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Review

Novel food and non-food uses for sorghum and millets ☆

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Abstract

Sorghum and millets have considerable potential in foods and beverages. As they are gluten-free they are suitable for coeliacs. Sorghum is also a potentially important source of nutraceuticals such antioxidant phenolics and cholesterol-lowering waxes. Cakes, cookies, pasta, a parboiled rice-like product and snack foods have been successfully produced from sorghum and, in some cases, millets. Wheat-free sorghum or millet bread remains the main challenge. Additives such as native and pre-gelatinised starches, hydrocolloids, fat, egg and rye pentosans improve bread quality. However, specific volumes are lower than those for wheat bread or gluten-free breads based on pure starches, and in many cases, breads tend to stale faster. Lager and stout beers with sorghum are brewed commercially. Sorghum's high-starch gelatinisation temperature and low *beta*-amylase activity remain problems with regard to complete substitution of barley malt with sorghum malt . The role of the sorghum endosperm matrix protein and cell wall components in limiting extract is a research focus. Brewing with millets is still at an experimental stage. Sorghum could be important for bioethanol and other bio-industrial products. Bioethanol research has focused on improving the economics of the process through cultivar selection, method development for low-quality grain and pre-processing to recover valuable by-products. Potential by-products such as the kafirin prolamin proteins and the pericarp wax have potential as bioplastic films and coatings for foods, primarily due to their hydrophobicity.

Keywords: Sorghum; Millet; Food; Bread; Malting; Brewing; Bioethanol; Gluten-free; Kafirin; Wax

Contents

Abbreviations: DDG, distillers dried grains; DDGS, distillers dried grains with solubles; GAX, glucuronoarabinoxylans; GMS, glycerol monostearate, HDL, high-density lipoprotein, LDL, low-density lipoprotein; SCFX, supercritical-fluid-extrusion; WVP, water vapour permeability

☆ Names are necessary to report factually on available data; however, the USDA neither guarantees nor warrants the standard of the product, and use of the name by the USDA implies no approval of the product to the exclusion of others that may also be suitable.

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1. Introduction

Sorghum and millets are the most drought-tolerant cereal grain crops and require little input during growth, but, as with other crops, yield better with good husbandry (ICRISAT/FAO, 1996). With increasing world population and decreasing water supplies, they represent important crops for future human use. While sorghum and millets are vital food crops for millions of people in parts of Africa and Asia, they are an underutilised resource in most developed countries, with sorghum being primarily used as animal feed and millet little cultivated (ICRISAT/FAO, 1996). Sorghum and millet have considerable further potential to be used as a human food and beverage source. In developing countries the commercial processing of these locally grown grains into value-added food and beverage products is an important driver for economic development (Taylor, 2004). The use of sorghum and millets not only provides farmers with a market for their products but also saves foreign exchange, which would otherwise be required to import cereals. Particularly in the developed countries, there is today a growing demand for gluten-free foods and beverages from people with coeliac disease and other intolerances to wheat who cannot eat products from wheat, barley, or rye.

Sorghum, in particular, could also play an important role in the production of ethanol and other bio-industrial products such as bioplastics, especially in dry areas where other crops are not as easily grown (McLaren et al., 2003).

Several previous reviews have addressed the subject of traditional foods from sorghum and millets in depth, for example McDonough et al. (2000), Murty and Kumar (1995) and Rooney and Serna-Saldivar (2000). This review sets out the state of the art in sorghum and millet science and technology with respect to their novel use in major food and beverage products, including baked goods and lager and stout beer, and the utilisation of sorghum for bio-industrial products such as ethanol, starch, and plastics. Emphasis is placed on how the particular structural and chemical compositional characteristics of the sorghum and millet grains influence their potential applications and the processing technologies required. The review concludes with some comments on further research needs.

2. Sorghum and millets in nutrition and health

Coeliac disease is a syndrome characterised by damage to the mucosa of the small intestine caused by ingestion of certain wheat proteins and related proteins in rye and barley (Fasano and Catassi, 2001). The gliadins (Kagnoff et al., 1982) and glutenins (Van de Wal et al., 1999) of wheat gluten have been shown to contain protein sequences that are not tolerated by coeliacs.

Modern screening studies show that coeliac disease is much more prevalent than previously thought. The average worldwide prevalence has been estimated as high as 1: 266 (Fasano and Catassi, 2001). Estimates place the number of persons with coeliac disease in the USA at roughly 3 million. The cornerstone treatment for coeliac disease is the total lifelong avoidance of gluten ingestion. This means that wheat, rye, and barley have to be avoided, including durum wheat, spelt wheat, kamut, einkorn, and triticale (Kasarda, 2001; Kasarda and D'Ovidio, 1999). Sorghum is often recommended as a safe food for coeliac patients, because it is only distantly related to the Triticeae tribe cereals wheat, rye and barley (Kasarda, 2001), being a member of the Panicoideae sub-family which also includes maize and most millets (Shewry, 2002). Sorghum therefore, provides a good basis for gluten-free breads and other baked products like cakes and cookies (biscuits) and in snacks and pasta. Although the millets have been less investigated for such food uses, they also have potential.

Sorghum and millet grains can contain substantial levels of a wide range of phenolic compounds. Their health-promoting properties, in particular their antioxidant activity, and their use as nutraceuticals and in functional foods are reviewed in the paper by Dykes and Rooney (2006). In addition to the potential health benefits of sorghum and millet phenolics, sorghum wax may also have unique health properties. Sorghum wax, which is concentrated on the surface of the pericarp of the grain, is composed of fatty aldehydes (46%), fatty acids (7.5%), fatty alcohols (41%), hydrocarbons (0.7%), wax and sterol esters (1.4%), and triacylglycerols (1%) (Hwang et al., 2002a). The fatty alcohols in sorghum wax can be classified as policosanols, which are primary long-chained alcohols.