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Impact of Defatted Sesame Meal on the Technological and Sensory Quality and Antioxidant Activity of Gluten-free Buckwheat Crackers

Elif Yaver[1]

[1]Department of Food Processing, Vocational School of Technical Sciences, Konya Technical University, Konya, Türkiye
elifyaver@hotmail.com / ORCID No: 0000-0002-2651-9922

Abstract

Currently, a gluten-free diet is the sole successful remedy for celiac disease. However, it is difficult for celiac patients to access commercially functional gluten-free foods. Defatted sesame meal as a by-product of the cold-pressed sesame oil production process is a good option to enrich gluten-free crackers because of its rich protein and fiber content. In the present study, defatted sesame meal was used to develop gluten-free cracker formulations. Gluten-free flour blend containing buckwheat flour:corn starch (7:3, w/w) was substituted with defatted sesame meal at 0, 5, 10, 15 and 20% levels. The effect of defatted sesame meal on the technological properties, antioxidant activity and sensory quality of gluten-free cracker samples were evaluated. The moisture contents of gluten-free buckwheat crackers containing 5, 10 and 15% defatted sesame meal were close to the control (0% sesame meal). The inclusion of sesame meal did not show adversely influence on the diameter and thickness values of buckwheat crackers. Compared to the control, samples made from 10 and 15% sesame meal exhibited higher spread ratio values. Samples with sesame meal exhibited a significantly ($p<0.05$) increased total phenolic content relative to the control. Moreover, crackers prepared from 15% (2.82 µmol TE/g) and 20% (2.90 µmol TE/g) sesame meal showed strong antioxidant properties. Sensory evaluation showed that high levels of sesame meal improved the appearance of crackers compared to the control. The incorporation of sesame meal up to 15% gave comparable overall acceptability to the control. The data revealed that defatted sesame meal (up to 15%) is a good alternative to improve the antioxidant capacity of gluten-free crackers with acceptable technological and sensory quality.

Key Words: *Gluten-free, Crackers, Sesame, By-product, Functional food*

Introduction

Celiac, an autoimmune disease, is one of the most common food intolerances worldwide and can occur at any age (Rivera et al., 2013). The gluten-free market has grown rapidly year on year and is expected to reach 7.5 billion dollars by 2027 (Kajzer and Diowksz, 2021). Developing special products for this market is an important opportunity for manufacturers.

Crackers are one of the popular cereal-based snacks worldwide. They can be easily enriched with functional constituents such as protein- and fiber-rich by-products. Tomic et al. (2022) incorporated pumpkin seed press cake flour into gluten-free chickpea crackers. They found that replacing chickpea flour with pumpkin seed meal improved the protein content and antioxidant activity of crackers, and improved their taste and flavor. Akeem et al. (2023) produced gluten-free crackers using composite flour containing germinated pearl millet+defatted sesame+tigernut flour. They stated that adding composite flour enhanced ash, fiber, protein, and calcium contents of crackers and improved their protein digestibility compared to the control.

Sesame (*Sesamum indicum*) seeds are a good source of unsaturated fat, protein, dietary fiber, vitamins, minerals (iron and calcium) and antioxidant compounds. Also, they contain lignans such as sesamol, sesamolin, sesamin and sesaminol which could exhibit anti-hypertensive, anti-inflammatory, anti-carcinogen and antioxidant features (Wei et al., 2022). Defatted sesame meal is a by-product of cold-pressed sesame oil production. It contains about 50% protein, dietary fibers and bioactive compounds (Melo et al., 2021).

To the best of my knowledge, this study represents the first research on the effect of cold-pressed sesame meal on the quality of gluten-free buckwheat crackers. Therefore, the objective of this study is to develop functional gluten-free crackers by adding defatted sesame meal at 0, 5, 10, 15 and 20% levels, and to investigate the impact of sesame meal addition on the moisture content, diameter, thickness and spread ratio, total phenolic content, antioxidant activity and sensory properties of gluten-free buckwheat crackers.

Materials and Methods

Materials

Light buckwheat flour was supplied from Bulvar Gıda (Konya, Türkiye). Corn starch, shortening, salt, caster sugar, baking powder and yeast were procured from a local supermarket in Konya, Türkiye. Cold-pressed defatted sesame meal was kindly donated by Neva Gıda, İstanbul, Türkiye. Xanthan gum was purchased from Smart Kimya, İzmir, Türkiye.

