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Mini Review



# Sorghum: An Important Source of Bioactive Compounds

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## Mini Review

Sorghum is the fifth most-produced cereal worldwide, where the USA, China, and Mexico were the largest producers in 2017 [1]. Sorghum has nutritional characteristics such as protein contents up to 12%, lipids 4.7%, ashes 2%, and carbohydrates 80%, depending on the variety [2,3]. Recently, it has been proven that sorghum could be considered as gluten-free food since regardless of the variety, it has a maximum of 5ppm, which allows its consumption in celiac people [4-6]. Several studies have shown the sorghum as a valuable source of bioactive compounds, where its lipid profile, phenolic compounds, and fiber content (soluble, insoluble, resistant starch, and β-glucans) stand out. The sorghum lipid profile consists mainly of waxes and oils (2:1), whose oil fraction contains about 90% linoleic, stearic, and palmitic acid [7]. A 2005 study showed that the sorghum lipid extracts (SLE) in concentrations of 1 and 5% helped to reduce non-HDL cholesterol by 36 and 69%, respectively, in Syrian male hamsters F1B [8].

Similarly [9] showed a reduction of 30.31% in non-HDL cholesterol in plasma, as well as a 46.13% in the liver esterified cholesterol, by providing 5% of SLE using male hamsters model (F1B) [9]. Lastly, in 2009 using a hypercholesterolemia hamster model, [10] observed the same behavior after mentioned, attributing this effect to an improvement in cholesterol metabolism as a result of alterations in the intestinal microbiota, suggesting a possible prebiotic effect in SLE [10]. Sorghum is plentiful in phenolic compounds such as simple phenolic acids (ferulic acid and p-coumaric acid), flavones, flavonoids, and 3-deoxyantocyanidins (3-DXAs), and polyphenolic compounds like condensed and hydrolyzed tannins [11,12]. These phenolics compounds found in sorghum are effective antioxidants, even higher than those found in blueberries, strawberries, and grapes, using the ORAC method [7].

AL Burdette [13] showed that apigenin, gallic, and ferulic acids from sorghum suppressed the production of cyclooxygenase-2 (COX-2), and tumor necrosis factor-α (TNF-α), as well as the inhibition of nuclear factor-κB (NF-κB) in macrophages activated by lipopolysaccharides [13]. On the other hand, 3-DXAs have been shown to inhibit the growth of cancer cells of leukemia (HL-60) and hepatoma cells (Hepg2) [14]. Besides, they have shown a chemoprotective effect of 3-DXAs by the induction of detoxifying and antioxidant enzymes through intracellular activation of NF-E2 [15]. Further, sorghum phenolic extracts (SPE) have been shown to reduce the expression of IL-β and TNF-α proinflammatory cytokines by up to 30 and 80%, respectively [16]. Likewise, SFE has reduced the reactive oxygen species (ROS) levels [17], COX-2, and iNOS [18], as well as a reduction of the nitric oxide production in macrophages with doses of 5.23 to 6.23 mg/mL [19]. Similarly, condensed tannins have reduced the activity of melanocytes and formation of melanomas in the colon after administration of doses from 200 to 1000 mg/mL [20]. Furthermore, phenolic compounds have shown a hypoglycemic effect by reducing the activity of α-amylase [21].

In the same way, systemic effects on glucose metabolism, such as increased AMPK [22], as well as overexpression of PPAR-γ [23], have been reported. The sorghum fiber fractions have been of interest, mainly the resistant starch (RS), which has been one of the most studied. It has been reported that sorghum can contain up to 65% of RS, depending on the variety, where brown sorghums had the highest content [24]. Most of the studies on sorghum´s RS have been focused on their content and the effect of the processing [25,26]. However, [27] showed that consumption of isolated RS from sorghum modulated the colonic microbiota, increasing in the population of Lactobacillus and Bifidobacteria, while a decrease in E. Colli was observed. Additionally, this study showed a decrease in blood triacylglycerols after the sorghum RS intake, suggesting a potential use for the prevention and treatment of obesity [27].

S Wathsala [28] shown that RS from whole sorghum stimulates the production of short-chain fatty acids (SFACs) during the colonic fermentation, proposing that sorghum RS may act as a prebiotic. Additionally, higher production in propionate, butyrate, and total SFACs has been observed in sorghum RS compared to the control [28]. In summary, sorghum is a valuable source of multiple compounds with potential biological impacts, since their nutritional features to the presence of phytochemicals and compounds such as fiber, that showed beneficial effects on the health in several studies in animal models. Nevertheless, studies focused on the beneficial effect of RS in sorghum are still limited, which mainly are focused on isolated RS, so that studies are still required to evaluate the effect of whole sorghum products on resistant starch and its beneficial effects. Future research should develop to prove the beneficial effects of different sorghum components in human health.

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