

feeding trials to evaluate the effect of tannins on feeding value. This information was prior to our current understanding that sorghum does not contain tannic acid.

**Myth #9: Sorghum tannins are unhealthy for humans and animals.**

**Fact:** Tannin sorghums are an outstanding source of antioxidants (Table 1) that can be used in a wide variety of applications including preservation of ground meat (Jeschke 2004). Recent evidence strongly indicates that tannins are of benefit to human health. Tannins bind proteins and make them indigestible. However, in vitro data indicate that the microflora in the colon degrade polymeric tannins into low molecular weight phenolic acids which could be absorbed through the colon (Deprez et al 2000). Tannins are nontoxic and may slow digestibility in humans, which is an advantage for type II diabetics.

**Table 1.** Antioxidant activity (ORAC) levels of tannin sorghum brans compared to common fruits. (Adapted from Awika 2004)

Commodity	ORAC (dry wt.)
Tannin sorghum bran	2400-3100
Blueberries	87-870
Strawberries	356-400
Plums	452-600
Grapes	100
Watermelon	15
Orange	80-150

**Myth #10: Tannin sorghums make unacceptable food products.**

**Fact:** Many excellent traditional products, such as porridges and alcoholic beverages, have been developed using tannin sorghums (Awika and Rooney 2004). Tannin sorghums are often preferred for production of sorghum beers and alcoholic beverages because of their dark color (Rooney and Awika 2004). The tannins affect malt enzyme activity but brewers avoid problems by using alkaline treatments during malting.

Good-quality breads containing tannin sorghum bran have high antioxidant and dietary fiber levels with a natural dark brown color and excellent whole grain flavor (Gordon 2001). In addition, healthy bread mixes containing tannin sorghum bran, barley flour, and flaxseed have been developed (Rudiger 2003).

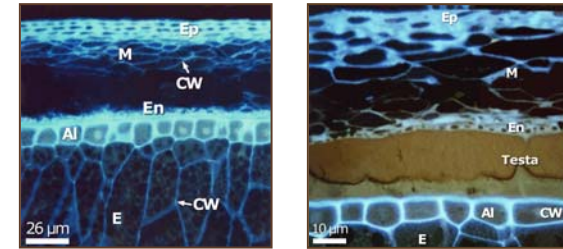
**Acknowledgment:** Partial Support for this work has been provided by the USAID Collaborative Research Support Program under INTSORMIL since 1979 and by the Texas Agricultural Experiment Station, Texas A&M University, College Station Texas. The sorghum program at Texas A&M has provided excellent support for this work on sorghum improvement over the past 40 years. Numerous graduate students, staff and colleagues have assisted in these research efforts.

## Myths About Sorghum Tannins

Lloyd Rooney, Regents Prof. & Faculty Fellow, C. McDonough, Research Scientist, and L. Dykes, Research Associate  
Cereal Quality Lab, Texas A&M University,  
College Station, TX 77843-2474 USA  
lrooney@tamu.edu

**Myth #1: Tannins are in all sorghums.**

**Fact:** Tannins are present only in sorghums with a pigmented testa layer (Fig. 1). The presence of the testa layer is controlled by  $B_1$  $B_2$  genes. When  $B_1$  $B_2$  is dominant, a pigmented testa is present. Sorghums without a pigmented testa do not contain tannins but in the analysis other nontannin materials absorb light and are usually reported as tannins.



**Fig. 1.** Fluorescence photomicrograph of cross-sections of a non-tannin (left) and a tannin sorghum kernel (right, adapted from Earp et al. 2004). Ep- epicarp; M- mesocarp; CW- cell wall; En- endocarp; Al- aleurone; E- endosperm cell

**Myth #2: Tannin sorghums are toxic.**

**Fact:** Tannin sorghums have erroneously been reported to contain tannic acid. Tannin sorghums have condensed tannins, which are not toxic. Many foods such as grapes, blueberries, cranberries, dark chocolate, and carobs have condensed tannins. These foodstuffs are consumed without adverse effects and are considered to be health foods because of the antioxidant properties of the tannins. Tannin sorghums are consumed by humans extensively in Africa and Asia.

