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How Stems of Sorghum Silage are Digested

L.H. Harbers and R.A. Schweitzer

Summary

Upper and lower portions of stem from three sorghum cultivars were ensiled and then subjected to rumen fermentation. The lower stems were readily digested, whereas the upper sections were poorly utilized. Several microscopic techniques were used to help explain the difference.

Introduction

Forage sorghums are popular for silage because of their adaptability to different climates and their high dry matter yield. Sorghums are generally considered inferior to corn as a silage. Grain yield accounts for part of the difference. However, another factor may be the lower digestibility of the stem portion of the sorghum plant.

We investigated the differences in the upper and lower parts of stems of three cultivars at two stages of maturity to try to identify differences in plant structure that might affect utilization by cattle.

Procedures

Three sorghum cultivars — a full-season, non-heading type (Funks G-1990); a mid-season, heavy-heading cultivar (Acco 351); and a late-season, moderate-heading sorghum (DeKalb FS-25E) — were harvested at two stages of maturity — milk and mature.

Stalks selected at random were cut into half-inch sections and ensiled 90 days. Samples were taken within the first two internodes of the top and within the fourth and sixth internodes of the bottom of the stem. Ensiled samples were then digested in nylon bags inside rumens of fistulated steers for up to 48 hours and observed with a scanning electron microscope. Frozen samples of fresh stalks collected when the plants were cut for silage were sectioned for microscopic studies of lignin and starch location.

Results and Discussion

All sorghum stems appear to have the same tissue arrangement. The rind, composed of sclerenchyma cells and vascular bundles, forms the outer layer of the stem, the bulk of which is composed of parenchyma cells and scattered vascular bundles. Structural differences between the upper and lower internodes appear to be mainly cell size.

The major tissue digested in the rumen was the parenchyma or thin-walled cells in the lower portion of the stems. That digestion is exemplified in Fig. 42.1. The picture shows that after 18 hours of rumen digestion, lignified vascular bundles remain intact except for a small portion at the center of the bundles (phloem). Many of the thin-walled cells around those bundles have been removed. The rind area in the upper right hand corner is intact. The fermentation sequence has virtually reached its end point at this stage.

Fig. 42.2 is a photograph of the upper portion of the stem as it was removed from the silo. Note the small, irregular line of tissue breakdown around the inside of the rind. Rumen microorganisms attack this same area, but even after 48 hours, there is very little other tissue digested as shown in Fig. 42.3.

Using a light microscope and special stains, we found large amounts of lignin in the vascular bundles and in the rind of the upper stem where parenchymal cells were not digested. In the lower stem, the rumen microbes digested mainly the non-lignified, thin-walled cells.

Variations between cultivars were found when sections were stained for starch. The location of starch was apparently unrelated to either microbial fermentation patterns or entrance into tissues, except that starch might have encouraged digestion of the parenchyma adjacent to vascular bundles.

Differences between parenchymal cell walls of upper and lower internodes were found with fluorescence microscopy. We found a consistently greenish fluorescence in the parenchyma of the lower internodes, indicating a lack of lignification. On the contrary, a consistent blue fluorescence was present in parenchymal cell walls in the upper part of the stalk, indicating lignification or presence of lignin-type compounds.

The presence of some sort of lignin derivatives, as shown by fluorescence (but not staining) could explain why the parenchyma cells in the upper portion of the stem are not digested.

