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BETA GLUCANS IN BISCUITS ENRICHED WITH BARLEY FLOUR MADE WITH DIFFERENT SWEETENERS

Gjore Nakov[1], Viktorija Stamatovska[2], Marko Jukić[3*], Ljupka Necinova[4], Nastia Ivanova[1], Ana Šušak[3], Daliborka Koceva Komlenić[3]

[1]Department of Biotechnology and Food Technology, University of Ruse "Angel Kanchev", Branch Razgrad, Aprilsko vastanie Blvd. 47, 7200 Razgrad, Bulgaria
[2]Faculty of Technology and Technical Sciences, "St. Kliment Ohridski" University of Bitola, Dimitar Vlahov bb, 1400 Veles, Republic of Macedonia
[3]Faculty of Food Technology Osijek, Josip Juraj Strossmayer University of Osijek, Franje Kuhača 20, HR-31000 Osijek, Croatia
[4]Healthy Food by Zegin, Bel kamen bb, 1000 Skopje, Republic of Macedonia

[*]e-mail: marko.jukic@ptfos.hr

Abstract

Accepting β-glucans as a functional, bioactive ingredient has increased the popularity and consumption of grain-based foods. Barley is a cereal containing a large amount of β-glucans. It can be successfully added to many food products such as bread, biscuits, ice creams, etc., and the resulting products have a greater share of β-glucans. This paper is determining the share of β-glucans in biscuits obtained from two types of flour (wheat and barley flour) with different sweeteners (sucrose, glucose and mixture of sucrose and glucose). The aim was to examine the influence of wheat and sweeteners on the amount of β-glucans in the produced biscuits.

Biscuits of wheat flour and biscuits with partial and complete replacement of wheat flour with barley flour (30%, 50%, 70% and 100% barley flour) are produced, according to the AACC 10-50D method. β-glucans in the flour and biscuits is determined according to AACC Method 32.23.01. Statistical analysis of the results obtained was done using XL Stat and Microsoft Excel 2013.

The conducted analysis showed that barley flour contained a higher amount of β-glucans (4.62 g / 100 g dry weight basis) than wheat flour (0.29 g / 100 g dry weight basis). Biscuits made of 100% barley flour were distinguished by higher β-glucans content compared to other manufactured biscuits. Regarding the used sweeteners, biscuits in which glucose solution was used as a sweetener had a higher amount of β-glucans than biscuits in which sucrose and a mixture of sucrose and glucose were used as sweeteners.

Based on the obtained results, it can be concluded that by increasing the amount of barley flour in the biscuit composition, the amount of β-glucans is increasing, as well. The use of glucose solution as a sweetener in the production of biscuits increases the content of β-glucans in biscuits.

***Key words**: Beta glucans, Biscuits, Wheat flour, Barley flour, Sweeteners.*

1. Introduction

Cereals constitute basic food for humans and are primary source of energy [1]. Food that positively affects human health contains ingredients that help the specific functioning of the body. It's very simple: food is fuel, food supplies the energy needed for daily functions and for normal metabolic processes [2]. The number of functional food products in certain food industries has been steadily increasing, as in the case with dairy industry. Opposite to this, baking industry still insufficiently uses the concept of functional foods [3].

One way of enriching the products is separating the germ, in which phenolic compounds and other

biological active substances are located, and then adding them to products like bread, cookies, cakes, and thus obtaining products with increased amount of fiber and increased food value [4]. Biscuit production is considered as very important part of food industry, because biscuits have a great nutritional value, especially when the raw materials from which they are made of are rich in fats, butter and proteins [5].

Biscuits are kind of cereal-based cookies and contain a large amount of sugars and fats [6]. The qualitative characteristics of biscuits depend on the chemical composition of the flour from which are produced and its quality [7]. The process of biscuit production depends on several factors: used raw materials, baking time, and type of biscuits to be produced [8]. The flour used for biscuit production is usually white wheat flour (oatmeal flour, corn flour, etc.) which contains at least 27% gluten [9].

Many authors have indicated the improved nutritional value of biscuits by using barley during their production [10,11].

The barley grain belongs to the family *Poaceae,* the genus *Triticeae и Hordeum* [12]. Barley is commonly used as animal feed, but also as an important raw material for production of beer and whiskey [13].

In recent years, the barley grain has been used completely (extruded or in the form of flour) for preparing breakfast, cereal soups and various types of bread [14]. Barley is interesting because of its relatively high content of soluble non-starch polysaccharides (fibrous material), of which β-glucans have a dominant position in terms of health benefits [15].

