Barley Grain as a Source of Health-Beneficial Substances

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Abstract: Barley is an excellent source of non-starch polysaccharides, i.e. soluble fiber (β-glucans and arabinoxylans), it contains many important vitamins (vitamin E and vitamin B-complex) and enzymes (superoxide dismutase, catalase). A set of the malting varieties and a line KM 1057 had statistically significantly higher content of arabinoxylans (4.40–5.58%) compared to the other KM lines (CZ origin) and the variety Merlin (Canada origin) (3.51–3.64%). Content of β-glucans in grain of varieties/lines was in a reverse order. The variety Merlin and lines KM (4.10–6.08%) had higher β-glucan content compared to the malting varieties and lines KM 1057 (2.78–4.02%). In the studied set of varieties/lines, strong negative correlation (r = –0.78**) between content of β-glucans and arabinoxylans was determined.

Keywords: barley; *Hordeum vulgare*; non-starch polysaccharides; β-glucans; arabinoxylans

INTRODUCTION

Barley is the primary cereal used in the production of malt worldwide. Significance of barley as a raw material for production of nutritiously valuable healthy foods was underlined in 2005 when the US Food and Drug Administration (FDA) confirmed the qualified health claim linking barley to prevention of cardiovascular diseases (as a result of high content of food fiber). Research on grain nutritious composition and number of clinical studies have proved that consumption of barley grain is an effective tool for the control of type II diabetes, the digestive system diseases, disrupted immunity of the organism and other civilisation diseases. Barley grain is an excellent source of soluble and insoluble dietary fiber and other bioactive constituents, such as vitamin E, B-complex vitamins, enzymes, minerals, and phenolic compounds (Gamlath *et al*. 2008; Izydorczyk & Dexter 2008).

The non-starch polysaccharides (NSP) of the barley kernel are structural components of the cell walls in hull, aleurone, and endosperm tissue. The NSP's are not digested by the human digestive system. Content of dietary soluble fiber is formed by β-glucans and arabinoxylans in a barley grain. Barley fiber and particularly β-glucans are not desirable for the brewing and malting industries. They increase density of malt or beer, prolong filtration, and cause haze and sediments in beer. High β-glucan content is not favorable for animal feed either, especially the broiler industry (Newman & Newman 2008).

The structural characteristics of arabinoxylans that can be at variance depending on their genotypic or cellular origin include the ratio of arabinose to xylose residues (Izydorczyk & Dexter 2008). Very specific is the presence of ferulic acid (usually 0.1–0.2% of the weight). Arabinoxylans are highly capable of binding water. Some arabinoxylan fractions are water-soluble and form extra viscous dispersions. Differences in solubility depend on the level of branching. Soluble arabinoxylans are important components of flour.

MATERIAL AND METHODS

The set of 8 malting varieties of spring barley and 4 hulless lines (KM lines) were grown in field experiments with low and high inputs (of fertilizers and pesticides) at the Experimental Station of Mendel University of Agriculture and Forestry in Žabčice near Brno (CZ) over the period of 2007–2008 in three repetitions.

β-glucans were measured by the FIA method (Flow Injection Analysis) (Havlová 2001). Arabinoxylans were assessed using spectrophotometric methods after Douglas (Havlová *et al.* 2001).

Chemical data from β-glucan and arabinoxylan analysis were evaluated by a two factor-analysis of variance ANOVA using the program STATISTICA 7.0 (StatSoft, Inc. Tulsa, Oklahoma, USA). The multiple range test of mean values (LSD-test, P = 0.05) was used as the post hoc procedure when the F-test from ANOVA indicated significant differences among cultivars and years.

RESULTS AND DISCUSSION

Mean squares for the cultivars, growing years, treatment and their interactions, in β-glucans and arabinoxylans were highly significant (P < 0.001) as indicated by the ANOVA F-test. The year and interaction of the inputs and year did not affect arabinoxylan content significantly.

