Food Chemistry 221 (2017) 984–989

Contents lists available at ScienceDirect

Food Chemistry

journal homepage: www.elsevier.com/locate/foodchem

Comparing sorghum and wheat whole grain breakfast cereals: Sensorial acceptance and bioactive compound content

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A R T I C L E I N F O

Article history:
Received 24 June 2016
Received in revised form 31 October 2016
Accepted 15 November 2016
Available online 17 November 2016

Chemical compounds studied in this article:
Luteolinidin (PubChem CID: 441701)
5-Methoxy-luteolinidin (PubChem CID: not available)
Apigeninidin (PubChem CID: 159360)
7-Methoxy-apigeninidin (PubChem CID: not available)
α-Tocopherol (PubChem CID: 14985)
β-Tocopherol (PubChem CID: 6857447)
γ-Tocopherol (PubChem CID: 92729)
α-Tocotrienol (PubChem CID: 5282347)
β-Tocotrienol (PubChem CID: 5282348)
γ-Tocotrienol (PubChem CID: 5282349)

Keywords:
Sorghum bicolor L.
Flavonoids
Tocopherols
Breakfast cereal

A B S T R A C T

The sensory acceptance and the content of bioactive compounds of whole-sorghum and whole-wheat breakfast cereals were compared. Sensory acceptance was assessed using the Food Action Rating Scale. 3-Deoxyanthocyanidins, flavones and flavanones were determined by high-performance liquid chromatography (HPLC) with diode array detection, and vitamin E by HPLC with fluorescence detection. Total phenolics and antioxidant activity were determined by spectrophotometry. The sorghum breakfast cereal had better sensory acceptance (70.6%) than wheat breakfast cereal (41.18%). Sorghum had higher 3-deoxyanthocyanidin content (100% higher), total phenolic compounds (98.2% higher) and antioxidant activity (87.9% higher) than wheat breakfast cereal. Flavones and flavanones were not detected in both breakfast cereals. Total vitamin E content was 78.6% higher in wheat than in sorghum breakfast cereal. Thus, consumption of whole sorghum breakfast cereal should be encouraged, since it had good sensory acceptance and is a source of bioactive compounds that can promote benefits to human health.

1. Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is a whole grain cereal that is better known to Western societies as an animal feed rather than a human food source (Stefoska-Needham, Beck, Johnson, & Tapsell, 2015). In countries, such as Australia, United States and Brazil, this cereal is mainly used for animal feed production. In contrast, sorghum is produced and used for human consumption in countries of Africa, Asia and other semi-arid regions of the world (Taylor, Schober, & Bean, 2006).

The use of sorghum for human consumption in Western countries has increased due to its functional potential (Poquette, Gu, & Lee, 2014). Sorghum could be used as a substitute for conventional cereals due to its high bioactive compounds, minerals, dietary fiber, vitamin E and carotenoids content (Cardoso, Pinheiro,

Abbreviations: 3-DXAs, 3-deoxyanthocyanidins; 5-MeO-LUT, 5-methoxy-luteliolinidin; 7-MeO-AP, 7-methoxy-apigeninidin; AP, apigeninidin; DAD, diode array detector; DPPH, 1,1-diphenyl-2-picrylhydrazyl; FACT, Food Action Rating Scale; HPLC, high performance liquid chromatography; LUT, luteolinidin.

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http://dx.doi.org/10.1016/j.foodchem.2016.11.065
0308-8146/

Martino, & Pinheiro-Sant'Ana, 2015a) and its potential to promote health and prevent diseases. This cereal can been used in the preparation of gluten-free products for individuals with celiac disease and other wheat intolerances (Stefoska-Needham et al., 2015). Furthermore, some sorghum genotypes contain tannins, which are bioactive compounds that could attract consumers interested in functional foods (Dlamini, Taylor, & Rooney, 2007).

Expanded extruded products, such as snacks and breakfast cereal, are very popular due to their crispness and ease of use. In the United States and other countries, including Brazil, these products are made typically with corn, although rice and wheat are also used. Although sorghum has a lower cost and is easier to produce than maize, until recently it had not been used for this purpose (Queiroz, Moraes, Martino, Paiva, & de Menezes, 2014). However, studies have been conducted in order to optimize the use of this cereal in the preparation of this type of product.