The FDA has prescribed the amount of fiber and β-glucans in barley products, so the whole dietary fiber content should be at least 10% based on the dry matter in peeled and non-peeled whole grain of barley, and the content of β-glucans should to be at least 4% based on dry matter. Barley flakes and barley flour must have dietary fiber of 8% on dry matter and at least 4% β-glucan. Barley brans and sifted barley flour should have dietary fiber of at least 15% on dry matter and at least 5.5% β-glucose on dry matter.Food made from appropriate barley sources should contain no less than 0.75 g of β-glucose per meal [16].

β-glucans are polysaccharides composed of D-glucose units associated with β-glucose bonds. As part of dietary fiber, β-glucans can be found in many natural sources, such as: yeasts, mushrooms, various types of bacteria, barley and oats [17]. They are high molecular weight polymers. The molecular weight of β-glucans from barley is 3×10^4 to 3×10^6 $gmol^{-1}$ [18]. β-glucans in barley and oat along with other non-starch polysaccharides are found in the aleurur layer that is a rich source of proteins and lipids [19, 20].

Cereal β-glucans are characteristic glucose polymers, different than other polymers, not only because of their source, but also because of their physic -chemical properties [21].

The aim of our study was to determine the quantity of β-glucans in biscuits produced from wheat and barley flour in different proportions (0%, 30%, 50%, 70% and 100%) with various sweeteners (sucrose, glucose as glucose solution and a mixture of sucrose and glucose) to characterize the barley as a suitable source of β-glucans to be used in the production of biscuits.

2. Materials and Methods

Wheat white flour T-500 (mill Popovo, Bulgaria) and barley flour produced by (Ekosem DOO, Bulgaria) are used for biscuits production. The rest of the raw materials are bought from local shops.

Biscuits are produced in the laboratory at the University of Ruse - branch Razgrad department of Biotechnology and Food Technology, in accordance with AACC Method 10-50D [22]. Fifteen types of biscuits are produced: basic control biscuits (100% wheat flour) and biscuits in which is made partial and complete substitute of wheat with barley flour (30%, 50%, 70% and 100% barley flour) with different sweeteners (sucrose, glucose like glucose solution and mix of sucrose and glucose solution).

2.1 Sample preparation

All samples are prepared according to the official method AACC Method 62-20A [23].

2.2 Determination of β-glucans

β-glucans were determined according to the official AACC Method 32.23.01 [24].

2.3 Statistical analysis

Statistical analysis of calculated weighted grades has been made with the help of XLSTAT 2017 and Microsoft Office Excel 2013 programs. During processing the results in XLSTAT 2017 program, analysis of variance (Anova) and Fisher`s Least Significant Difference test (LSD) with an importance factor (significance) of 95% ($p < 0.05$) has been used.

3. Results and Discussion

The content of β-glucans (soluble dietary fiber) in barley products may vary depending on the type of barley and variety used in the production [16].

The quantity of β-glucans in the used flour is presented in Figure 1. The figure shows that barley flour contains a large amount of β-glucans (4.62 ± 0.00 g/100 "dwb") compared to wheat flour (0.29 ± 0.00 g/100 "dwb"), which is statistically significant ($p < 0.05$). Mariotti *et al.*, (2014) found that barley flour has a higher amount of β-glucans compared to wheat flour (0.136 and 2.923 g/100 "dwb" respectively) [25].

Figure 2 shows the quantity of β-glucans in biscuits produced from wheat flour and barley flour in different ratio (0 : 100, 30 : 70, 50 : 50, 70 : 30 and 100 : 0, respectively). During production, sucrose and glucose were used as sweeteners. Biscuits produced from 100% barley flour (2.21 ± 0.00 g/100 "dwb") contain the largest quantity of β-glucans, while biscuits produced from 100% wheat flour (0.18 ± 0.00 g/100 "dwb") contain the smallest. All values are statistically different ($p < 0.05$).

Also, when using a glucose solution as sweetener (Figure 3), the largest amount of beta-glucose is found in biscuits of 100% barley flour (2.93 ± 0.01 g/100 "dwb"), and the smallest in biscuits of 100% wheat flour (control, 0.38 ± 0.00 g/100 "dwb"). All values for β-glucans in biscuits are statistically significant ($p < 0.05$).

The obtained values for the content of β-glucans in biscuits produced from wheat flour and barley flour in different proportions (0 : 100, 30 : 70, 50 : 50, 70 : 30 and 100 : 0 respectively) with sucrose sweetener are given in Figure 4.

