Food Chemistry 238 (2018) 82–86

Contents lists available at ScienceDirect

Food Chemistry

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

Study on evaluation of starch, dietary fiber and mineral composition of cookies developed from 12 sorghum cultivars

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ARTICLE INFO

Article history:
Received 12 May 2016
Received in revised form 30 October 2016
Accepted 20 December 2016
Available online 22 December 2016

Keywords:
Sorghum
Cookies
Dietary fiber
Sensory evaluation
Micronutrient composition

ABSTRACT

The study aimed to identify best cultivars suitable for sorghum cookies accordingly nutrient and mineral compositions were evaluated. Protein and fat content of cookies were ranged from 5.89 ± 0.04 to 8.27 ± 0.21% and 21.03 ± 0.01 to 23.08 ± 0.03% respectively. The starch content of cookie ranged between 47.06 ± 0.01 and 42.15 ± 0.03% and dietary fiber was reported highest in CSH14 (9.27 ± 0.01%). The highest Mg (56.24 ± 0.03 mg/100 g) P (255.54 ± 0.03 mg/100 g), and K (124.26 ± 0.02 mg/100 g) content were found in C43 cultivar. CSV18R was reported highest iron content (1.23 ± 0.01 mg/100 g). The sensory scores for overall acceptability of cookies were highest in CSH23, CSH13R and CSV18R cultivars which are rich in dietary fiber and minerals. Normally the hybrids are high yielders and the grain price/qt is 20% lower than varieties. It is implied the raw material costs of two identified cultivars (CSH23 & CSH13R) would help the industry to reduce overall cost of production and offer a better profit margins over the varieties.

1. Introduction

Sorghum [*Sorghum bicolor*(*L*) *Moench*] is an important source of energy and protein for a large segment of the human population in the semi-arid and arid tropics (ICRISAT, 2009) where it is too hot and dry for successful wheat and maize production (Doggett, 1988). Sorghum is a drought-resistant and is the second most important cereal food in Africa and Asia after maize (Taylor, 2004). It is of great nutritional significance in the diets of millions of rural poor people and it constitutes their major source of protein and energy (ICRISAT, 2009). Sorghum is gluten free grain and hence can be useful for patients with Celiac disease.

The average starch content of sorghum is 69.5%. About 70 to 80% of the sorghum starch is amylopectin and the remaining 20–30% is amylose. Both genetic and environmental factors affect the amylose content of sorghum (FAO, 1990).

Sorghum is an excellent source of energy, containing about 75% complex carbohydrate includes fibers and starches which are usually digested slowly and therefore provide satiety and delayed hunger. It is excellent source of iron, zinc and rich in B complex vitamins that play a major role in energy metabolism. Sorghum's high-energy content and presence of B-complex vitamins are a perfect combination for energy utilization (Henley, 2010). It is rich in minerals whose bioavailability ranges from lowest (less than 1% for some forms of Fe) to highest (more than 90%) for Na and K. The macro and micro-nutrient contents of improved varieties vary greatly over a wide range of environments; however, some varieties show consistent trends in composition (Pontieri et al., 2014).

Snack food consumption has been increased as a result of urbanization and increase in the number of working women. Food based industry can exploit this development by fabricating nutritious snack foods. Cookies hold an important position in snack food industry due to their variety in taste, crispiness and digestibility. They offer a valuable vehicle of supplementation with nutrients because of their popularity, relatively low cost, varied taste, ease of availability, high nutrient density and long shelf-life (Sudha, Vetrimani, & Leelavathi, 2007). Cookie is a small, flat and baked food product usually containing fat, flour, egg, sugar and baking agents. Cookies are mostly baked until crispy or just long enough for them to remain soft. Cookies are made in a wide variety of styles by using an array of ingredients including chocolate, butter, pea-nut butter, nuts or dried frost (Chappalwar, Peter, Bobde, & John, 2013). Wheat flour is the principal component of virtually all biscuits/cookies because when mixed with water, it forms unique visco-elastic dough due to development of gluten (Kent & Evers, 1994). However, good quality product can be prepared using non-wheat (non- gluten) flours like sorghum.

Many studies have focused on proximate, mineral and vitamin composition of the sorghum grain (Pontieri et al., 2014) but few

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http://dx.doi.org/10.1016/j.foodchem.2016.12.069
0308-8146/

studies reported the proximate composition of biscuits developed from composite flours (Angeline, Preethi, & Mohankumar, 2014). If data is available on dietary fiber and minerals content of cookies made with 12 sorghum cultivars, it can be utilized to promote production of nutritionally potential cookies with suitable sorghum cultivar. Therefore, this research work aim is to evaluate starch, dietary fiber and minerals content of cookies developed from 12 sorghum cultivars. Thus, providing the utilization of nutritionally potent cookies made with suitable sorghum cultivar at reasonable price.

