INFLUENCE OF PLANT PARTS ON *IN VITRO* DRY MATTER DISAPPEARANCE OF FORAGE SORGHUM SILAGES

J. White and K.K. Bolsen

Summary

Five mid- to late- season forage sorghum hybrids were used to plot the changes in silage *in vitro* dry matter disappearance (IVDMD) when their proportions of grain, leaf, sheath, and stalk were altered. The average IVDMD of the parts were: grain 76.9%, leaf 57.7%, sheath 52.7%, and stalk 60.8 percent. The grain proportion had a large positive effect on silage IVDMD dynamics, whereas the sheath plant part had a negative effect.

Introduction

Historically, Kansas has been the leading state in forage sorghum silage production. Forage sorghum silage is often the feed of choice for producers who are over-wintering cows and stockers. Numerous studies indicate that grain sorghum silage is nutritionally superior to forage sorghum silage. It has a higher protein content and is more digestible than forage sorghum silage. Our previous trials have shown that only high-grain producing forage sorghum hybrids approach the feeding value of grain sorghum hybrids when they are fed in high-silage growing rations.

This experiment was conducted to examine the influence of the grain fraction on the in vitro dry matter disappearance (IVDMD) of forage sorghum silages. It was hypothesized that the IVDMD of the silage would be the sum of the IVDMD of the ensiled plant parts. Our objectives were to: 1) monitor changes in IVDMD as the ensiled plant parts were blended to comprise various proportions of the reconstituted silage dry matter; 2) develop regression equations to predict the IVDMD of forage sorghum silages based on plant part ratios; and 3) determine which plant part(s) concentrations would be the most useful criteria when selecting for improved silage digestibility.

Experimental Procedures

Five mid- to late-season forage sorghum hybrids were planted on June 3, 1987 and grown under dryland conditions on a Smolan silty clay loam soil near the Kansas State University campus in Manhattan. The hybrids included were Cargill 455, DeKalb 25E, Funk's 102F, Golden Acres-TE Silomaker, and Northrup King 300. One month prior to planting, 100 lb/acre of anhydrous ammonia was applied. A pre-plant soil test indicated that phosphorus and potassium were adequate. Furdan 15G® (Carbofuran, 1.0 lb/acre) was applied in the furrow at planting, and Atrazine® (2.5 lb/acre) was used as the pre-plant herbicide. Cygon (Dimethoate, .5 lb/acre) was used to control greenbugs, spider mites, and grasshoppers. A randomized complete block design with three replications was used, with each plot containing six rows, 30 inches apart and 200 feet in length.

All plots were harvested at the hard-dough state of kernel maturity. Stage of maturity was determined by visual and physical evaluation of several heads per plot. Silage yield was determined by harvesting three inside rows of each plot with a precision forage chopper. Grain yield was determined by clipping all heads from a random 60 foot section of the remaining inside row of each plot and threshing the heads in a stationary thresher. Three subsamples of five plants each were taken from the remaining inside row at harvest to determine plant part ratios. Plants were cut 2 inches above the soil surface, separated into grain, leaf blade (removed at the collar), sheath (removed at the node), and stalk. Separated materials were manually chopped to about 3/8-inch in length. Samples containing l/4 to l/2 pound of separate plant parts were then placed in nylon bags with a pore size of 1 mm. The nylon bags containing the plant part samples were ensiled along with their respective whole-plant material in plastic-lined, 55 gallon pilot silos, with two silos per hybrid. The silos were stored at outside ambient temperature for 120 to 135 days prior to opening. At opening, the nylon bags were recovered for chemical analyses. The pH was determined on the individual plant part samples and the surrounding silage. Samples were dried in a forced air oven at 130 F for 72 hours and then ground in a Wiley mill to pass a 1 mm screen.

The IVDMD of each silage sample was determined in triplicate. Earlier research in our laboratory (KAES Report of Progress 539) has shown a high correlation between silage IVDMD and *in vivo* apparent dry matter digestibility. To determine IVDMD dynamics for sorghum hybrids having different proportions of plant parts, each of the five forage sorghum silages and plant parts within each hybrid were combined in such a way that the samples had a specific plant part increased in 50 mg increments from the initial infield proportion to 1.0. These samples were adjusted to weigh 500 mg of DM $\pm$ 10 mg and were digested in duplicate. The IVDMD of each plant part of each hybrid was determined in triplicate.

Using plant part ratio data, the silages of the hybrids were reconstituted using the ensiled plant parts. The reconstituted silage IVDMD was determined in triplicate. The summation IVDMD of a hybrid was calculated by multiplying the proportion of the DM per part by the IVDMD of the respective part and then adding the four values.

