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Nutritional characteristics of gluten-free products marketed in Serbia

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Abstract

Gluten-free products, primarily intended for people with gluten-related disorders, have become increasingly popular among healthy consumers. Despite reformulation efforts through the last decades, some concerns remain about the nutritional profile of gluten-free products. Therefore, this study aimed to compare the nutritional characteristics of gluten-free and gluten-containing food products within the same category in the Serbian market. A total of 175 gluten-free and 344 gluten-containing equivalent food products classified into six categories were compared based on labeled nutritional information. The gluten-free fine bakery products and snacks had less, but gluten-free bread, pastries, and pasta had significantly higher energy values than the gluten-containing products. While gluten-free pasta had a higher protein content, gluten-free flour had a higher content of saturated fatty acids than their gluten-containing equivalents. Gluten-free breakfast cereals contain less sugar compared to regular products. The salt content in gluten-free food products was also lower than that of equivalent products. However, the total fiber content was not statistically different between the groups. Overall, the results indicated differences between the nutritional characteristics of gluten-free and gluten-containing food products, which should be considered for implementing a well-balanced gluten-free diet.

Key words*: food labels; energy value; nutritional composition; gluten-free diet.*

INTRODUCTION

Gluten is a cereal protein that consists of prolamins and glutelin fractions. Due to its ability to bind a large amount of water, gluten has good viscoelastic properties, which are important for dough preparation and bakeability [1]. However, in people with celiac disease or gluten-sensitive enteropathy, which is characterized by a permanent specific hypersensitivity to the prolamin fraction, ingestion of even small gluten content from wheat, rye, and barley can damage the small intestine and cause malabsorption associated with many secondary adverse outcomes [2]. Celiac disease is estimated to affect approximately 1% of the general population. [3]. Up to now, the only effective celiac disease treatment is a gluten-free diet, based on the consumption of foods with gluten maximum up to 20 mg /kg [4].

In recent years, the gluten-free diet has gained popularity, even among people without diagnosed gluten intolerance. The main reasons for the growing popularity of gluten-free diets are the consumer perception that they are healthier than gluten-containing alternatives and that they contribute to better weight control management [5]. Therefore, further growth of gluten-free products in the global market is expected [6]. However, eliminating cereals from the diet is linked to nutritional risks, such as insufficient dietary fiber, B vitamins, and mineral intake [7]. Moreover, previous studies have shown that gluten-free products have a low protein content and a higher content of fat, saturated fatty acids (SFA), sugar, and salt [8-10]. Due to the high starch content, the consumption of gluten-free foods contributes to the total energy and glycemic load, increasing the risk of diabetes and other metabolic diseases.

Additionally, the lack of adequate content of minerals, such as calcium, iron, and zinc, can increase the risk of bone density disorders, anemia, and weakened immunity [11]. Based on the results of evaluations of the nutritional quality of gluten-free food products, many authors highlighted the necessity for improving the nutritional profiles of these products in the food industry [12-14]. Considering that the quality of gluten-free products produced in Serbia is unknown, this study aimed to compare the nutritional characteristics of commercial gluten-free products to gluten-containing alternatives on the market.

MATERIAL AND METHODS

The study was conducted in Belgrade, Serbia, from November 2022 to February 2023 by collecting and analyzing nutritional information from the labels of gluten-free and equivalent gluten-containing commercial products produced by domestic manufacturers. The criteria for including gluten-free food products was the statement "gluten-free" in the central part of the field of vision or within the product name. In addition to the largest supermarkets, the survey included products on manufacturers' websites and those offered by online stores. Data from the database of dietary products of the Ministry of Health of the Republic of Serbia was also used to obtain additional information on foods intended for people with gluten sensitivity marketed in Serbia [15].

A total of 175 gluten-free and 344 gluten-containing products were collected and grouped into the following categories: flour and flour substitutes, bread and pastry mixes, bread and pastries, pasta, breakfast cereals, fine bakery wares, and snack products. The following parameters from the nutrition declarations were collected and analyzed: energy values, contents of fat, SFA, carbohydrates, sugars, proteins, and salt, expressed per 100 g of product, as mandatory content in nutritional declarations, and for a certain number of products, fiber content too [16]. The fiber and salt content for both groups of products was estimated according to the criteria for the corresponding nutritional claims for these nutrients [17].

The results were processed using standard statistical methods and then presented graphically. The SPPS statistical program (version 20, Chicago, IL, USA) was used for statistical data processing, and the results were considered statistically significant if $p < 0.05$.

