

Effect of Stage of Maturity on the Chemical Composition and In Vitro Digestibility of Sorghum Grain

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Story in Brief

Dwarf Redlan (waxy), Redlan (normal) and Darset (bird-resistant) varieties of grain sorghum were collected at weekly intervals starting 35 days preharvest. The early maturing Darset (BR = Bird-resistant) variety contained 78.6 percent dry matter on day 35 while the Dwarf Redlan (waxy) was much less mature (58.6 percent dry matter) at the same point, indicating black layer formation and physiological maturity had not yet occurred for Dwarf Redlan. Moreover, dry seed weight did not plateau until day 28 preharvest for the Dwarf Redlan although the earlier maturing Darset (BR) and Redlan (normal) varieties had reached final dry matter deposition by day 35 preharvest. Dry matter deposition, as measured by dry seed weight, was essentially complete when the dry matter content of the grain reached 70 percent. Although the concentration of starch, ash and crude protein was very similar from day 35 through harvest for all three varieties, changes in soluble protein (Landry-Moureaux Fraction I) and tannin content continued throughout maturity, suggesting that physiological changes in the kernel may continue even after dry matter deposition is complete. In vitro dry matter disappearance (IVDMD) of the Dwarf Redlan (waxy) remained unaffected through maturity. Relative digestibility (IVDMD) of the Darset (BR) variety, however, continued to increase as maturity approached and as tannin levels decreased. These studies suggest that the success of early-harvesting sorghum grain may be partially dependent on the particular variety that is utilized.

Introduction

Underground water depletion in many areas, soaring costs of irrigation water and recent drought conditions in the Southern Great Plains have increased the appeal of sorghum grain as a production alternative. More livestock producers in Oklahoma will be faced with the opportunity or necessity of using sorghum grain in their feeding programs. In order to insure adequate utilization of sorghum grain, some form of processing is required. Unfortunately, sorghum grain is a highly variable product due to numerous factors such as variety, source, endosperm type and environmental conditions during growth. This variation may influence the success of sorghum grain processing efforts. One energy efficient grain processing alternative of current interest is to harvest grain before maturity (about 30 percent moisture) and store the material in a silo. Little is known, however, of the physiological changes that occur as the kernel matures, especially with BR sorghums. Consequently, the objective of this study was to monitor changes in chemical composition and in vitro digestibility of several varieties of sorghum grain as they progress through maturity.

Materials and Methods

Three varieties of sorghum grain (Table 1) were grown and harvested under similar conditions at the Southwestern Livestock and Forage Research Station, El Reno, Oklahoma. Grain samples were collected at weekly intervals starting about 5 weeks preharvest. Each sample was hand-threshed, cleaned and ground through a 20-mesh screen in a laboratory Wiley mill. Starch content was measured as α -linked glucose polymers using an enzymatic method, and tannin content was determined by a modified vanillin-HCl assay. Crude protein was determined by Kjeldahl analysis and soluble protein by the first stage of the Landry-Moureaux Fractionation Sequence D. Relative digestibility of each sample was estimated by an in vitro dry matter disappearance (IVDMD) technique. Ground grain samples (.4 g dry matter) were placed in 50-ml centrifuge tubes and inoculated with buffered rumen fluid (15 ml McDougall's buffer: 15 ml strained rumen fluid) from a concentrate (80 percent corn) fed steer. After 18 hours of incubation at 39° C (102° F), the samples were centrifuged, decanted and dried. Percent IVDMD was calculated by difference.

Table 1. Descriptive characteristics of sorghum grain

Variety	Seed coat color	Testa ^a layer	Endosperm		
			color	starch type	Classification
Dwarf Redlan	red	absent	white	waxy ^b	waxy
Redlan	red	absent	white	normal ^c	normal
Darset	brown	present	white	normal	bird-resistant

^aPresence of testa layer indicative of high tannin levels.

^bWaxy starch contains essentially 100% amylopectin.

^cNormal starch contains about 75% amylopectin and 25% amylose.

Results and Discussion

The three varieties used in this study appeared to mature at different rates (Figure 1). The Darset (BR) sorghum matured the earliest (78.6 percent dry matter on day 35 preharvest) while the Dwarf Redlan (waxy) matured much more slowly (58.6 percent dry matter on day 35). This pattern is also reflected in dry seed weight (Figure 1). The dry weight of 100 kernels for the Darset and Redlan varieties had reached harvest levels by day 35 preharvest, except for a slight deviation for the Redlan on day 21 preharvest, suggesting that the deposition of seed components (starch, protein, etc.) was complete. The slower maturing Dwarf Redlan, however, increased dry matter deposition until day 28 preharvest. These observations reinforce the theory that the deposition of dry seed components is complete when the dry matter of the kernel reaches about 70 percent.