Results and Discussion

Agronomic data for the five forage sorghum hybrids are shown in Table 25.1. The hybrids reached half bloom 71 to 77 days after planting and were harvested 108 to 118 days after planting (data not shown). Silomaker had the lowest grain yield, and NK 300 had the lowest silage yield. There were no significant differences among the hybrids for the proportion of the whole-plant DM as leaf or sheath. DeKalb 25E had the highest proportion of stalks and the highest forage to grain ratio.

All whole-plant silages and ensiled plant parts were well preserved, as indicated by the terminal pH values of approximately 4.0 and no observed spoilage or off odors (Table 25.2). The pH values of the grain were the highest. There were significant differences among the hybrids for IVDMD of the ensiled plant parts (Table 25.3). For all hybrids, the grain proportion had the highest IVDMD, whereas the sheath had the lowest. Our data suggest that increasing the grain proportion of forage sorghum would improve silage digestibility to a greater extent than increasing leaf proportion in forage sorghum hybrids.

The effects of increasing the proportion of each ensiled plant part in the reconstituted silages on IVDMD response are shown in Figures 25.1 to 25.4. For all silages, plots of IVDMD against increasing proportions of grain were positive (Figure 25.1), whereas plots of IVDMD against the proportion of sheath were negative (Figure 25.2). Plots of IVDMD against proportion of leaf (Figure 25.3) and stalk (Figure 25.4) produced less variation than did those against grain or sheath.

Only small differences in IVDMD were observed among the whole-plant silages, but significant differences in lVDMD occurred among the ensiled plant parts. These data indicate that the IVDMD of a forage sorghum silage is not the sum of the IVDMD of its ensiled plant parts. However, the IVDMD of the reconstituted silages were very close to the sum of the IVDMD of the ensiled plant parts (Table 25.4). There appeared to be an associative effect, i.e., a non-linear IVDMD response, when ensiled plant parts were blended to various proportions of the reconstituted silages. The proportion of grain in an ideal forage sorghum hybrid would be limited by such associative effects. Other research has demonstrated that 15 to 30% grain in a sorghum grain and silage-based ration increased digestibility and DM intake, but higher proportions of grain (45 to 60%) did not result in further improvement.

Regression equations were generated for predicting the influence of plant parts on the lVDMD of each of the live hybrids (Table 25.5). In all cases, grain entered the model first, providing additional evidence that the proportion of grain in forage sorghum hybrids has the greatest influence on the subsequent IVDMD of the whole-plant silage.

Table 25.1. Dry Matter Yields and Plant Part Percentages of the Five Forage Sorghum Hybrids

	DM Yield		Plant Part			
Hybrid	Grain	Silage	Grain	Leaf	Sheath	Stalk
	- - Tons/Acre - -		--- % of the Whole-plant DM - - -			
Cargill 455	2.9 [a]	8.8 [a]	37.1 [ab]	20.8	12.4	29.5 [bc]
DeKalb 25E	2.7 [a]	9.2 [a]	28.2 [a]	21.0	10.7	40.1 [d]
Funk's 102F	2.9 [a]	8.2 [b]	37.4 [ab]	21.0	12.7	28.9 [bc]
GA-TE Silomaker	2.4 [b]	8.0 [b]	39.9 [ab]	21.5	13.3	25.3 [abc]
NK 300	2.8 [a]	7.7 [b]	41.3 [b]	22.9	17.0	19.5 [ab]
LSD (P = .05)	.21	.50				
SE			4.42	1.78	1.99	2.30

[abcd] Means within a column with different superscripts differ (P<.05).

Table 25.2. pH Values for the Whole-plant and Plant-part Silages of the Five Forage Sorghum Hybrids

Hybrid	Whole-plant	Plant Part: Grain	Leaf	Sheath	Stalk
		-----------------pH-----------------			
Cargill 455	4.06 [c]	4.32 [ab]	4.18 [c]	4.02 [b]	4.10 [b]
DeKalb 25E	3.88 [a]	4.42 [a]	4.04 [a]	3.97 [a]	3.80 [a]
Funk's 102F	4.07 [c]	4.36 [abc]	4.22 [d]	4.26 [d]	4.16 [c]
GA-TE Silomaker	3.98 [b]	4.41 [bc]	4.28 [e]	4.16 [c]	4.14 [bc]
NK 300	4.06 [c]	4.68 [d]	4.10 [b]	4.06 [b]	4.24 [d]
SE	.011	.017	.010	.012	.013

[abcde] Means within a column with different superscripts differ (P<.05).