Methods

Preparation of gluten-free crackers

Gluten-free control crackers (0% sesame meal) were prepared by mixing 250 g of gluten-free flour blend (buckwheat flour:corn starch, 7:3, w/w), 50 g of shortening, 4 g of salt, 3.75 g of caster sugar, 3.75 g of baking powder, 2.5 g of yeast, 2.5 g of xanthan gum and water. Crackers containing defatted sesame meal were incorporated into four different levels (5, 10, 15 and 20%). The dough was fermented at 35°C for 2 h. After that, it was sheeted and cut into a circular shape. Cracker doughs were baked (Kumtel LX-9645, Kayseri, Türkiye) at 175°C for 9 min.

Laboratory analysis

The moisture content of samples was determined by a rapid moisture analyzer (Shimadzu M0C63u, Kyoto, Japan).

Diameter and thickness of crackers were measured via a caliper. To find spread ratio, the diameter was calculated by dividing the thickness.

Phenolic compounds were extracted by the method of Yaver (2023). Two grams of sample were reacted with 20 mL of methanol:distilled water:HCl (8:1:0.1, v/v/v) at 30°C for 2 h. The extracts were subjected to centrifugation (Nüve NF800, Ankara, Türkiye) at 3000 rpm for 10 min. The Folin-Ciocalteu reagent method described by Yaver (2023) was used to determine the total phenolic content of crackers. The antioxidant activity of crackers was determined by the DPPH assay (Yaver, 2023).

Sensory evaluation of gluten-free crackers was carried out by 12 panelists using a 9-point hedonic scale (1; extreme disliking, 9; extreme liking). Panelists assessed the taste, odor, appearance, crispness and overall acceptability parameters.

Statistical analysis

The data were analyzed and compared with the Tukey HSD test at a significance level of $p<0.05$ using JMP 5.0 (SAS, North Carolina, USA).

Results and Discussion

Moisture content and diameter, thickness and spread ratio values of gluten-free buckwheat crackers are given in Table 1. The moisture content of crackers ranged between 6.13% and 6.59%. Compared to the control gluten-free buckwheat crackers, samples containing 20% defatted sesame meal had a slightly higher moisture content. The rich dietary fiber content of sesame meal may be responsible for this increase in moisture content (Melo et al., 2021).

Table 1. Moisture content and technological features of gluten-free crackers

Crackers	Moisture (%)	Diameter (mm)	Thickness (mm)	Spread ratio
Control	6.13±0.10^{b}	49.19±0.44^{a}	1.45±0.21^{a}	33.92±0.20^{c}
5%	6.18±0.08^{b}	49.13±0.54^{a}	1.50±0.25^{a}	32.75±0.25^{d}
10%	6.26±0.06^{ab}	49.29±0.51^{a}	1.33±0.24^{a}	37.06±0.28^{a}
15%	6.37±0.10^{ab}	49.59±0.48^{a}	1.32±0.25^{a}	37.57±0.25^{a}
20%	6.59±0.07^{a}	49.78±0.49^{a}	1.42±0.28^{a}	35.06±0.20^{b}

Values within the same column that are accompanied by distinct letters show a significant difference ($p<0.05$).

The diameter and thickness values of gluten-free crackers changed between 49.13-49.78 mm and 1.32-1.50 mm, respectively (Table 1). There were no notable differences between crackers' diameter and thickness. This revealed that incorporation of defatted sesame meal (up to 20%) does not display a negative impact on the diameter and thickness values of gluten-free crackers. It was also found that when the amount of sesame meal increased from 0% to 10%, spread ratio value increased from 33.92 to 37.06. The increase in spread ratio may be due to the decreasing gluten content as a result of defatted sesame flour addition (Shahzad et al., 2021). Similar findings have been reported for crackers made with composite flour containing defatted sesame flour by Akeem et al. (2023). On the other hand, crackers prepared with 20% sesame meal had a lower spread ratio than crackers made with 10 and 15% sesame meal (Table 1). This result could be attributed to the high protein and fiber content of defatted sesame meal, which could bind to available water and increase viscosity (Giuberti et al., 2018; Melo et al., 2021). The antioxidant properties of gluten-free samples enriched with defatted sesame meal are presented in Table 2. Sesame meal incorporated crackers exhibited a progressive and considerable increase in the phenolic content by

increment of sesame meal level. The presence of phenolic components in sesame meal, mainly lignans, could be responsible for this increase in total phenolic content (Melo et al., 2021).