The concentration (percent of dry matter) of starch and ash in each of the three varieties was very similar from day 35 preharvest to maturity (Figure 2). Crude protein content (percent of dry matter) was also fairly constant during this period (Figure 3). In contrast, the concentration of Landry-Moureaux Fraction I protein (highly soluble albumins and globulins) appeared to decrease during maturation for the Darset and increase for the Redlan (Figure 3). Although total protein deposition may be complete, changes in the physiological characteristics of that

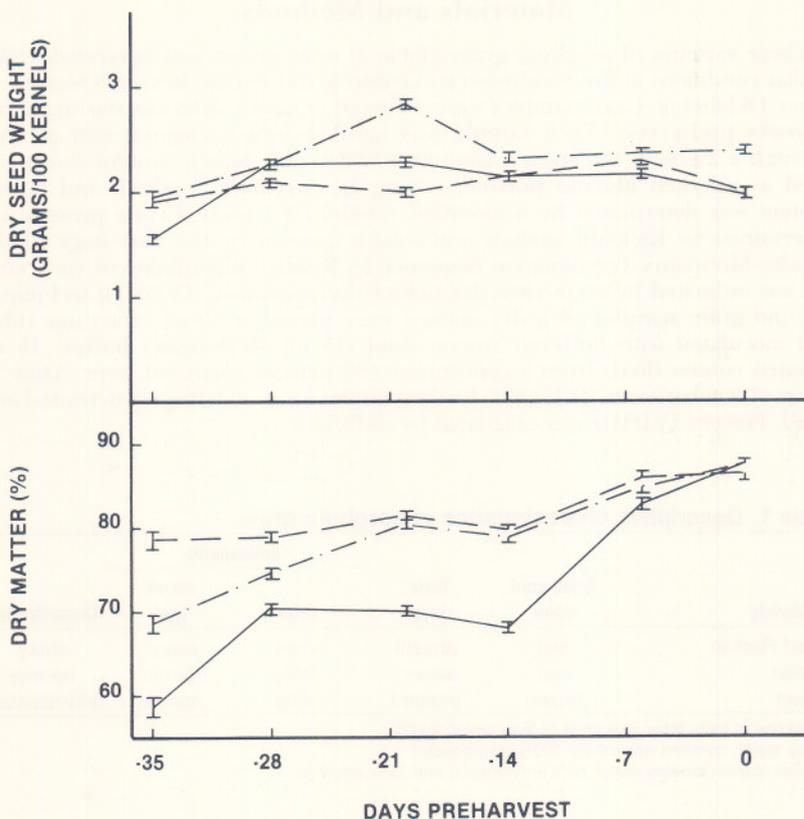


Figure 1. Effect of stage of maturity (mean \pm S.E.) on dry matter content and dry seed weight (Dwarf Redlan —, Redlan --, Darset - -)

protein appear to continue. Tannin content of the Darset (BR) variety decreased between days 35 and 28 preharvest (Figure 4). If tannin content does decrease with maturity, as this study suggests, perhaps bird-resistant (high tannin) sorghums should not be harvested too early.

The digestibility (IVDMD) of the Darset (BR) variety appeared to increase as maturity progressed (Figure 4). The decrease in tannin content noted earlier may be partially responsible for this effect. The IVDMD of the Dwarf Redlan (waxy) was very constant from day 35 preharvest through maturity as was the Redlan variety except for an unexplainable depression on day 20 preharvest. Consequently, the digestibility of some varieties (Darset) may be affected by physiological changes in certain kernel components, i.e., tannin, while digestibility of other sorghum grain varieties remain unchanged.