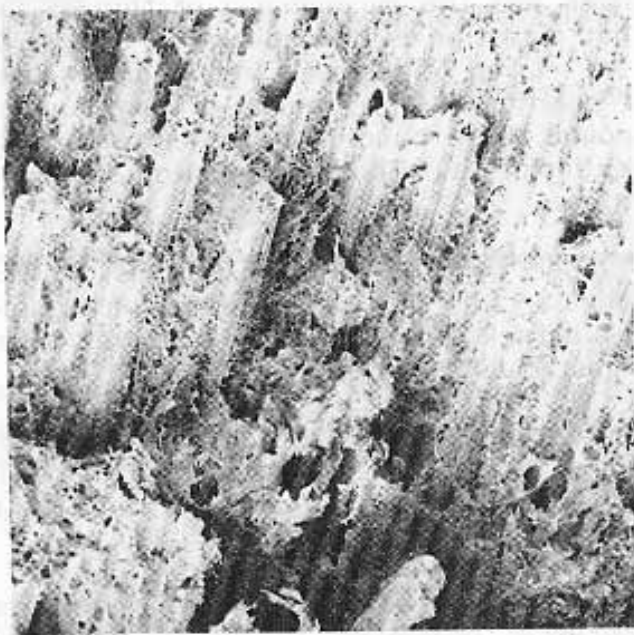


Figure 42.1. Photomicrograph of the lower stem after 18 hours of rumen fermentation, showing disappearance of thin-walled parenchyma with rind and vascular bundles remaining.

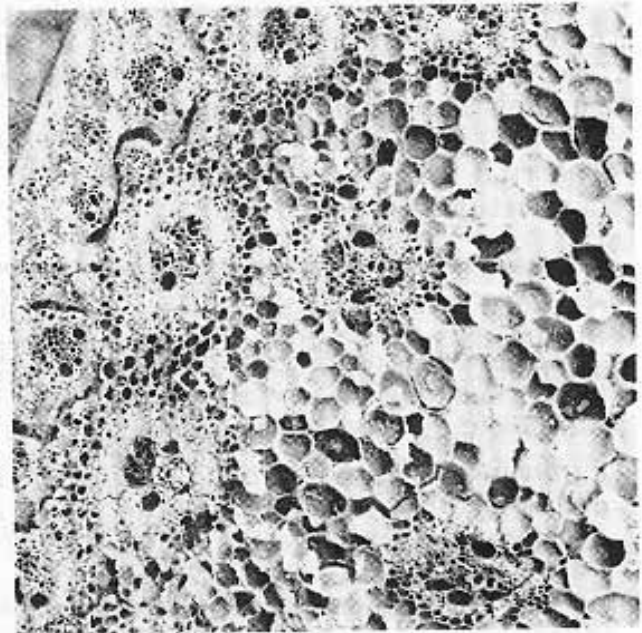


Figure 42.2. Ensiled upper internode (25E, milk stage), demonstrating erosion of intercellular material near the stem periphery during ensiling.

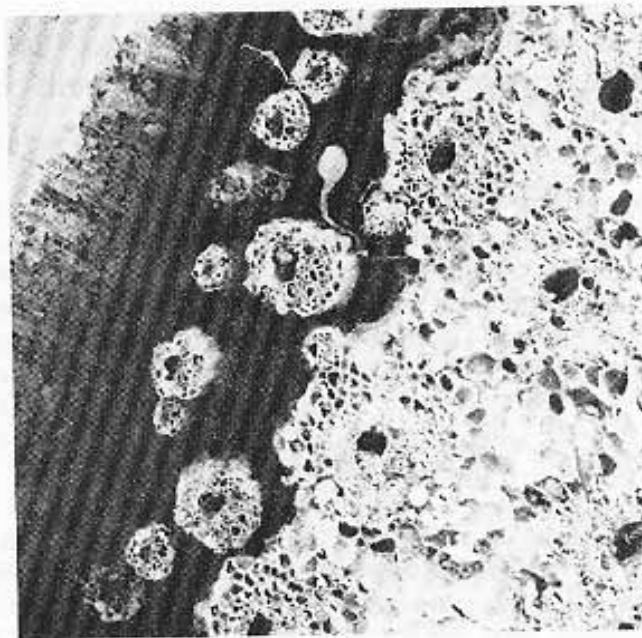


Figure 42.3. Upper stem after 24 hours of rumen fermentation, showing little digestion except of peripheral sclerenchyma. That tissue was also partially digested during ensiling (see Fig. 42.2).