

ANATOMIC AND CHEMICAL TRAITS, AND IN VITRO DIGESTIBILITY OF THREE TROPICAL GRASSES.

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ABSTRACT

Single linear correlation was established between in vitro dry matter digestibility (IVDMD) and contents of chemical entities as well as proportion of different tissues. Top and bottom leaves were sampled from Jaraguagrass, setariagrass and dwarf elephantgrass. Among the chemical entities, lignin showed better correlation with IVDMD. The proportion of sclerenchyma in the samples of stem and leaf lamina from the top layer and the parenchymall cells in the leaf sheath showed highly significant correlations with the IVDMS NDF content correlated positively with percentage of sclerenchyma, lignified vascular tissues and parenchyma bundle sheath, but negatively with percentage mesophyll and epidermis tissues. NDF showed good correlation with IVDMD, if associated with lignin.

KEYWORDS

Hyparrhenia rufa, *Pennisetum purpureum* cv Mott, *Setaria anceps*, anatomy, digestibility, chemical composition, nutritive value

INTRODUCTION

The chemical analysis and the in vitro digestibility are the methods traditionally used to evaluate the nutritional value of fodder. Histological studies about the way in which the arrangement and the proportion of different tissues affect the chemical composition and digestibility of forages are very promising (Akin, 1989; Wilson et al. 1989). This fact stems from the heterogeneous organization of the fodder fractions in relation to tissues and cell types. In the leaf of tropical grasses, tissues such as the mesophyll and phloem are rapidly and totally degraded. The epidermis and the parenchymatous bundle sheath are partially and slowly digested and the vascular bundle and sclerenchyma are not degradable (Akin, 1989). Linear correlation has been established between chemical composition or in vitro digestibility data with percentage of some plant tissues (Wilkins, 1972; Wilson et al., 1989). This work aimed at evaluating the degree of correlation among the chemical composition, the in vitro drymatter digestibility and the proportion of tissue in sections of stem and leaf lamina and sheath from the top and bottom layers of tillers of three tropical grasses.

METHODS

The grasses Jaraguagrass (*Hyparrhenia rufa*), Dwarf elephantgrass (*Pennisetum purpureum* cv Mott) and Setariagrass (*Setaria anceps* cv. Kazungula) grown in field plots were NPK fertilized and watered as needed. Leaf lamina and sheath and the subtended stem portion were sampled when signs of leaf senescence of lower leaves became visible. Samples were obtained from the top last expanded leaf and bottom senescent leaf from 60 tillers of each species, in the summer and autumn aftermath.

Chemical analysis of crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF) and lignin (L) were performed as well as the estimates of proportion of epidermis (EPI), mesophyll (MÊS), sclerenchyma (SCH), parenchymall cells (PAC), parenchymatous bundle sheath (PBS) and lignified vascular tissue (LVT). In vitro drymatter digestibility (IVDMD) was performed according to Tilley and Terry (1963).

Five millimeter segments from the middle portions of leaf lamina and sheath and the nodal segment were soaked in methacrylate (JB-4) according to Feder and O'Brien, (1968) and Glauert, (1983). From these, micrometer sections were obtained, mounted in permanent slides and stained with anillin blue. Using a slide projector the tissues were drawn in vegetable paper. The drawings were inserted in a 486 microcomputer the tissue proportion was determined using the software ALDUS PHOTOSTYLER 2.0 and IMAGE 1.0.

RESULTS AND DISCUSSION

Summer samples had higher IVDMD (67,4 vs 64,0%). Seasonal effects on chemical composition and tissue proportion varied according to plant species. IVDMD was higher for samples taken from plant top (76,0 %) than those from the bottom (61,1%) ; still, NDF values were higher in recently expanded leaves (70,7%), as compared to lower, senescent ones (57,7%). Epidermis (39,8%) and mesophyll (35,8%) contributed the most to the transverse leaf lamina section; whereas the parenchyma cells predominated in the leaf sheath (65,8%) and stems (80,0%)(data not shown). A better combination of nutritive value traits were found in leaf lamina of dwarf elephantgrass and setariagrass. Setariagrass contained lower lignin content, lower proportion of PBS and higher proportion of EPI, while elephantgrass exhibited lower NDF content, higher MÊS and lower proportion of SCH. Jaraguagrass exhibited lower IVDMD, higher lignin and NDF contents as well as proportion of tissues with thickened cell wall (PBS, SCH and LVT) (Table 1). Association of IVDMD with chemical or anatomical traits varied with tiller fraction (Table 2). The content of lignin and the proportion of sclerenchyma were the only characteristics to show significant correlation with IVDMD of the blade. On the remaining of the tiller fractions the chemical components and the proportion of parenchymall cells of the leaf sheath and the sclerenchyma in the stem showed highly significant correlation with IVDMD. Besides, percentage sclerenchyma correlated with NDF ($r=.59$); ADF ($r=.58$) and L ($r=.53$).

Differences in IVDMD, chemical and anatomical figures were observed for grass species, plant organ and its level of insertion in the tiller. NDF and ADF values correlated positively with percentage of SCH, PHS and LVT and negatively with EPI and MÊS.

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Table 1

In vitro drymatter digestibility (IVDMD), chemical composition and tissues proportion in leaf lamina of three grasses.

Variable	Species		
	Setariagrass	Elephantgrass	Jaraguagrass
IVDMD	68.9	71.6	65.1
NDF (%DM)	63.7	59.7	69.2
ADF (%DM)	32.5	34.7	40.1
Lignin (%NDF)	6.8	7.7	8.8
Epidermis*	48.6	35.2	34.6
Mesophyll*	32.7	39.5	35.1
Parenchymatous bundle sheath*	7.9	10.8	13.0
Sclerenchym*	1.7	1.3	2.3
Vascular tissue*	3.0	5.7	7.1

* - % of transverse section

Table 2

Correlation coefficients between IVDMD and chemical composition and tissue proportion in different plant fractions.

	Tiller fractions					
	Top lamina	Bottom lamina	Top and bottom lamina	Sheath bundle	Culm	Tiller
NDF (%DM)	-0.39	-0.71**	-0.05	-0.22	-0.82***	-0.56**
ADF (%DM)	-0.12	-0.63*	-0.07	-0.63***	-0.87***	-0.72***
CP (%DM)	0.07	0.12	0.03	0.51**	0.80***	0.65***
Lignin (% NDF)	-0.30	-0.82***	-0.53	-0.48**	-0.88***	-0.62***
Parenchymatous cells	-0.16	-0.25	-0.04	0.68***	0.32	0.15
Parenchymatous bundle sheath	-0.11	-0.36	-0.10	—	—	—
Mesophyll	0.14	0.26	0.08	—	—	—
Vascular tissue	-0.10	-0.32	-0.08	-0.08	-0.36	0.31**
Sclerenchyma	-0.66**	-0.22	-0.12	-0.04	0.58**	-0.37***
Epidermis	-0.06	0.11	0.05	-0.03	0.24	-0.06

* (P<0.05); ** (P<0.01) ; *** (P<0.001)