Table 25.3. IVDMD of the Plant-part Silages of the Five Forage Sorghum Hybrids

Hybrid	Plant Part: Grain	Leaf	Sheath	Stalk
	------------- % of the DM ------- -------			
Cargill 455	72.4 [aw]	56.6 [by]	49.0 [az]	60.8 [bx]
DeKalb 25E	77.5 [bw]	61.4 [cx]	54.2 [by]	60.4 [bx]
Funk's 102F	78.2 [bw]	56.5 [aby]	53.2 [by]	55.3 [ay]
GA-TE Silomaker	77.3 [bw]	60.1 [bcy]	57.2 [cz]	65.3 [cx]
NK 300	79.2 [bw]	54.0 [ay]	49.6 [az]	62.2 [bx]
Mean	76.9 [bw]	57.7 [by]	52.7 [bz]	60.8 [bx]
SE	------------- 1.03 ---------------			

[abcd] Means within a column with different superscripts differ (P<.05).
[wxyz] Means on the same line with different superscripts differ (P<.05).

Table 25.4. IVDMD of Whole-plant Silage, Reconstituted Silage, and the Sum of the Plant Parts

Hybrid	Whole-plant Silage	Reconstituted Silage	Sum of the Plant Parts Silage
	- - - - - - - - - - - - - - - **% of the DM**	- - - - - - - - - - - - - -	
Cargill 455	58.4[by]	63.3[bz]	62.8[z]
DeKalb 25E	58.2[by]	66.4[az]	64.8[z]
Funk’s 102F	58.8[by]	63.4[bz]	63.8[z]
GA-TE Silomaker	61.5[ay]	67.7[az]	67.9[z]
NK 300	61.7[ay]	63.9[bz]	65.6[z]
SE	.238	.662	

[ab] Means within a column with different superscripts differ ($P<.05$).
[yz] Means on the same line with different superscripts differ ($P<.05$).

Table 25.5. Regression Equations for Predicting Silage IVDMD of the Five Forage Sorghum Hybrids

Hybrid	Intercept	Grain	Leaf	Sheath	Stalk	SE	R^2
Cargill 455	54.9	14.5	---	-7.8	1.6	.49	.97
DeKalb 25E	55.2	19.1	---	-4.0	.2	1.03	.89
Funk’s 102F	50.9	27.2	2.4	---	---	.77	.95
GA-TE Silomaker	53.2	20.1	3.7	---	1.1	1.40	.77
NK 300	50.8	30.4	----	-1.9	9.3	1.04	.95

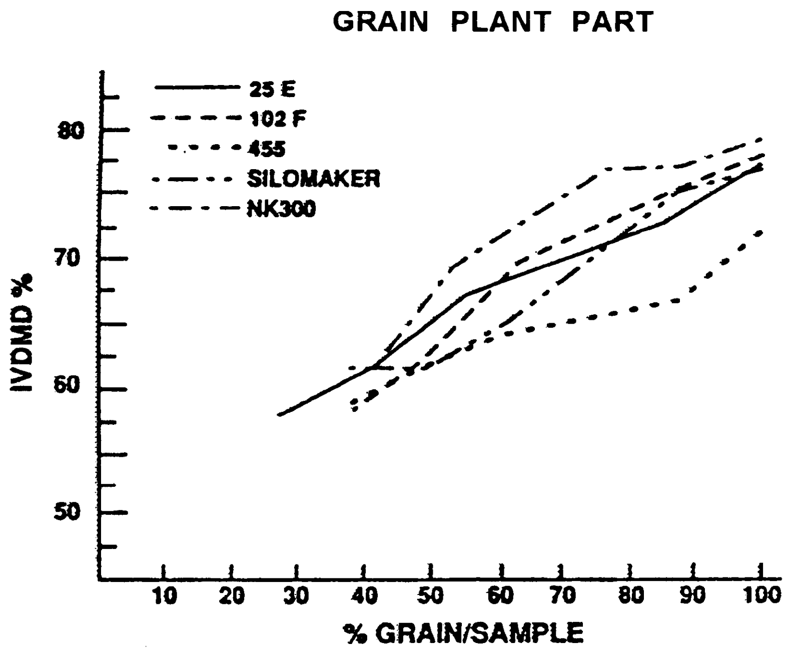

Figure 25.1. Effect of Increasing the Proportion of Grain in the Reconstituted Silages on IVDMD.

