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VARIABILITY OF β-GLUCANS CONTENTS IN GRAIN OF BARLEY CULTIVARS

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Abstract

Barley is one of the most important cereal species which has been used in human nutrition for a very long time ago. The aim of this investigation is estimation variability of barley cultivars on the base of analysis of β-glucan concentration in grain. The contents of β-glucans in grain of six genetically divergent barley cultivars (Erich, Atlas, Nonius, Horizont, G-3003 and Djerdan) were determined. The grain samples were grinded by laboratory grinder. Particles of <500 µm size were used in the experiment The contents of β-glucans were determined by ICC standard Method No 168. The value of β-glucans varied and indicated differences among analyzed cultivars. The highest content of β-glucans had barley cultivar Djerdan (7.012%) and the lowest content had Erich (5.214%).

Key words: *barley, β-glucans, content, cultivars*

Introduction

Barley is one of the most important cereal species which has been used in human nutrition for a very long time ago. Barley grain is not much different from the other grains, but the assortment of nutrients it contains is definitely superior (Knežević et al., 2011). The barley grain contain carbohydrates up to 73.4%, protein 12%, fat 1.8%, and also very high content of minerals (K, P, Mg, Ca, Na, S, Fe, Cu, Zn, J) and vitamins (the quantities of vitamin B12 and vitamin E, as well as vitamins A and D, are higher than in other grains). Grains are an essential part of human nutrition and the main source of complex carbohydrates (Mandić and Nosić, 2009). They are widely used in primary human nutrition, but are also used as fodder (Pržulj et al., 2010).

Grain of barley contain β-glucans - soluble plant fibers which are concentrated exactly in aleurone and sub-aleurone layers which enclose endosperm. The contents of β-glucans in grains depend on various factors which act in the period of endosperm development: effects of 1,3-1,4-β glucanase enzyme which enables degradation of endosperm cell wall in germination period, nitrogen level, temperature, precipitations etc. Barley and oat contain larger quantities of β-glucans than any other grain. β-glucans have positive influence on human health make barley an important raw material in the functional food production (Dodig et al., 2007). The β-glucans are dietary fibers (oligosaccharides, polysaccharides and their derivatives) which cannot be decomposed to absorbable components by human digestive enzymes).

Our ancestors have been using whole grains since ancient times, but mass production of white flour has taken place in due course. However, it has been scientifically confirmed that nutritive values of whole grains are considerably higher than those of refined grains from which all the nutritive substances have been removed, since grain membrane also contains nutrients necessary for development, growth and preservation of organism. In the grinding process, the aleurone layer (the prismatic cells layer that encloses endosperm, but is more similar to a shell due to its mechanical properties) is isolated together with the shell. That is how bran is made, while endosperm is used for obtaining powdered products of various granulations. The presence of two types of glucosidic bonds [β-(1-3) and β-(1-4)] in β-glucans molecules influences their physical and chemical properties, such as viscosity and solubility (Chen et al., 2014). Viscosity depends on soluble β-glucans concentration and on their molecular mass. In relatively small concentrations (1%) β-glucans have high viscosity which is present in wider pH range (Havrletova et al., 2011).

In comparison with all other fibres, β-glucans have the most positive effect on human health, that is estimated on the base of positive effect on metabolism and reduction of cholesterol and sugar in blood (Haggard e al., 2013; Park et al., 2009) risk of cardiovascular diseases as well as in prevention and treatment of allergies (Pereira et al., 2004; Taketa et al., 2011).

Investigation of biological activity of β-glucans (Rondanell et al., 2009; Ka-Lung et al., 2013) have confirmed their potential application in functional food production, but also in pharmaceutical industry and medicine due to physiological effects. In addition to that, there were no reports of harmful effects of food rich in beta-glucans from oat or barley flour or their extracts. On the base of these fact in the last few decades are increased interest in β-glucansas because of its functional and bioactive properties.

The aim of this investigation is estimation variability of barley cultivars on the base of analysis of *β*-glucan concentration in grain.

Materials and methods

In this paper, grain samples of six various barley cultivars (Erich, Atlas, Nonius, Horizont, G-3003 and Djerdan) were used for analysis. The grain samples were grinded by laboratory grinder. Particles of <500 µm size were used in the experiment.

The contents of β-glucans were determined by Megazyme method (ICC Standard Method No 168). The assay is specific for mixed-linkage [(1-3)(1-4)-β-D-glucan]. Method principle is: Samples are suspended and hydrated in a buffer solution of pH 6.5 and then incubated with purified lichenase enzyme and filtered through Whatman No.41. An aliquot of the filtrate is then hydrolyzed to completion with purified β-glycosidase. The produced D-glucose is assayed using a glucose oxidase/peroxidase reagent. Then the absorbances were measured at 510 *nm* for each sample A1, A2 and blank. The contents of β-glucan were calculated by using the factor for the conversion of absorbance values to µg of glucose and factor for the conversion from free D-glucose, as determined, to anhydro-D-glucose, as occurs in β-glucan (McCleary and Codd, 1991).

Results and discussion

The results indicate that there is genetic diversity in content of dietary fibers among tested genotypes. The contents of β-glucans in analyzed barley cultivars varied in ratio from 5.214% in cultivar Erich to 7.012% in cultivar Djerdan (tab. 1). Values of β-glucans concentration for other analyzed barley cultivars vary between those values.

The contents of *β*-glucan in grain barley reported so far, have ranged from less than 2% to more than 10%, and variation is not only caused by genetics and environment, but is also due to the analysis methodology.