**Myth #3: Birds and animals will not eat tannin sorghums.**

**Fact:** In a field with white, red, and tannin sorghums, birds will first eat white sorghum and then red sorghums before eating the tannin sorghums. Birds and animals consume tannin sorghums but prefer other sorghums when given a choice.

**Myth #4: Tannin sorghums prevent the digestion of nutrients.**

**Fact:** Tannins can decrease the feed efficiency of livestock, depending on the animal species, the method of processing the grain and the diet fed. In general, animals consume more feed to produce about the same or slightly less weight gains. The feed efficiency can be reduced by 5 to 10% compared to non-tannin sorghums.

**Myth #5: Tannins are measured by total phenol analysis.**

**Fact:** The total phenol analysis measures phenolic acids, flavonoids (i.e. anthocyanins, flavones, flavonols), condensed tannins, and tyrosine. All plants contain phenols.

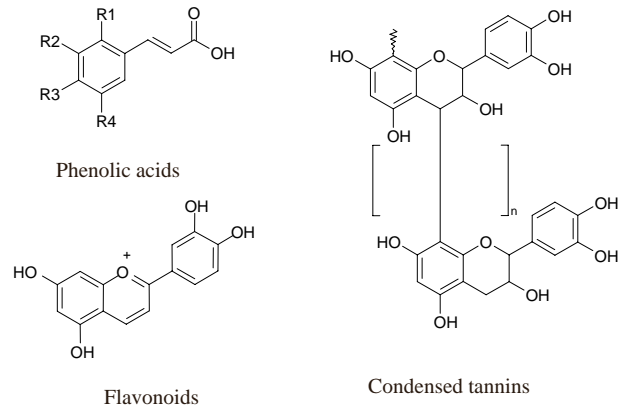


Fig. 2. Structures of phenolic compounds.

**Myth #6: It is difficult to test for tannins.**

**Fact:** The chlorox bleach test is a good tool to identify sorghum with tannins. For tannin sorghums, bleaching dissolves the pericarp and turns the pigmented testa of tannin types black; non-tannin sorghums do not turn black (Fig. 3). However, the bleach test can yield false-positives on samples that have been molded and weathered which means that some non-tannin kernels might have some dark spots (Dykes et al. 2002, Taylor, 2001, Waniska et al. 1992).

Colorimetric methods have been used to measure sorghum tannins. These include the Vanillin/HCl assay and the HCl/Butanol assay. These methods are quick and economical to perform and give an estimate of tannin content.

Normal-phase HPLC analysis with fluorescence detection efficiently separates tannins according to their degree of polymerization (Gu et al. 2002, Awika et al. 2003) and shows that sorghums without a pigmented testa have no tannins.



Fig. 3. Chlorox bleach test of non-tannin and tannin sorghums.

**Myth #7: All red sorghums have tannins.**

**Fact:** Grain color is not a reliable indicator of tannins in sorghum (Fig. 3). Only sorghums with a pigmented testa layer contain tannins. The presence of tannins in sorghums is controlled by the  $B_1$ - $B_2$  genes. Sorghums with a white, red, or lemon yellow pericarp may or may not have tannins. The grain in Fig. 3 with a testa has condensed tannins and cannot be visually distinguished from the ones without pigmented testa.

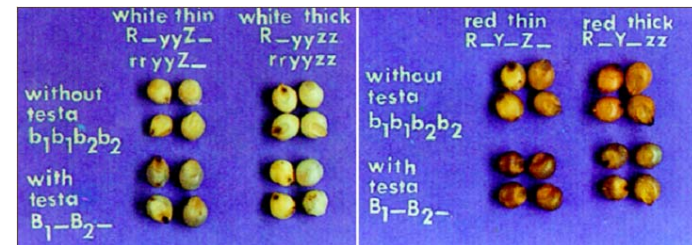


Fig. 3. Variation in appearance of sorghum tannins. (Adapted from Rooney and Miller 1982).

**Myth #8: Tannic acid is present in tannin sorghums**

**Fact:** Tannic acid has never been found in sorghum even though tannic acid has been used as a reference (standard) in some of the analyses. Only condensed tannins are present in tannin sorghums. Early experiments used tannic acid in