

Effect of Length of Reconstitution 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 (BR= bird-resistant) varieties of sorghum grain were reconstituted to 30 percent moisture and stored under oxygen-limited conditions for varying lengths of time ranging from 1 to 21 days. Length of reconstitution had little effect on the starch or protein content of any of these three varieties. Highly soluble albumin and globulin protein (Fraction I), however, increased markedly on day 1 for all three varieties. Decreases in the concentration of the less soluble prolamine protein (Fraction II) during reconstitution may be responsible for the increased concentration of albumin and globulin protein. Tannin content of the Darset (BR) sorghum was decreased by almost 60 percent on day 1 of reconstitution. Length of reconstitution had little effect on the in vitro dry matter disappearance (IVDMD) of the Dwarf Redlan and Redlan varieties. The IVDMD of the Darset variety, however, was increased by 35 percent on day 1, perhaps due to increased soluble protein and decreased tannin content. These studies suggest that most, but not all, of the beneficial effects of reconstitution occur in the early stages of this process.

Introduction

Utilization of sorghum grain in beef cattle rations has received renewed interest due to water conservation and increased energy costs in grain production. In order to maximize utilization of sorghum grain, however, some type of processing is required to increase starch availability. One low-energy grain processing alternative is to reconstitute the grain by raising the moisture level to 30 percent and storing it under oxygen-limited conditions for 21 days. Previous work in this laboratory has indicated that reconstitution is less effective for some varieties (waxy or normal) than for others (bird-resistant). In order to gain a better understanding of the sequence of events that occur during reconstitution, the chemical composition and relative digestibility (IVDMD) of several varieties of sorghum grain were monitored from day 1 through day 21 of reconstitution.

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. Seventy grams of whole berries of each variety were placed in 250-ml glass bottles and sufficient water added to raise the moisture level to 30 percent. The bottles were sealed and agitated frequently until all free water had been absorbed. Duplicate bottles were removed on days 1, 2, 3, 4, 5, 7, 9, 12, 16

Table 1. Descriptive characteristics of sorghum grain

Variety	Seed coat color	Testa ^a layer	Endosperm		Classification
			color	starch type ^b	
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.

and 21 of incubation and the samples were composited and ground through a 20-mesh screen in a laboratory Wiley mill with the aid of dry ice. Starch content was measured as α -linked glucose polymers using an enzymatic method and tannin content measured as catechin (tannin-like substance) equivalents by a modified vanillin-HCl assay. Crude protein was determined by Kjeldahl analysis and soluble protein by the first two stages of the Landry-Moureaux Fractionation Sequence D. Relative digestibility was measured by an in vitro dry matter disappearance (IVDMD) procedure. 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 tubes were centrifuged, decanted and dried. Percent IVDMD was calculated by difference.

Results and Discussion

Reconstitution had little effect on the starch content of any of these three varieties (Figure 1). Similarly, crude protein content was not markedly changed by length of reconstitution (Figure 1). Solubility properties of the sorghum protein, however, did appear to be altered. Highly soluble albumin and globulin protein increased on day 1 for all three varieties (Figure 2). This increase in soluble protein on day 1 may be due to water imbibition by the kernel as well as the initiation of germination. The concentration of these proteins decreased on day 2 for the Dwarf Redlan (waxy) and Redlan (normal) varieties. Perhaps fermentative action by bacteria reduces the concentration of soluble protein at this stage. By day 16, however, highly soluble Fraction I protein concentration had returned to pretreatment levels and continued to rise for the Redlan and Darset (BR) varieties through day 21. Soluble protein in Fraction I may have been increased at the expense of Fraction II protein (Figure 2). The concentration of prolamine (Fraction II) protein decreased as reconstitution progressed for all three varieties.

