

Ten Myths about Tannins in Sorghums

L Rooney (Department of Soil & Crop Science, Texas A&M University, College Station, TX 77843-2474, USA)
Corresponding author: lrooney@tamu.edu

Myth #1: Tannins are present in all sorghums

Fact: 99% or more of all sorghums in the USA do not contain tannins. Tannins are present 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.

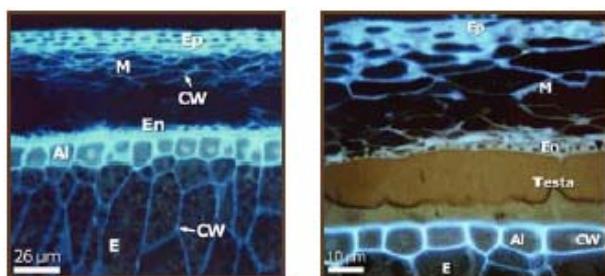


Figure 1. Fluorescence photomicrograph of cross-sections of a non-tannin (left) and a tannin sorghum kernel (right, adapted from Earp et al. 2004).

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 any adverse effects and are now considered as health foods because of the antioxidant properties of the tannins. Tannin sorghums are consumed as human food extensively in Africa and Asia without problems.

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: Tannins are measured by total phenol analysis

Fact: The total phenol analysis measures phenolic acids, condensed tannins, and tyrosine. All plants contain phenolic compounds.

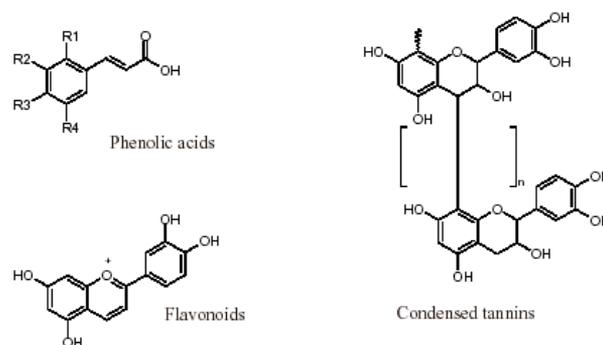


Figure 2. Structures of phenolic compounds.

Myth #5: Tannin sorghums prevent the digestion of nutrients

Fact: Tannins will decrease efficiency of growth in poultry and livestock; however, the amount depends on the animal species, processing the grain before feeding and the diet fed. In general, animals consume more feed to produce about the same or slightly less weight gains. In general, the feed efficiency is reduced by 5 to 10%.

Tannin sorghums do slow and reduce the digestibility of nutrients especially proteins. However, Elkin et al. (1996) demonstrated that sorghums containing equivalent amounts of tannins have different digestibilities. This suggests that tannins are only partially responsible for lower protein digestibility.

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. Care must be used when evaluating the bleached samples since some nontannin kernels might have some dark spots (Dykes et al. 2002, Taylor 2001,

Waniska et al. 1992).

Colorimetric methods have been used for many years 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). This research will provide significant new information on sorghum tannins.

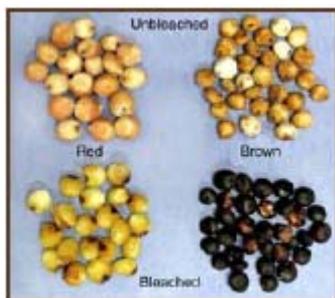


Figure 3. Chlorox bleach test of non-tannin and tannin sorghums.

Myth #6: All red sorghums have tannins

Fact: Grain color is not a reliable indicator of tannins in sorghum (Fig. 4). Only sorghums with a pigmented testa layer contain tannins. The presence of tannins in sorghums is controlled by the B_1-B_2 gene. Sorghums with a white, red, or yellow pericarp may or may not have tannins. The grain in Fig 4 with a testa has condensed tannins and cannot be distinguished from the ones without pigmented testa.

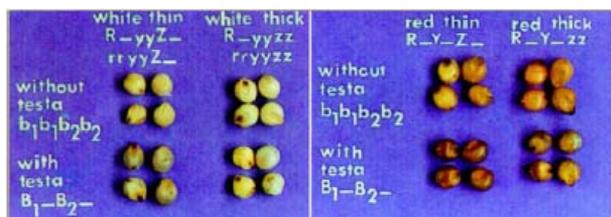


Figure 4. Variation in appearance of sorghum tannins. (Adapted from Rooney and Miller 1982).