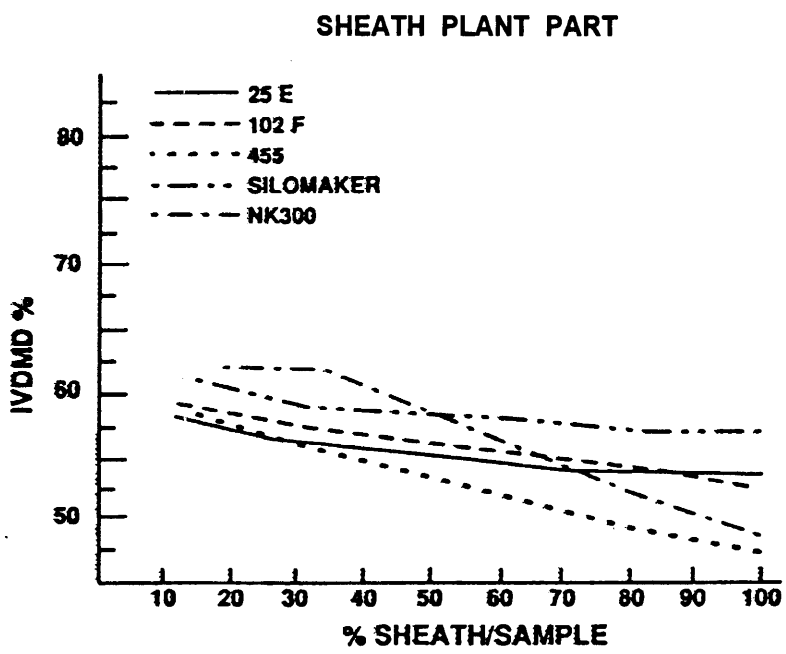

Figure 25.2. Effect of Increasing the Proportion of Sheath in the Reconstituted Silages on IVDMD.

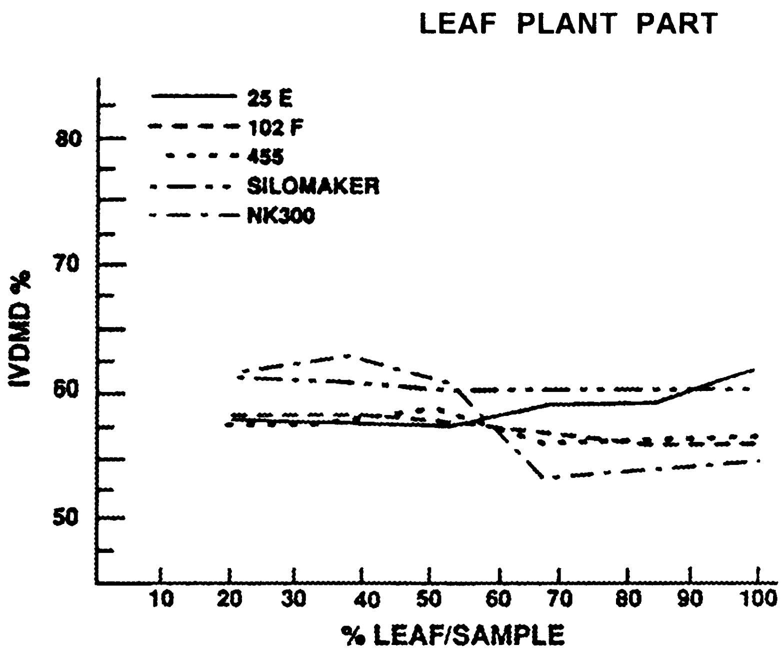

Figure 25.3. Effect of Increasing the Proportion of Leaf in the Reconstituted Silages on IVDMD.

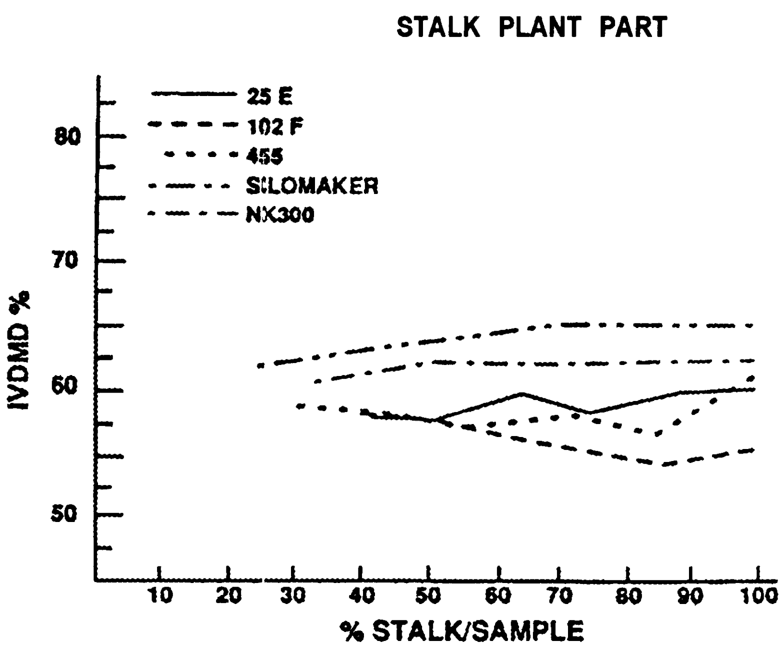

Figure 25.4. Effect of Increasing the Proportion of Stalk in the Reconstituted Silages on IVDMD.