RESULTS AND DISCUSSION

Many previous studies have pointed out that gluten-free products are more expensive than standard products, up to 4 times [14,18,19,20]. However, the price of gluten-free products is not correlated with their nutritional value [18]. The production of gluten-free foods is technologically more demanding since the absence of gluten affects the structure and quality of the final products. Gluten-free products are mainly based on gluten-free flours (e.g., corn and rice flour), native or modified starches, or starches and flours from alternative plant sources. The functional properties of gluten in gluten-free bakery products are compensated by the addition of additives (e.g., xanthan gum, guar gum, locust bean gum, pectins, etc.), proteins (from milk, eggs, plant sources), as well as the addition of enzymes that modify starch (e.g., cyclodextrin glycosyltransferase) or promote protein cross-linking (e.g. transglutaminase) [21]. Generally, gluten-free products are characterized by high carbohydrate and low protein content. In addition to contributing to the energy value, starch also affects the glycemic index of gluten-free foods [22].

The results of the comparative analysis of the nutritional characteristics of different categories of gluten-free and gluten-containing foods produced in Serbia are shown in **Figure 1**. Regarding energy value, statistically significant differences between gluten-free and standard foods are observed for pasta, bread, and pastries, as well as for products from the fine bakery and snack products category. However, unlike gluten-free pasta ($p < 0.001$) and gluten-free bread and pastries ($p < 0.01$), whose energy value is significantly higher, the energy value of gluten-free fine bakery and snack products is considerably lower ($p < 0.001$) compared to standard products.

As expected, gluten-free breads and pastries ($p < 0.001$) and fine bakery and snack products ($p < 0.01$) contain significantly more carbohydrates than the corresponding gluten-containing products. On the other hand, the fat and SFA content in gluten-free products (bread and pastries, breakfast cereals, and fine bakery and snack products) is significantly lower than in products from the same categories that contain gluten. However, previous studies have reported a higher fat content in gluten-free foods, especially in gluten-free bread and fine bakery and snack products [23,24]. Compared to equivalent foods, these differences are explained by differences in the nutritional profile of raw materials or by the subsequent addition of fat to achieve the appropriate texture of gluten-free products [25,26]. This study showed that gluten-free flours contained significantly higher contents of total fat ($p < 0.01$) and SFA ($p < 0.05$) compared to equivalent gluten-containing products, which can be the result of using alternative plant sources, such as coconut flour, which contains 14 g/100 g SFA [13]. On the other hand, the lower SFA content in gluten-free bakery and snack products can be explained by the use of vegetable oils,

Figure 1. Comparative analysis of energy value and nutrient content in gluten-free and standard products of different categories. Results are presented as mean and standard error (*p < 0.05; **p < 0.01; ***p < 0.001).

primarily sunflower oil [27]. Although the difference was not statistically significant, the gluten-free pasta contained more fat than gluten-containing pasta ($p > 0.05$).

Gluten-free foods generally contain less protein than standard products [6]. However, this is not of great nutritional significance, as the primary protein sources in the diet are foods of animal origin [25]. In 2015, a study performed in Austria reported lower protein content in 4 out of 7 categories of gluten-free foods, especially in bread and pastry mixes, compared to gluten-containing equivalents [19]. Also, a study conducted in the United Kingdom in 2017 showed that all gluten-free products contain significantly fewer proteins than standard products [7]. In this study, protein contents for gluten-free bread and pastry mixes ($p < 0.01$) and gluten-free fine bakery and snack products ($p < 0.05$) were lower than for gluten-containing products from the same categories. At the same time, gluten-free pasta contained more proteins ($p < 0.01$) than standard pasta.

Fiber intake is known to be inversely related to the risk of chronic non-communicable diseases, including type 2 diabetes, colon cancer, and cardiovascular disease. Cereals and cereal products are the primary sources of dietary fiber [28]. In comparison to gluten-containing equivalents, we found that gluten-free bread and pastry mixes have a significantly lower fiber content ($p < 0.05$), while gluten-free pastries contain higher fiber content ($p < 0.05$). Also, gluten-free pasta had a slightly higher fiber content than standard pasta (Figure 1). Similar results were reported in studies conducted in 2018 [7,13]. However, the results of studies from 2015 did not report significant differences in the average fiber content between gluten-free and gluten-containing products [19,25]. Since refined flours and starches are low in fiber [29], the trend of rising fiber content in gluten-free products could be explained by the addition of inulin, psyllium husk, pectin, and pseudocereals as a response of manufacturers to address the risk of insufficient fiber intake [30]. Pseudocereals, such as quinoa and amaranth, are recognized as gluten-free sources of fiber, protein, vitamins, and minerals. In addition to pseudocereals, legumes, and synthetic fibers are also used to improve gluten-free products' nutritional value and sensory and structural characteristics [31].

In terms of fiber content, 25% of gluten-free products were classified as "sources of fiber" meaning they contained at least 3 g fiber per 100 g, and 56% were considered "rich in fiber" containing at least 6 g fiber per 100 g. The findings also indicated that the proportion of gluten-free products with high fiber content is slightly higher than that of gluten-containing products; however, this difference was not statistically significant ($p > 0.05$), as shown in **Figure 2**.