Figure 1. β-glucans in used flour (mean value of 3 consecutive samples ± standard deviation; values with different exponents (a-b) are statistically significant ($p < 0.05$) Anova, Fisher's LSD)

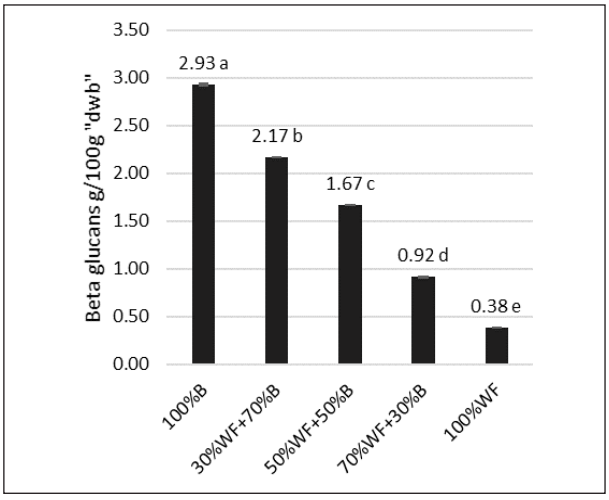

Figure 3. β-glucans in biscuits with wheat flour (WF) and barley flour (B) in a different ratio with glucose like sweetener (mean of 3 consecutive samples ± standard deviation; values with different exponents (a-e) are statistically significant ($p < 0.05$) Anova, Fisher's LSD)

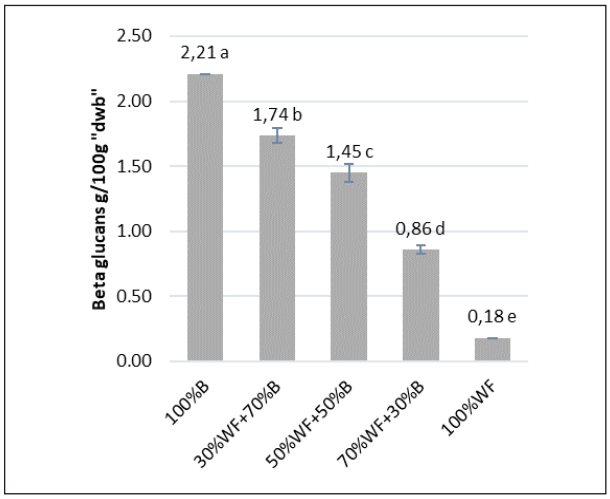

Figure 2. β-glucans in biscuits with wheat flour (WF) and barley flour (B) in different ratio with sweetener - sucrose and glucose mix (mean value of 3 consecutive samples ± standard deviation; values with different exponents (a-e) are statistically significant and different ($p < 0.05$) Anova, Fisher's LSD)

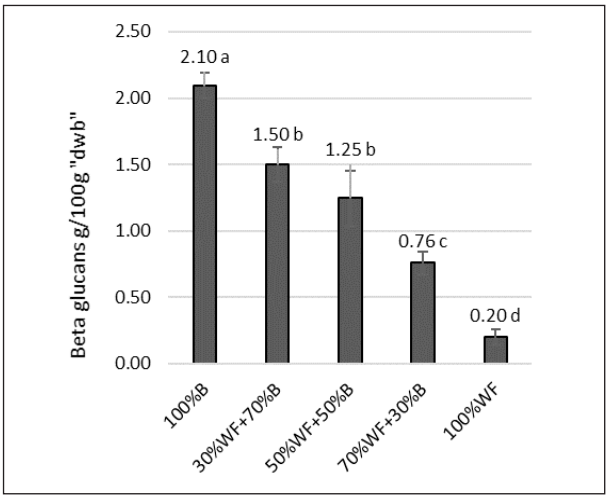

Figure 4. β-glucans in biscuits with wheat flour (WF) and barley flour (B) in a different ratio with sucrose like sweetener (mean of 3 consecutive samples ± standard deviation; values with different exponents (a - d) are statistically significant ($p < 0.05$) Anova, Fisher's LSD)

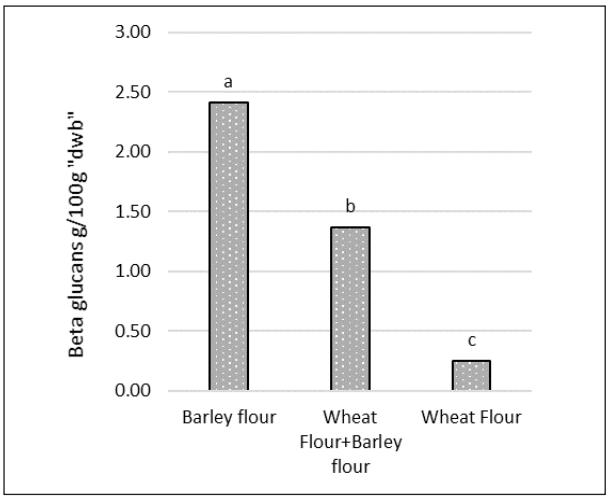

Figure 5. Influence of the used flours on β-glucans in biscuits (values with different exponents (a-c) are statistically significant (p < 0.05) AnovA, Fisher's LSD)