2. Materials and methods

The raw materials sugar, fat, milk powder, baking powder, wheat grains, salt and flavour were procured from local market Hyderabad (TS, India). The chemicals used were availed from Himedia chemicals pvt. Ltd. Twelve sorghum cultivars (CSH 14, CSH 23, CSH 25, CSH 13R, CSV 15, CSV 20, CSV 23, CSV 27, SPV 462, C 43, RS 29, CSV 18R) were made available from Indian Institute of Millets Research, Rajendranagar Hyderabad (TS, India) where the research was carried out. Three replicates (n = 3) of each cultivar were used for the studies.

2.1. Preparation of flours

Sorghum flour and wheat flour were obtained by dry milling of grains in hammer mill and the flour passed through sieve of 60 mesh (Sonaye & Baxi, 2012) was used for cookies preparation.

2.2. Chemical analysis of sorghum cookies prepared from various sorghum cultivars

The protein, fat, starch and dietary fiber contents of the cookies were estimated by using standard method of AOAC (1990). Atomic Absorption Spectrophotometer was used to determine minerals following the specified wavelengths.

2.3. Preparation of sorghum cookies

Cookies were prepared according to the method of Mohamed, Elsoukkary, Doweidar, and Atia (2004) with some modifications. The ingredients are tabulated in Table 1. Sugar and fat were creamed in a planetary mixer for 45 min at 60 rpm. Milk powder was added to the above cream and mixed for 5 min to obtain homogeneous cream. Then, sorghum flour along with sodium chloride and baking powder was added and mixed for 3 min at 60 rpm. Dough was sheeted and cut using automatic cookie making machine (Arun Rega Bakery Machineries Pvt. Ltd, Coimbatore) followed by baked in aluminum tray at 180 °C for 15 min. Baked cookies were cooled and packed in airtight polyethylene packs. Control sample was prepared using wheat flour (Fig. 1).

Table 1
Formulation of sorghum cookies.

Sr. No.	Ingredients	Quantity
1	Vegetable Fat	1200 g
2	Sugar	600 g
4	Milk powder	80 g
5	Water	600 ml
6	Baking powder	40 g
7	Salt	20 g
8	Essence (Vanilla)	50 ml
9	Sorghum Flour/Wheat flour	3000 g

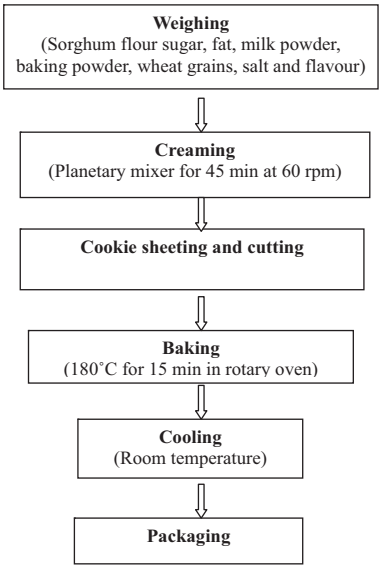

Fig. 1. Flow diagram of cookies production.

2.4. Sensory evaluation of cookies

Sensory evaluations of sorghum cookies were carried out using 9-point hedonic scale. Ten members of a semi trained panel were asked to rate the cookies for their various sensory attributes like appearance, color, flavour, crispness, mouth feel and overall acceptability as described by Larmond (1977).

2.5. Statistical analysis

All determinations were made in triplicate and average values are reported. Statistical analysis of data was done applying one way analysis of variance (ANOVA) performed using *SPSS Software*. Mean and standard deviation were computed for each sample and differences between the mean were determined by Tukey's HSD test and considered highly significant when ($p < 0.05$) and significant at ($p < 0.05$).

3. Results and discussions

Nutrient and mineral content of studied cookies found statistically significant ($p < 0.05$) using ANOVA and data was further analyzed to know the significance difference between the homogeneous groups using Tukey's HSD test and results are presented in the Tables 2 and 3

3.1. Protein, fat, starch and dietary fiber content of cookies made with different sorghum cultivar

The moisture, protein, fat, starch and dietary fiber content of cookies are summarized in the Table 2. Moisture content of cookies was reported 2.13 to 3.23% and found statistical significant ($p > 0.05$). Cookies prepared from C 43 cultivars showed lowest moisture which is significantly different from few cultivars as depicted in Table 2.

Protein and fat content of wheat cookies (control) was 6.5% and 23% respectively whereas sorghum cookies were ranged from 5.89 ± 0.04 to 8.27 ± 0.21% and 21.03 ± 0.01 to 23.06 ± 0.01% respectively with statistically significant ($p < 0.05$). Fat content of few cultivars showed statistical non-significance within the groups as shown in the Table 2. Generally cookies are characteristics of low moisture, high fat and high sugar and similar results were