Other kernel components may also be changed by reconstitution. For example, tannin content of the Darset variety decreased markedly on day 1 (Figure 3), and continued to decrease, although more slowly, through day 21. The initial stages of the germination process may result in degradation or inactivation of tannin. Relative digestibility (IVDMD) of the Dwarf Redlan (waxy) and Redlan (normal) varieties was largely unaffected by reconstitution (Figure 3). In contrast, IVDMD of the Darset (BR) variety was increased almost 35 percent on day 1 of reconstitution, which raised this variety to a level similar to that of the Redlan variety. This

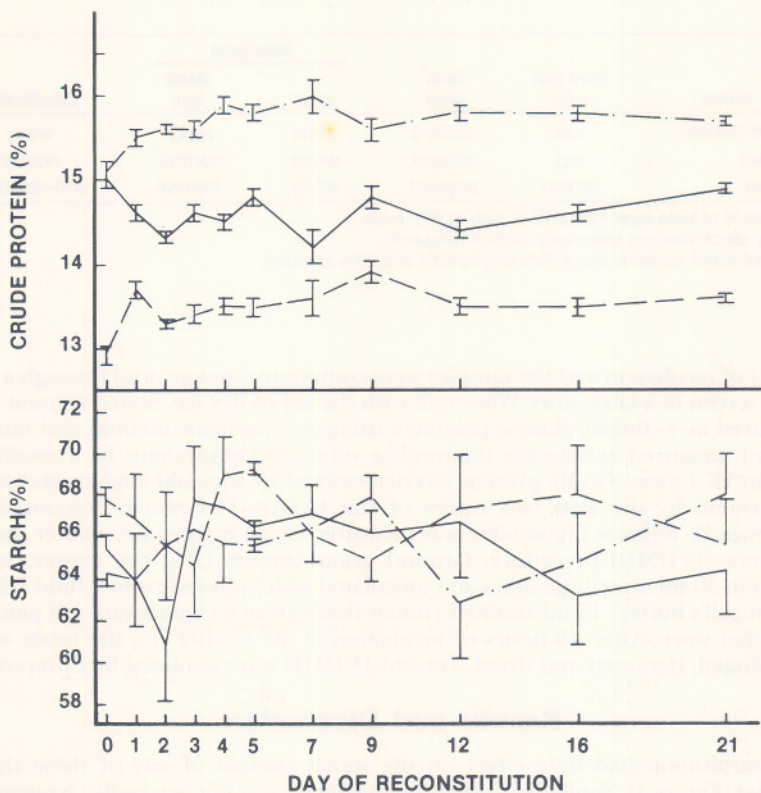


Figure 1. Effect of day of reconstitution (mean \pm S.E.) on crude protein and starch content of different sorghum grains (Dwarf Redlan —, Redlan--., Darset - - -)

effect is probably related to the increase in soluble (Fraction I) protein and decrease in tannin observed for the Darset variety on day 1.

Rapid changes in the chemical constituents of sorghum grain in the early stages of reconstitution indicate that much of the benefit of this process may be accrued fairly early in the normal 21-day period. For example, increased soluble protein and decreased tannin content of the Darset (BR) variety on day 1 apparently resulted in a rapid increase in IVDMD. Although a 21-day incubation is probably required to maximize the effect of reconstitution, much of the response generated by this process appeared in this study to occur by day 2 or 3. Consequently, this study suggests that in situations where turnover time of processed grain is critical, shorter reconstitution periods of 3 to 5 days might be considered.