As far as we know, there are no studies on sensory analysis of whole-grain sorghum breakfast cereals compared to whole-grain wheat breakfast cereals. Sensory properties of a food product are important for its acceptance (Carson, Setser, & Sun, 2000). Sorghum-based products showed good acceptability (Carson et al., 2000; González, 2005; Shin, 1986). Therefore, sorghum has sensory potential to replace traditional cereals, being considered an excellent option for the food industry.

In addition, we found no studies that have assessed and compared the content of bioactive compounds in whole-grain sorghum and wheat breakfast cereals. Thus, the present study aimed to compare the sensory acceptance and the content of bioactive compounds of whole-grains sorghum and wheat breakfast cereals.

2. Materials and methods

2.1. Raw material, preparation and storage

Sorghum grains (genotype SC319) were grown by Embrapa Milho e Sorgo in Nova Porteirinha, MG, Brazil, between May and September 2013. The whole grains were initially milled into flour using a disc mill model 3100 (Perten Instruments, Huddinge, Sweden) set at position 2, added with 10% sucrose as fine granulated sugar and 0.5% of iodized salt (NaCl), and processed in a co-rotating intermeshing twin-screw extruder model Evolum HT 25 (Clextral, Firminy, France) at constant screw speed of 600 rpm and temperature profile of 30, 60, 90, 110, 110, 110, 120, 120, 130 and 140 °C, from feeding to the outlet (Vargas-Solórzano, Carvalho, Takeiti, Ascheri, & Queiroz, 2014). The screw diameter (D) was 25 mm and the total configured screw length (L) was 1000 mm, providing an overall L/D ratio of 40. The die had four round openings of 2.0 mm in diameter each and 9 mm in length. The formulation was placed in the feeding zone by a twin-screw, loss-in-weight gravimetric feeder model GRMD15 (Schenck Process, Darmstadt, Germany), and monitored by Schenck Process Easy Serve software (Schenck Process, Darmstadt, Germany). Distilled water was injected between the first and second feeding zones through a port measuring 5.25 mm in internal diameter from the start of the barrel using a plunger metering pump model J-X 8/1 (AILIPU Pump Co. Ltd., China) set to compensate for moisture differences in the samples and provide a final moisture content of 12%. The samples were collected over 15–20 min and subsequently ground into particles measuring 212 μm.

The whole-grain wheat flour was acquired and extruded by SL Alimentos in Mauá da Serra, PR, Brazil. The wheat flour was added with 10% sucrose as fine granulated sugar and 0.5% of iodized salt (NaCl), which was processed in a co-rotating twin-screw model Evolum BC 72 (Clextral, Firminy, France) at constant screw speed of 200 rpm and temperature profile of 50, 81, 112, 118, 127 and 143 °C, from feeding to the outlet. The other conditions of extrusion were similar to sorghum.

The whole-grain sorghum and whole-grain wheat breakfast cereals (Fig. 1) were stored in polyethylene bags at 10 ± 2 °C until analyses.

2.2. Sensory acceptance

The acceptance of sorghum and wheat breakfast cereals was evaluated by 51 untrained judges (21.6% male, 78.4% female) from the Federal University of Viçosa, Brazil, and surrounding areas. The study protocol was approved by the Human Ethical Committee in Scientific Research (CAAE: 13630513.0.0000.5153) of the Federal University of Viçosa.

The breakfast cereals (10–15 g) were served in plastic 50 ml cups coded with three digit numbers. Mineral water was provided for cleaning the mouth between analyzes of each product formulation. Along with the samples, each judge received a form to evaluate the acceptance of the extrudates. The Food Action Rating Scale (FACT) was used, being assigned score 9 to "I would eat it whenever I had the chance" and the score 1 for "Just eat that if I was forced" (Minim, 2013).

2.3. Determination of bioactive compounds

The occurrence and content of flavonoids (3-DXA, flavones and flavanones) and vitamin E (α, β, γ and δ-tocopherols and tocotrienols) were determined in sorghum and wheat breakfast cereals in five replicates. During all analyses, the samples and the extracts were protected from light (artificial and sunlight) and oxygen using amber glassware, aluminium foil and blackout curtains, and bottles with nitrogen gas environment.

Fig. 1. Whole-grain sorghum breakfast cereal (A) and whole-grain wheat breakfast cereal (B).