Mean β-glucan content (Table 1) in the studied set was 4.23% within the interval of 2.78–6.08%. Ehrenbergerová *et al.* (2008) described β-glucan content in various barley lines in the range of 4.03–7.57%, Gamlath *et al.* (2008) reported 1.8–6.1% and Izydorczyk and Dexter (2008) 3.6–9.7%. Rey *et al.* (2009) reported average β-glucan value of 55 g/kg compared to 35 g/kg for cultivars and lines with nonwaxy starch.

Average arabinoxylan content in grain was 4.47%, i.e. 3.66–5.46% (Table 1). Gamlath *et al.* (2008) showed larger range of arabinoxylan content (2.2–7.0%) and Izydorczyk and Dexter (2008) reported percentage range of arabinoxylans between 3.50–6.05%. Fleury *et al.* (1997) reported that the amount of arabinoxylans in the western Canadian hull-less barley (3.37–4.30%) was significantly lower than that in two- or six-rowed (5.41–6.42%) covered barley.

Statistically significantly higher percentage β-glucan content was detected in the variety Merlin (6.08%, Table 1) versus to all the other varieties in the set. But this variety also had the lowest arabinoxylan content (3.66%) in grain and did not differ significantly from the other KM lines (3.67–3.73%) with the exception of the line KM 1057. The line KM 1057 had statistically significantly higher arabinoxylan content (5.46%) versus all the studied varieties/lines but at the same time it had statistically significantly lower β-glucan content (2.78%). Further, higher concentration of β-glucan in grain was determined in the lines KM 2084, KM 2283 and the variety Malz (4.68–5.75%). The line KM 1910 (4.10%) and the other malting varieties (3.31–4.68%) belonged to the varieties with lower β-glucan content. In the studied set of varieties/lines, strong negative correlation (r = –0.78**) between content of β-glucans and arabinoxylans was determined. This finding is confirmed by higher representation of arabinoxylans in the above mentioned line KM 1057 (5.46%) and the malting varieties (4.44–5.14%) with the exception of the variety Merlin (3.66%). On the contrary, the variety Merlin together with the lines KM 2084, KM 1910, and KM 2283 had the lowest arabinoxylan content in grain (3.66–3.73%), but high β-glucan concentration.

On the average, the grain samples from the treated experiments had statistically significantly lower β-glucan content (4.03%) than those from the untreated ones (4.42%). Arabinoxylan content was higher in the treated experiment (4.61%) compared

Table 1. Average β-glucan and arabinoxylan contents in grain of the spring barley varieties/lines (2007–2008)

Varieties/lines	Arabinoxylan (%)	β-glucan (%)
Merlin	3.66^{a}	6.08^{h}
KM 1910	3.67^{a}	4.10^{d}
KM 2084	3.73^{a}	5.75^{g}
KM 2283	3.73^{a}	5.27^{f}
Bojos	4.44^{b}	3.31^{b}
Prestige	4.54^{bc}	3.34^{b}
Jersey	4.68^{bc}	4.02^{d}
Malz	4.72^{c}	4.68^{e}
Amulet	4.78^{c}	3.70^{c}
Tolar	5.06^{d}	3.97^{d}
Sebastian	5.14^{d}	3.73^{c}
KM 1057	5.46^{e}	2.78^{a}

to the untreated experiment (4.31%). On average in 2008 the varieties had higher β-glucan and arabinoxylan content (3.58% and 4.43%, respectively) than in 2007 (4.88% and 4.47%, respectively). Weather conditions of years in the growing location affected non starch polysaccharides as previously confirmed by Ehrenbergerová *et al*. (2008) and Fleury *et al*. (1997).

CONCLUSION

Varieties with high β-glucan and arabinoxylan contents could be perspective for human diet. These requirements were fulfilled by the malting variety Malz in our experiment. The other varieties/lines either had high β-glucan content and low arabinoxylan content (Merlin, KM 2084, KM 2283, and KM 1910) or low β-glucan content and high representation of arabinoxylans (KM 1057, Tolar, Sebastian). Therefore, strong negative correlation was determined between β-glucan and arabinoxylan content ($r = -0.78^{**}$). The varieties with lower content of non starch polysaccharides are desirable for use in the malting industry.

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