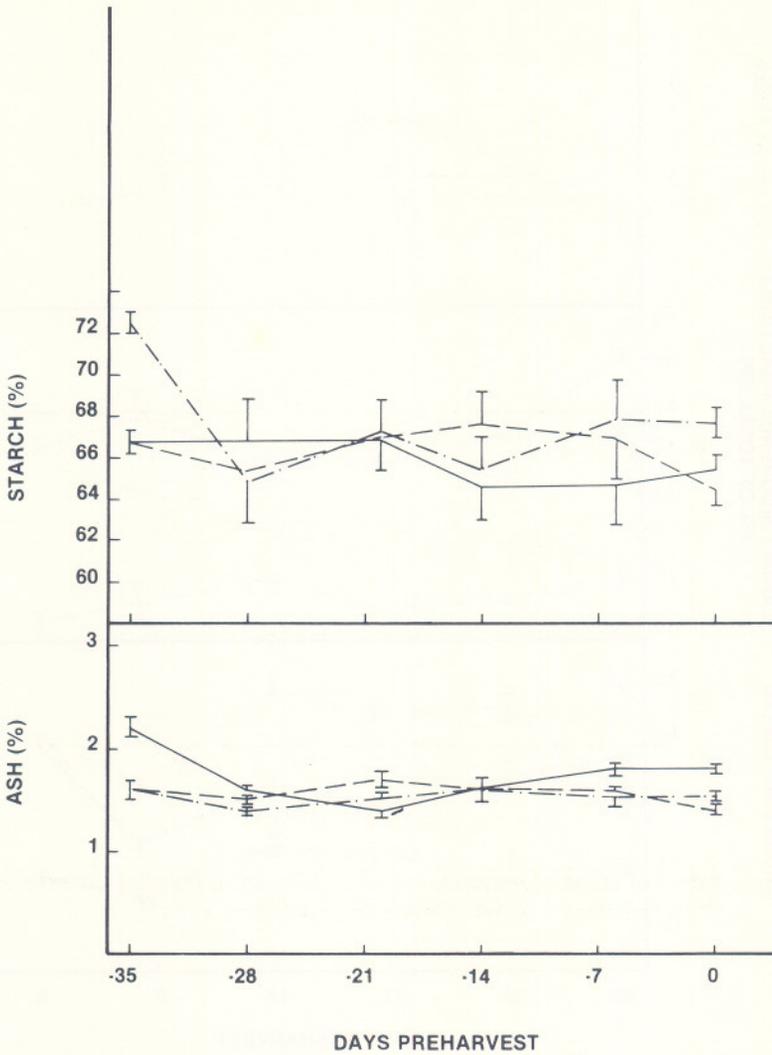


Figure 2. Effect of stage of maturity (mean \pm S.E.) on starch and ash content (Dwarf Redlan —, Redlan -·-, Darset - - -)

