A Comparison of Tifton 85 and Coastal Bermudagrass Cell Walls

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Introduction

Bermudagrass is well adapted to the warm humid climates of the southeastern states allowing good biomass production either as hay or in grazing situations. However, fiber digestibility is poor resulting in limited animal performance. Selection for improved bermudagrass resulted in the development of Tifton 85 with improved digestibilities and animal performance compared to Coastal bermudagrass. Fiber analysis indicated Tifton 85 had slightly higher NDF and ADF, yet higher digestiblity compared to Coastal bermudagrass. We evaluated these two bermudagrass lines for cell wall characterisitcs that might explain the differences routinely observed in animal performance.

Methods

Plants were grown at Tifton, GA and harvested at two stages of regrowth, 3 and 6 weeks. Cell walls were isolated from ground samples (1 mm) using a modified Uppsala Fiber Isolation procedure. Isolated walls were analyzed for total neutral sugars, total uronosyls, acid insoluble lignin, neutral sugar composition, and hydroxycinnamic acids.

Results and Discussion

A comparison of cell wall characteristics of Tifton 85 and Coastal bermudagrass revealed several differences between these two lines. Table 1 shows the total cell wall, lignin, neutral sugar and total uronosyl content of the two lines. Major wall constituents increased from 3 and 6 week harvest times for Tifton 85 and Coastal bermudagrass, as one would expect with increased maturity of the plants. However, there was no increase in the acid insoluble lignin in the Coastal line indicating that the small increase in the cell wall fraction was due to structural carbohydrates (Table 1). Total uronosyls did not change with maturity. A comparison of Coastal to Tifton 85 indicated the total cell wall fraction and acid insoluble lignin were less in the Tifton 85 line yet there were higher amounts of total neutral sugars. This result differed from earlier fiber analysis that indicated Tifton 85 had slightly higher NDF and ADF levels yet lower permanganate lignin. A comparison of the neutral sugar composition of isolated walls (Fig. 1) indicated that Tifton 85 had a higher glucose content than Coastal. The higher glucose content would support earlier findings of higher ADF levels since the major carbohydrate in ADF is cellulose. Part of the problem in comparing fiber analysis based on the detergent system with the analysis scheme used here is that hot detergent solutions (especially acid detergent) solubilize significant amounts of lignin and wall carbohydrates (most likely as lignin carbohydrate complexes). The earlier observed higher NDF values for Tifton 85 may be due to less lignin complexes and higher cellulose content that would not be solubilized by the hot detergent solutions.

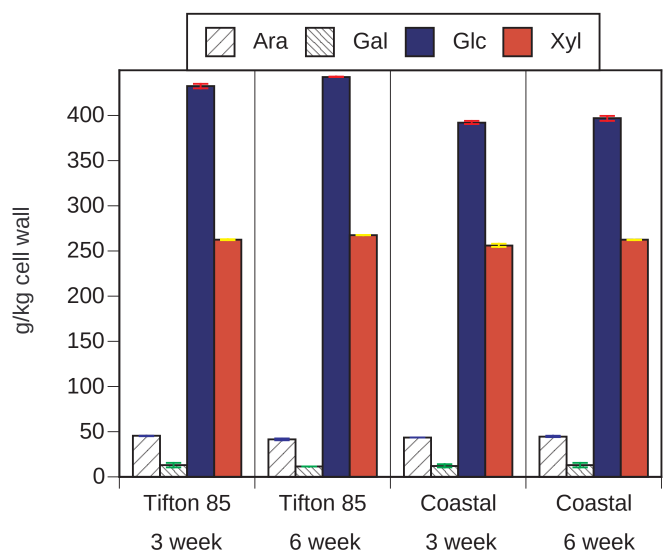

Figure 1. Neutral sugar composition of Tifton 85 and Coastal bermudagrass harvested after 3 and 6 weeks of regrowth.

The hydroxycinnamic acid composition of the walls was also similiar (Table 2) at the two harvest dates and between the two lines of bermudagrass. It is important to note there were no differences in the *p*-coumarates and ferulates (monomers and dimers) that were simply ester linked to wall components. However, ferulates that were also etherified were different between Tifton 85 and Coastal lines and appear to change with maturity of the plants. The more mature Coastal line had higher levels of total ether linked ferulates. It is important to realize that the number of possible chemical bonds between ferulates and lignin residues is not limited to simple ether linkages; therefore, it is impossible to determine the total amount of ferulates cross-linked to lignin. However, it seems likely that the portion released is indicative of the total bonding pattern within the wall matrices.

Taken together, these results indicate that the improved digestibility and animal performance of Tifton 85 is most likely due to lower lignin concentrations coupled with lower levels of crosslinked polysaccharides based on the lower levels of ferulates ether linked to lignin. In addition, Tifton 85 has a significantly higher concentration of cellulose in its wall matrices. Since there is no strong evidence that other wall components are directly cross-linked to cellulose, increased quantities of cellulose within a matrix with equal or less lignin should lead to a more digestible wall.

Table 1. General cell wall characteristics of Tifton 85 and Coastal Bermudagrass.

			g kg^{-1} DM	g kg^{-1} of cell wall		
Sample	Harvest	DM	CW	AIL	TU	Tot. NS
Tifton 85	3 wk	879.2 ± 1.3	778.9 ± 8.1	174.5 ± 0.7	20.5 ± 1.6	753.4 ± 3.2
Tifton 85	6 wk	872.3 ± 3.6	785.0 ± 2.6	177.5 ± 1.0	20.4 ± 1.0	763.2 ± 1.3
Coastal	3 wk	827.9 ± 2.8	820.8 ±10.7	202.8 ± 2.6	20.4 ± 0.5	704.1 ± 7.5
Coastal	6 wk	848.7 ± 0.9	832.1 ± 9.6	200.1 ± 2.3	20.7 ± 0.2	716.9 ± 3.9

Table 2. Total hydroxycinnamic acids released from Tifton 85 and Coastal bermudagrass. Room temperature alkaline hydrolysis will release all hydroxycinnamates linked to wall components by a simple ester linkage, while the high temperature alkaline hydrolysis (4M at 170 °C for 2 h) releases all ester and simple ether linked hydroxycinnamates. Determination of hydroxycinnamates linked to wall components by both ester and ether linkages was made by subtracting the room temperature hydrolysis from the high temperature hydrolysis. (*p*CA= *p*-coumarates, FA= ferulates, diFA= dehydrodiferulates, Tot FA = total ferulates)

		g k^{-1} CW							
		Ester Linked				Ether Linked			
Sample	Harvest	pCA	FA	diFA	Tot FA	pCA	FA	diFA	Tot FA
Tifton 85	3 wk	9.9	6.7	4.1	10.7 ± 0.7[a]	0.8	3.1	2.8	5.9 ± 0.4
Tifton 85	6 wk	10.7	6.1	4.7	10.8 ± 0.5	0.5	4.0	3.6	.5 ± 0.2
Coastal	3 wk	10.0	5.9	4.1	9.9 ± 0.4	0.5	2.9	4.6	7.4 ± 3.1
Coastal	6 wk	10.2	5.9	4.6	10.5 ± 0.9	0.9	4.5	4.8	9.3 ± 0.2

[a]Standard error of the mean for duplicate samples