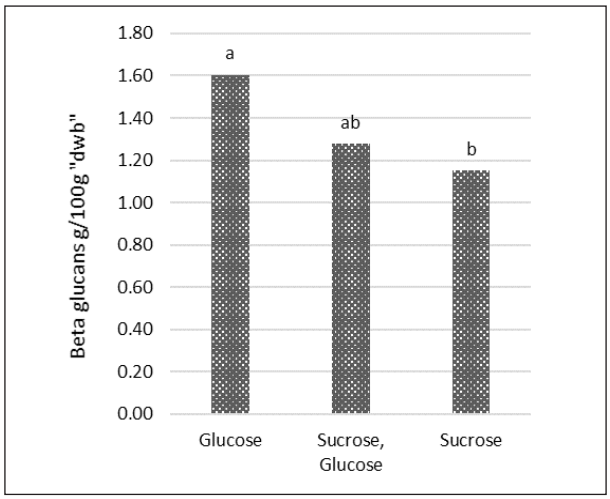

Figure 6. The influence of different sweeteners on the amount of β-glucans in biscuit (values with different exponents (a - b) are statistically significant (p < 0.05) Anova, Fisher's LSD)

From Figure 4 can be noted that even in this group of biscuits, by reducing the amount of barley flour (from 100% barley flour to 100% wheat flour), the amount of β-glucans found in biscuits decreases (from 2.93 ± 0.01 g/100 "dwb" at 0.38 ± 0.00 g/100 "dwb", respectively), that is, by increasing the amount of barley flour, the amount of beta-glucans in biscuits increases.

Bulbulušić *et al.*, [26], in their analyzes of the impact of barley flour and the baking temperature on the amount of β-glucans found that biscuits produced from 100% baked barley flour at 200 ^{0}C contain 2.66 ± 0.01 g/100 "dwb"), biscuits of 70% barley flour and 30% wheat flour contain 2.16 ± 0.07 g/100 "dwb" β-glucans, while biscuits produced from 50% barley flour and 50% wheat flour contain 1.52 ± 0.10 g/100 "dwb". The results show that by reducing the quantity of barley flour, the amount of β-glucans is reduced, which is in line with our analysis. The same is noticed when biscuits are baked at temperature of 105 ^{0}C [26].

Figure 5 shows the effect of the used flour on the quantity of β-glucans in produced biscuits regardless of the used sweetener. The results showed statistical significance ($p < 0.05$) among the used flour. From the values obtained for the presence of β-glucans in the produced biscuits, it can be seen that the largest amount of β-glucans is found in biscuits produced only from barley flour. The increase of barley results with increasing the present β-glucans in biscuits, regardless of the used sweetener.

Regarding the influence of used sweeteners (sucrose, glucose solution and sucrose and glucose mixture) on the quantity of β-glucans in the produced biscuits, it can be noted that there is a statistical difference between the used sweeteners. Biscuits with glucose solution are characterized by a higher amount of β-glucans compared to biscuits in which mixture of sucrose and glucose and only sucrose are used as sweeteners (Figure 6).

4. Conclusions

- In this study, we analyzed the presence of β-D-glucans in barley and wheat flour, as well as their presence in biscuits produced from wheat and barley flour in different proportions (0%, 30%, 50%, 70% and 100%). with various sweeteners (sucrose, glucose as a glucose solution and a mixture of sucrose and glucose).

- From the analysis of the used flour, it can be concluded that barley flour contains a higher amount of β-glucans than wheat flour. Regarding the influence of the used flour on the quantity of β-glucans in biscuits, it can be concluded that the increase in the share of barley flour increases the content of β-glucans in biscuits. Biscuits produced from 100% barley flour contain the highest amount of β-glucans, while the smallest quantity is found in biscuits produced from 100% wheat flour (control biscuits). From examining the impact of the used sweeteners, it can be concluded that despite the same formulation, various sweeteners still affect the amount of β-glucans. Biscuits produced with glucose (glucose solution) contain the highest number of β-glucans, while the smallest quantity is found in biscuits with sucrose sweetener.

- According to the research, barley can find application in the production of biscuits as a source of health-beneficial β-glucans.

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