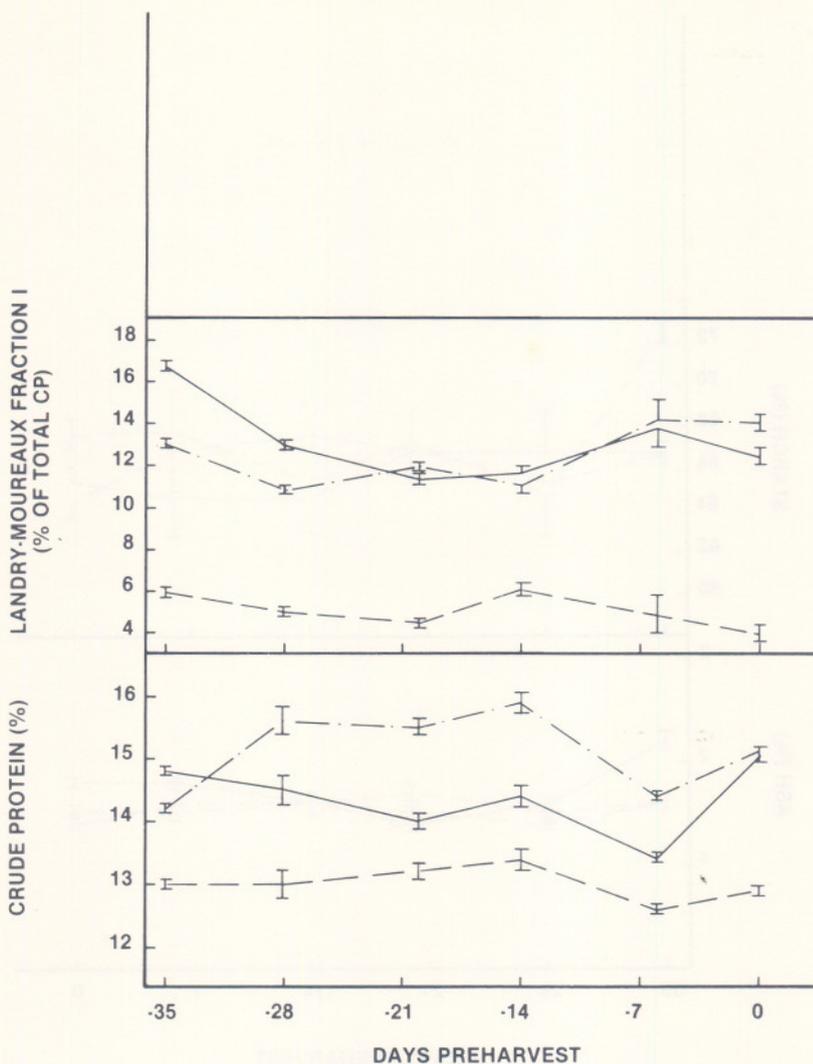


Figure 3. Effect of stage of maturity (mean \pm S.E.) on crude protein and Landry-Moureaux Fraction I protein (Dwarf Redlan —, Redlan - · -, Darset - - -)

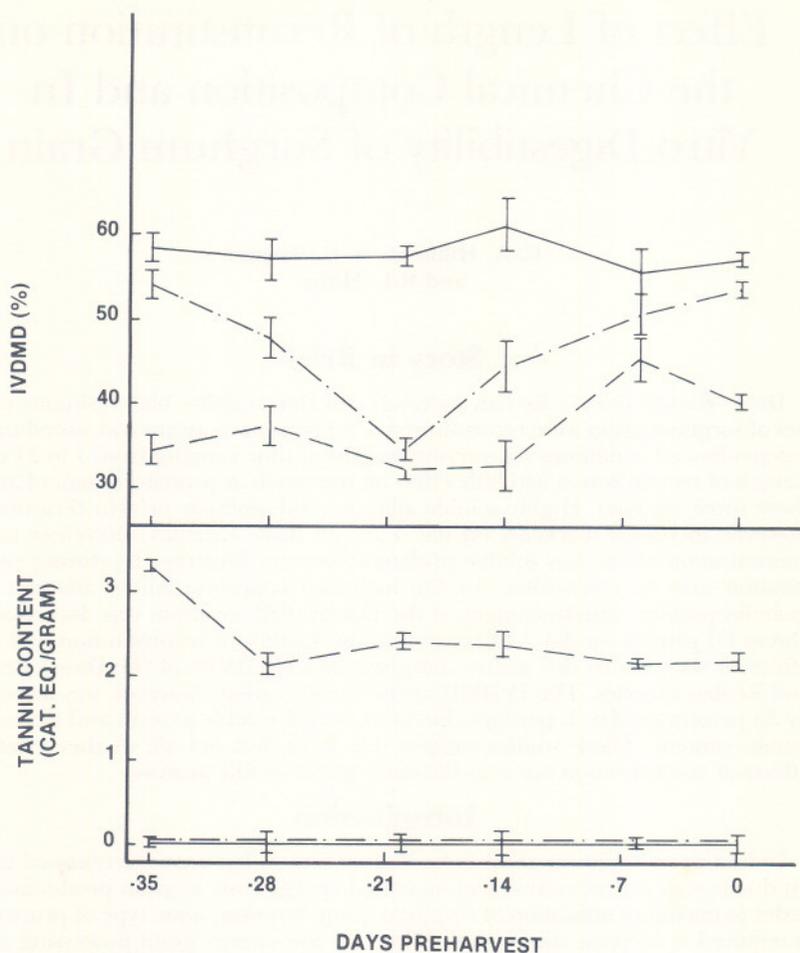


Figure 4. Effect of stage of maturity (mean \pm S.E.) on tannin content and IVDM (Dwarf Redlan —, Redlan -·-, Darset - - -)

High-moisture harvest of sorghum grain is normally initiated when the grain reaches about 30 percent moisture. These studies indicate that this practice is sound, at least for normal and waxy sorghums. The tannin content of the Darset variety declined in early maturity, suggesting that early harvesting of bird-resistant sorghums may not be feasible. However, in previous studies of reconstitution, fermentation of sorghum grain appeared to either inactivate or destroy most of the tannin in sorghum. If one can insure adequate fermentation of early harvested bird-resistant sorghum during ensiling, this concern may be of little consequence.