

Sorghum Composition, Structure, and Quality

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TAES - Texas Agricultural Experiment Station
National Grain Sorghum Producers Assn.
INTSORMIL- International Sorghum and Millet
Collaborative Research Support Program
USAID- United States Agency for
International Development



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Sorghum Kernel Characteristics and Structure

'Color' is affected by pericarp color (1), pericarp thickness (2), pigmented testa (3), endosperm color (4), and glume color.

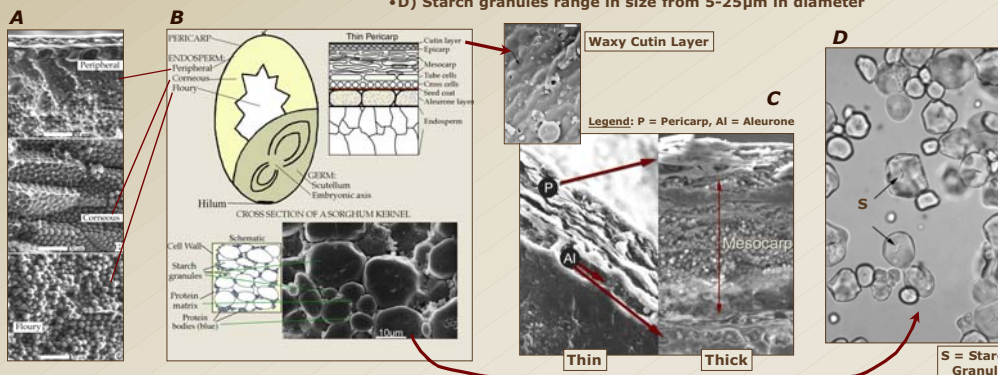


Sorghum Kernel Characteristics:

- Naked caryopsis
- Flattened, spherical, and obovate shapes
- Thousand kernel wt 20-35 g
- Test weight 55 to 63 lb/bu
- Grain density 1.20-1.40 g/cc

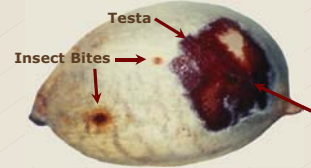
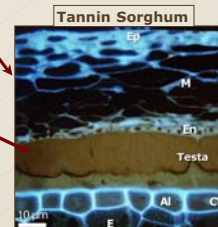
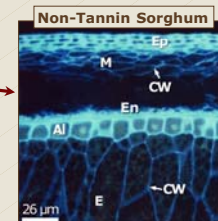
Structural Descriptions, all determined by genetics (below left to right):

- A) 3 types of endosperm - peripheral, corneous, floury
- B) Kernel structure schematic showing pericarp and endosperm structure
- C) Thin or thick pericarp with a waxy cutin layer on the surface; thick pericarp contains starch in the mesocarp while thin has no starch; pigmented compounds can be in the pericarp and aleurone
- D) Starch granules range in size from 5-25µm in diameter



Myths About Tannins in Sorghum

FGIS/GIPSA Class	Genetics
Sorghum No Tannins	b ₁ b ₂ B ₂ ---
Tannin Sorghum Low Tannins	B ₁ -b ₂ B ₂ ---
Tannin Sorghum High Tannins	B ₁ -B ₂ -S s



Legend: Ep = epicarp, M = mesocarp, En = endosperm, CW = cell wall, AI = aleurone, E = endosperm

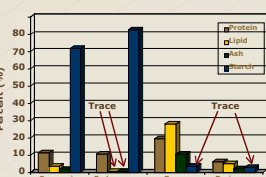
- 99% of US Sorghums do not contain tannins
- All sorghums contain phenols
- Most sorghums do not contain any condensed tannins
- Only sorghums with B₁-B₂-ss and B₁-B₂-S₁ have condensed tannins (brown sorghums)
- Most analytical tests measure total phenols but report the data as tannins
- Tannic acid does not occur in any sorghum
- Tannin sorghums have reduced feed efficiency
- Testa is detectable in brown sorghums using the bleach test (right)
- Sorghums with tannins can be used as functional foods



Composition of Grain

TABLE 1. Typical Composition of Sorghum Grain Mean Range

Proximate analysis	Mean	Range
Protein (Nx6.25), %	10.6	8.1-16.8
Ether extract, %	3.4	1.4-6.2
Crude fiber, %	2.7	0.4-7.3
Ash, %	2.2	1.2-7.1
Nitrogen free extract ^a , %	79.5	65.3-81.0
Fiber, %		
Insoluble	7.2	6.5-7.9
Soluble	1.1	1.0-1.2
Acid detergent	3.3	2.9-3.6
Protein fractionation		
Prolamine, %	52.7	39.3-72.9
Glutelins, %	34.4	23.5-45.0
Albumins, %	5.7	1.6-9.2
Globulins, %	7.1	1.9-10.3



Percent of components in each part of the caryopsis

Comparisons with Maize

- Protein slightly higher and fat lower
- Tryptophan slightly higher
- Lysine slightly lower
- First limiting in lysine, then threonine
- Lysine provides about 45% of FAO/WHO requirement
- Starch similar to maize
- Tannins in brown sorghum only
- Phytin content similar to maize
- Reduced aflatoxins and fumonisins

Factors Affecting Sorghum Quality/Composition



Insect bites and adverse environmental conditions (weathering, A above) produce pigmented spots in the affected areas, and produce false positive bleach test results in red and white varieties (arrows). Weathering in the field can seriously darken white kernels (B).



Discolored Damaged
Hot and humid conditions during maturation negatively affect grain quality and result in discolored and/or damaged grain



Types of Damage:
Molds, insect, excessive heat, and moist conditions that induce sprouting will adversely affect kernel quality. Sound grain at top for comparison.

Sorghum Quality is Affected By:

- Genetics
- Environment
- Genetics x Environment
- Harvesting, Drying, and Storage conditions
- Handling/Blending/Cleaning

U.S. Federal Grain Inspection Service (FGIS/ GIPSA) recognize four market classes:

- "Sorghums" - any pericarp color, less than 3% kernels with tannins
- "White Sorghums" without pigmented testa
- "Tannin Sorghums" have a thick colored testa
- "Mixed Class" > 3% kernels with tannins

Grade	Federal Grain Inspection Service Market Classes (FGIS/GIPSA)				Broken Kernels and Foreign Material	
	Minimum Test (lb/bu)	Moisture (%)	Total (%)	Heat Damaged (%)	Total (%)	Foreign Material (%)
US No 1	57	13	2	0.2	4	1.5
US No 2	55	14	6	0.5	7	2.5
US No 3	53	15	10	1	10	3.5
US No 4	51	18	15	3	13	4.5