napiergrass need to be breeded to get higher proportion of LB to improve their quality.

CONCLUSIONS

The five napiergrass studied differed in most of the characteristics signifies that the variety should be selected cautiously for productive purposes. Leaf blade has been identified as the most important criteria for selection of napiergrass. However, selection of napiergrass based on leaf (i.e. leaf blade and leaf sheath) may be misleading since in contrast to leaf blade, leaf sheath linked to such characteristics of napiergrass which may limit intake, digestibility and animals productive response.

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