

## Utilization of African Grains in Nutritionally Unique Foods

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African grains vary significantly in kernel structure, processing properties, and nutritionally important components. The major African grains are sorghum, pearl millet, *fonio*, *teff*, and finger millet. They are used as whole ground grains or they are pearled to remove the pericarp as bran. The type of grains grown in the region varies depending upon the variety which has been used for centuries. Some special grains are grown and used for special foods. We focus on sorghum because it is widely used in Africa and India. For example the sorghums in India are grown in the rainy season and also in the dry season. The *rabi* or dry season sorghums have white softer kernels because there is little rain during production. For the wet season, lemon-yellow sorghums are usually preferred. In Africa, sorghum is used in production of many different foods, from beer to an array of porridges.

The use of whole grains from sorghum provides an excellent array of products with good nutritional value that differ in color and other attributes. Sorghums can be used effectively to produce gluten-free products that are attractive, nutritious, and profitable. The supply chain for special sorghums is improving but still limited. Sorghum has relatively high grain yields and is well adapted to a range of environments. Sorghums are strong competitors in gluten-free foods as well as other food systems that use sorghum bran or whole grain in blends. Sorghum ranges from bland flavor and light color to dark chocolate-like colors with unique phytochemicals. It's a productive crop with high grain yields adapted to hot dry areas where other crops are not well adapted. For example it will produce grain under hot dry conditions where maize fails and is contaminated with aflatoxins.

Sorghum varies in composition and kernel structure and is consumed as porridges, flat breads, couscous, and a wide variety of fermented products and composites with cowpeas and other grains. Most sorghums are milled by decortication to remove the pericarp to produce food products, usually porridges and couscous, or endosperm particles cooked into thick and thin porridges. Some very soft floury sorghums are ground into whole grain meal or flour and used in numerous foods. In some cases, only soft floury sorghums can be grown and they often contain tannins which control grain deterioration and

bird damage in the field. Tannin sorghums are soft and cannot be decorticated so they are used as ground whole porridges especially when hard work is being done. The tannin sorghums are preferred since they "stay with the person longer" than white sorghum porridges. Special foods made from high tannin sorghums are provided to new mothers. In some cases, the pigments of sorghum are used as a colorant for foods. Sorghum hybrids are high yielding and can be milled into an array of gluten-free and slowly digested products.

Sorghums are often misunderstood because they have tannins which adversely affect the nutritional value of high tannin sorghums. Thus, for feeding animals the tannin sorghums are not preferred because they negatively affect digestibility and thus reduce the feed efficiency of the grains. Therefore, the industry has discounted the feeding value of tannin sorghum grains. Tannin sorghums are said to be bird-proof but birds will eat tannin sorghum if other foods are unavailable. The tannins protect the grain against mold deterioration in the field.

Sorghums vary significantly in phytochemicals depending upon their genetics. Sorghum is a practical source of desirable phenolics from tannins to flavonoids. Some varieties have very high levels of condensed tannins while others have exceptionally high levels of rare 3-deoxyanthocyanins. Sorghums with lemon-yellow pericarp have very high levels of flavanones. Other sorghums, especially tan and red sorghums, have high levels of flavones. Sorghum has much higher levels of phenols than other cereals in general but different sorghums vary in type and quantities of phenolics. For example, Onyx is a special sorghum with high levels of 3-deoxyanthocyanidins which was released by Texas AgriLife Research. This is a unique characteristic that produces red pigments which turn black when they are exposed to sunlight. These types are high in 3-deoxyanthocyanin compounds and may or may not contain condensed tannins. It is a very effective colorant for food products with more tolerance to high pH than vegetable and fruit pigments.

The combination of tannins and other flavonoids present in sorghum make it an effective source of phytochemicals because it is easily grown and processed into food products. Sorghums that contain condensed tannins are used for special foods where slower digestion is desired and unique color is an advantage. Tannin grains can be decorticated to produce bran with high levels of tannins and, before or after roasting, they can be used to produce attractive colored products similar to

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cocoa for use in foods to provide a wide array of colors. The combination of tannins with proteins and possibly carbohydrates significantly reduces digestion rate and lowers the glycemic index. Sorghum with condensed tannins provides an opportunity to develop foods with high levels of dietary fiber and antioxidants. Slowly digested components increase significantly during processing of the whole grains. Desirable dark colors plus an array of phytochemicals are present in these food systems. Our research has clearly demonstrated that the tannin sorghums have very high levels of antioxidants effective in ground meat systems and other applications. In addition, sorghum tannin brans have anti-cancer and anti-inflammatory activities. Tannin and black sorghums and their brans produce

attractive colors in food products. During heat processing of tannin sorghums, the levels of slowly digested starch increased significantly, which indicates tannin sorghum consumption may be promising for combatting type II diabetics.

Sorghums can be decorticated using rice milling equipment which significantly concentrates the phenolics in the bran. Bran and or ground whole tannin grain can be stabilized and used in a number of applications. Tannin sorghums may be used in pet foods to enhance antioxidants and give color to the extrudates or processed products. The bran fractions have appealing dark colors that may produce excellent cocoa extenders from either black or tannin sorghums.