Table 2. Total phenolic content and antioxidant activity of gluten-free crackers

Crackers	Total phenolic content (mg GAE/100 g)	Antioxidant activity (µmol TE/g)
Control	70.00±0.92^{e}	2.61±0.06^{c}
5%	77.36±0.98^{d}	2.64±0.03^{bc}
10%	96.25±1.13^{c}	2.73±0.04^{abc}
15%	101.61±1.04^{b}	2.82±0.05^{ab}
20%	109.89±0.97^{a}	2.90±0.03^{a}

Values within the same column that are accompanied by distinct letters show a significant difference ($p<0.05$).

The inclusion of defatted sesame meal elicited great results of antioxidant activity in gluten-free crackers, changing from 2.61 to 2.90 µmol TE/g (Table 2). Hafez (2018) found that defatted sesame meal showed high antioxidant activity. The high antioxidant activity of crackers may be associated with lignans in sesame meal, which have antioxidant activity (Sarkis et al., 2014; Shu et al., 2019).
Sensory scores of gluten-free buckwheat crackers are demonstrated in Figure 1. Crackers enriched with 5 and 10% sesame meal elicited similar taste scores to the control. However, higher levels (15 and 20%) of sesame meal decreased taste scores of crackers. On the contrary, increasing level of sesame meal increased odor score of gluten-free crackers. Moreover, gluten-free crackers produced with 10, 15 and 20% sesame meal revealed greater appearance scores than crackers produced with 0 and 5% sesame meal. There were no notable differences between the crispness scores of control and sesame meal-enriched crackers. Regarding the overall acceptability parameter, the enrichment of gluten-free crackers with defatted sesame meal up to 15% revealed similar scores to the control. However, the overall acceptability score of crackers made from 20% sesame meal was lower than the control. Prakash et al. (2018) stated that consumers liked the incorporation of defatted sesame meal up to 50% into biscuit formulation in terms of color, odor, crispiness and taste parameters.

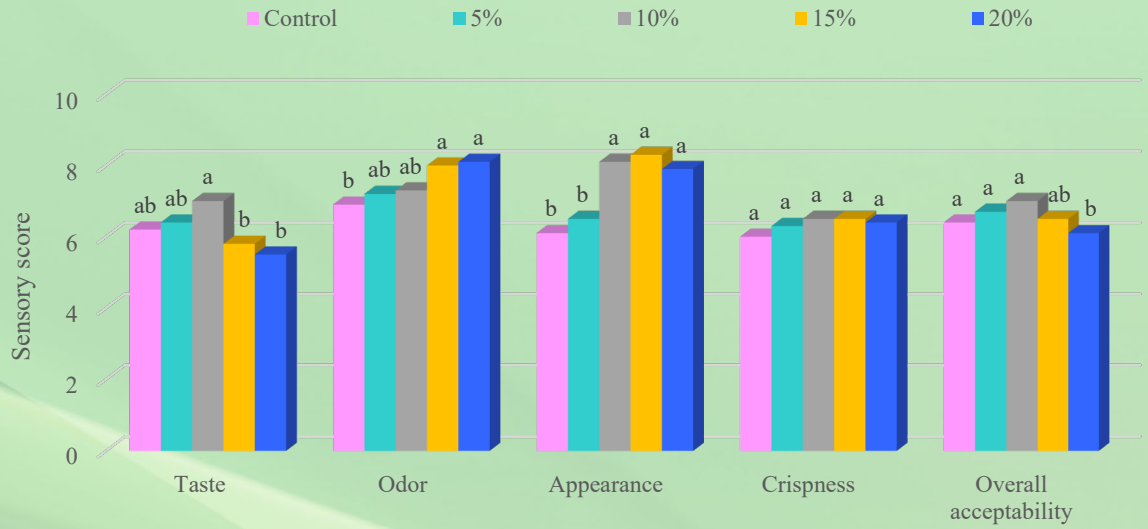

Figure 1. Sensory evaluation of gluten-free crackers

As a conclusion of this study demonstrated that defatted sesame meal (up to 15%) is a good ingredient to improve antioxidant activity of gluten-free crackers as well as acceptable technological and sensory quality. Compared to the control, sesame meal-enriched crackers (up to 15%) revealed a higher spread ratio, stronger antioxidant activity and acceptable sensory quality.

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