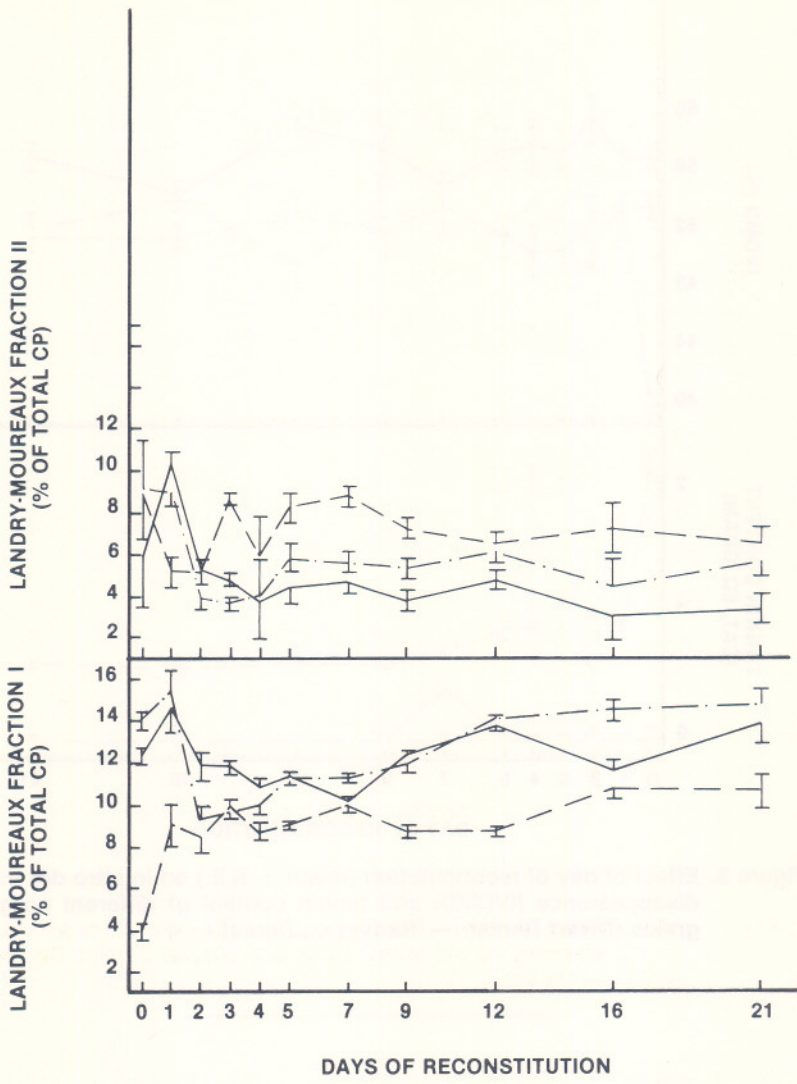


Figure 2. Effect of day of reconstitution (mean \pm S.E.) on some protein fractions in different sorghum grains (Dwarf Redlan —, Redlan -.-, Darset -.-)

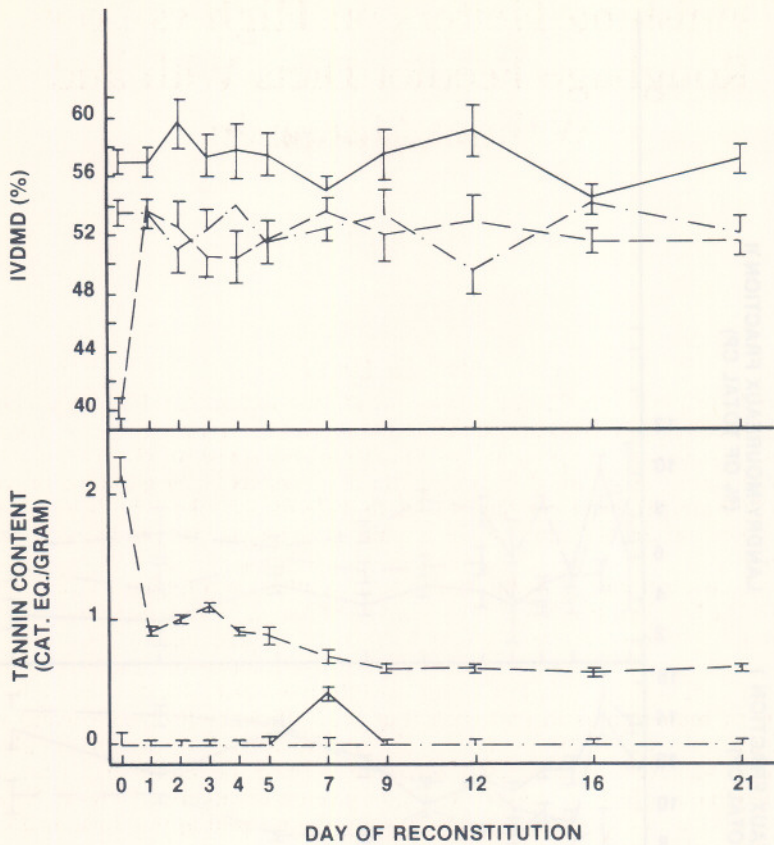


Figure 3. Effect of day of reconstitution (mean \pm S.E.) on in vitro dry matter disappearance (IVDM) and tannin content of different sorghum grains (Dwarf Redlan —, Redlan -.-, Darset - - -)