Table1. The values of concentration of β-glucans in analyzed barley cultivars

No.	Barley cultivars	Absorbances (510nm)			**β -glucan**
		A 1	A2	ΔA	% (w/w)
1.	Erich	0.938	1.020	0.979	5.2143
2.	Atlas	1.168	1.182	1.176	6.4243
3.	Nonius	0.784	0.802	0.812	5.5834
4.	Horizont	1.228	1.188	1.236	6.5421
5.	G-3003	0.964	0.922	0.958	5.8455
6	Djerdan	1.289	1.245	1.298	7.0120

β-glucans are genetically determined and its value can be increased by cultivation (and application of proper agro-technical measures), the aim of our researches was determination and comparison of β-glucan contents in 6 barley genotypes and selection of cultivars with higher contents of β-glucans, as a modest contribution to barley cultivation.

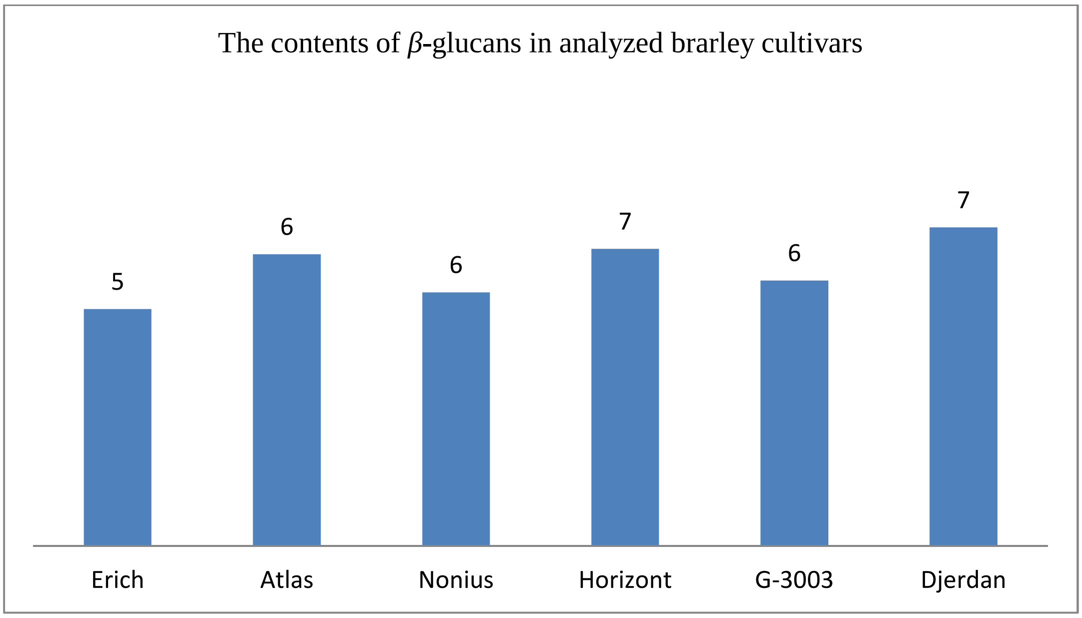

Figure 1. Variability of β-glucan contents in analysed barley cultivars

In this investigation established diferences anong analyzed cultivars (Fig. 1). Barley cultivar Nonius (5.583%) and G-3003 (5.845%) had more similar value of β-glucan contents to Erich (5.214%) cultivar with the least value of protein content, while Atlas (6.424%) and Horizont (6.542%) had more similar value of β-glucan contents to Djerdan (7.012%).
The environmental factors have influence to grain β-glucan content. Grain β-glucan increased with increasing N application. There are differences among cultivar according to responses to N nutrition as well in expression of correlation β-glucan with other traits. So, grain with low β-glucan concentration usualy have lower hectolitre mass, low value of protein content while there are no correlation between grain β-glucan and average grain weight, malt extract etc. (Blakely and Harasymow, 2010). Therefore, some barley genotypes 1,3;1,4)-β-D-glucanless mutants showed cold-sensitive phenotype, as well a reduction in plant height, plant vigour and yield (Taketa et al., 2012).

However, during the maturation (1,3 and 1,4)-β-D-glucan continually deposited in the seeds, even after the enzyme activity gradually decreased (Tsuchiya et al., 2005) while the reason is not yet clearly explained (Tonooka et al., 2009). The wider range of β-glucan content for the barley collections in another studies may be attributed to more samples and the greater differences in the environments of a particular cultivar origin. For example, higher β-glucan content in Tibet barley cultivars may be at least partly related to their hulless type and is desirable in light of their use as feed. Also, the barley grown in Zhejiang had a much lower β -glucan content (Chen et al., 2014). In the same study showed that β -glucan contents is similar in barley genotypes from Canada and Australia, indicating that β-glucan content is not a predominant factor in determining quality and productive traits of barley. The earlier analytical method, by measuring viscosity gave high values, while the enzymatic method, developed by McCleary and China; it grows in widely ecological locations and finds manifold uses. Commonly, it is used as a material for malting and feed processing while, in Tibet, barley is a stable food crop. However, there has been little research on β -glucan content in China

Conclusion

In this study established differences among barley cultivars according to contents of β-glucan in grain. By biochemical analysis of β-glucan contents in six genetically divergent cultivars of barley we have established variability in β-glucan contents. Cultivar Djerdan has the highest contents of β-glucans 6.597% (w/w). Cultivar are most similar to it and are the richest in β-glucans. The positive effects of barley in human nutrition are the consequence of high biological value of its nutritive components and dietary fibres (β-glucans). The β-glucans correlation with other grain traits indicate importance of study their ineraction and use as a criteria in breeding program. The, exploitation of germplasm potential and revealing the formation nature of grain quality in barley will aid in the development of better cultivars with desirable dietary traits.

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