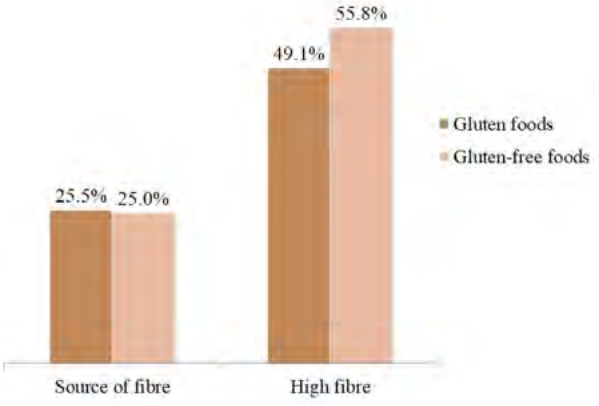

Figure 2. The percentage of gluten-free and gluten-containing products that could be classified as a source of fiber or high in fiber.

In this study, the average salt content of gluten-free products was significantly lower than that of equivalent products ($p < 0.001$). However, a study conducted in Slovenia in 2020 found no significant differences in the average salt content between gluten-free and gluten-containing products [32]. Contrary to previous research [8,13,27], gluten-free bread and pastries contained significantly less salt than their equivalent products ($p < 0.001$) (Figure 1). Additionally, the salt content in gluten-free fine bakery and snack products was lower than in standard products ($p < 0.01$). Similar findings have been reported in the Italian market for these products [12]. Overall, in this study, 25.3% are characterized by a low salt (≤ 0.3 g/100 g), and 30.8% by a very low salt content (≤ 0.1 g/100 g) (**Figure 3**).

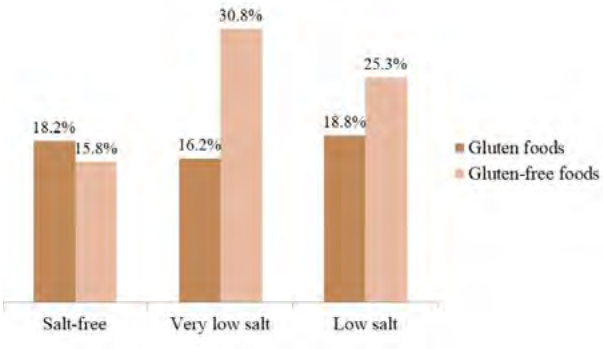

Figure 3. The percentage of gluten-free and gluten-containing products classified by the content of salt.

In a recent study comparing gluten-free and equivalent gluten-containing products in 2022 with products from the same categories in 2013, significant differences were observed in the nutritional profile of gluten-free products compared to products containing gluten, especially in pasta. A trend towards a decrease in protein and salt content in gluten-free products was observed [6].

CONCLUSION

Overall, based on the results obtained and compared with the available literature data, a trend of improving the nutritional profile of gluten-free foods was observed. However, this conclusion cannot be generalized since there are apparent differences between different categories of gluten-free products. Due to the differences in nutritional characteristics, gluten-free and gluten-containing foods cannot be considered equivalent. These differences should be taken into account to achieve an adequate gluten-free diet.

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Nutritivne karakteristike bezglutenskih proizvoda na tržištu Srbije

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Kratak sadržaj

Bezglutenski proizvodi, koji su prvenstveno namenjeni osobama sa intolerancijom na gluten, su sve više zastupljeni i u ishrani zdravih osoba. Uprkos pristupima reformulacije u cilju unapređenja nutritivne vrednosti, sprovedenim tokom prethodnih decenija, i dalje postoje zabrinutosti u pogledu nutritivnih profila bezglutenskih proizvoda. Cilj ovog istraživanja je bio da se uporede nutritivne karakteristike različitih kategorija bezglutenskih i proizvoda sa glutenom prisutnih na tržištu Srbije. Analizirane su nutritivne deklaracije 175 bezglutenskih i 344 standardnih prehrambenih proizvoda, u pogledu energetske vrednosti, sadržaja masti, zasićenih masnih kiselina, ugljenih hidrata, šećera, proteina, vlakana i soli. Bezglutenski fini pekarski i snek proizvodi su imali nižu, a bezglutenski hleb i peciva, kao i bezglutenske testenine veću energetsku vrednost u odnosu na ekvivalentne kategorije glutenskih proizvoda. Bezglutenske testenine su sadržale više proteina, bezglutenska brašna veće količine zasićenih masnih kiselina, dok su bezglutenska žita za doručak sadržala manje šećera. Sadržaj soli u bezglutenskim proizvodima je bio značajno niži u odnosu na standardne proizvode. Sadržaj vlakana se nije razlikovao između kategorija različitih grupa bezglutenskih i glutenskih proizvoda. Dobijeni rezultati ukazuju da postoje značajne razlike u nutritivnom sastavu bezglutenskih i standardnih namirnica i ove razlike treba imati u uvidu prilikom planiranja balansirane bezglutenske ishrane.

Ključne reči*: deklaracije; energetska vrednost; nutritivni sastav; bezglutenska ishrana.*