Myth #7: 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 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 #8: 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 indicagtes that tannins are of benefit to human health. Tannins are known to bind to proteins making them indigestible since some animal studies have shown that they are excreted in the feces intact. However, in vitro data indicate that the microflora in the colon can degrade polymeric tannins into low molecular phenolic acids which could be absorbed through the colon. Tannins are nontoxic and may slow digestibility in humans, which is an advantage to type II diabetics.

Myth #9: Tannin sorghums make unacceptable food products

Fact: Many acceptable products, such as porridges and alcoholic beverages, have been developed from tannin sorghums in Africa (Awika and Rooney 2004). 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). 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.

Table 1. Antioxidant activity (ORAC) levels of tannin sorghum brans compared to common fruits. (Adapted from Awika 2003).

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: There are NO uses for tannin sorghum

Fact: Tannin sorghums have been used in the production of good-quality breads, malt, beer, and distilled beverages (Maltai). Tannin sorghum brans have higher antioxidant activity in vitro than fruits (Table 1). Sorghum tannins can be used as antioxidants in meat systems (Jeschke 2004) and they may retard oxidative damage due to high-energy irradiation (McDonough et al. 2004).

References

- Awika JM.** 2003. Antioxidant properties of sorghum. Ph.D. Dissertation, Texas A&M University, College Station, TX, USA.
- Awika JM, Dykes L, Gu L, Rooney LW and Prior RL.** 2003. Processing of sorghum (*Sorghum bicolor*) and sorghum products alters procyanidin oligomer and polymer distribution and content. *J. Agric. Food Chem.* 51:5516–5521.
- Awika JM and Rooney LW.** 2004. Sorghum phytochemicals and their potential impact on human health. *Phytochemistry* 65:1199–1221.
- Dykes L, Awika JM, McDonough CM, Rooney LW and Waniska RD.** 2002. False positives for tannin sorghum in non-tannin sorghum using the bleach test. Online: <http://www.aaccnet.org/meetings/202/abstracts/a02ma286.asp>.
- Earp CF, McDonough CM, Awika JM and Rooney LW.** 2004. Microscopic changes during development of sorghums with and without pigmented testa. *J. Cereal Sci.* 39:153–161.
- Elkin RG, Freed MB, Hamaker BR, Zhang Y and Parson CM.** 1996. Condensed tannins are only partially responsible for variations in nutrient digestibilities of sorghum grain cultivars. *J. Agric. Food Chem.* 44:848–853.
- Gordon LA.** 2001. Utilization of sorghum brans and barley flour in bread. M.S. Thesis, Texas A&M University, College Station, TX, USA.
- Gu L, Kelm M, Hammerstone JF, Beecher G, Cunningham D, Vannozzi S and Prior RL.** 2002. Fractionation of polymeric procyanidins from lowbush blueberry and quantification of procyanidins in selected foods with an optimized normal-phase HPLC-MS fluorescent detection method. *J. Agric. Food Chem.* 50:4852–4860.
- Jeschke B.** 2004. Chemical, color and sensory attributes of sorghum bran-enhanced beef patties in a high oxygen environment. MS Thesis. Texas A&M University, College Station, TX, USA.
- McDonough CM, Awika JM, Turner ND, Xu L and Rooney LW.** 2004. The potential for use of antioxidants from sorghum bran in foods as countermeasures against radiation damage in space. Online: <http://www.aaccnet.org/meetings/2004/abstracts/a04ma391.htm>.
- Rooney LW and Awika JM.** 2004. Specialty sorghums for healthful foods. Pages 283–312 in *Specialty Grains for Food and Feed* (Abdel-Aal E and Wood P, eds.). American Association of Cereal Chemists. St. Paul, MN.
- Rooney LW and Miller FR.** 1982. Variation in the structure and kernel characteristics of sorghum. Pages 143–162 in *Proceedings of the International Symposium on Sorghum Grain Quality*, Oct. 28–31, 1981 (Rooney LW and Murty DS, eds.). Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.
- Rudiger C.** 2003. The formulation of a nutraceutical bread mix using sorghum, barley, and flaxseed. M.S. Thesis, Texas A&M University, College Station, TX, USA.
- Taylor JRN.** 2001. Methods to be used to Identify and Specify Characteristics Desired by Industrial Processors that use Sorghum as an Input, Technical Report #2. Task Order No. 4.1. USAID, Gaborone, Botswana.
- Waniska RD, Hugo LF and Rooney LW.** 1992. Practical methods to determine the presence of tannins in sorghum. *J. Appl. Poultry Res.* 1:122–128.