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Molina-Cano J.L. (ed.), Christou P. (ed.), Graner A. (ed.), Hammer K. (ed.), Jouve N. (ed.), Keller B. (ed.), Lasa J.M. (ed.), Powell W. (ed.), Royo C. (ed.), Shewry P. (ed.), Stanca A.M. (ed.).
Cereal science and technology for feeding ten billion people: genomics era and beyond

Zaragoza : CIHEAM / IRTA
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 81

2008
pages 345-347

Testing and breeding hulless barley for healthy food

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SUMMARY – One of health promoting effects of hulless barley (HB) food products is lowering blood cholesterol level; the main cause of this effect is high β-glucan content. Vitamin E also can be responsible for reduction of blood cholesterol. HB genotypes of diverse origins tested in the location of Stende during 2004-2005 had higher β-glucan content than covered ones (in average 49.3 mg kg^{-1} and 38.9 mg kg^{-1} respectively); the range of HB β-glucan content in the location of Priekuli was 37.3-77.5 mg kg^{-1}, but for covered barley varieties it was 26.1-39.4 mg kg^{-1}. β-glucan content of 11 HB breeding lines (2005) was 54.2-76.8 mg kg^{-1}. Vitamin E content in 7 HB accessions ranged 32.8-40.6 mg kg^{-1} and it was higher than in covered barley and other cereals. The taste, colour and loaf structure of 30% HB bread was scored equally to wheat bread. Our results indicate that HB can be successfully used in health promoting food products.

Introduction

Hulless barley (HB) is a promising cereal, which is particularly interesting for the food industry due to economic reasons and to its health promoting effects. Compared with other cereals, barley endosperm has a relatively high content of β-glucan. The β-glucan content of barley grain usually varies between 2 and 7% (Grausgruber *et al*., 2004). Positive roles of β-glucan in human nutrition and health include lowering blood cholesterol levels, increasing mineral and vitamin bio-availability and reducing colon cancer have been noted (Klopfenstein, 1988). Reduction of serum cholesterol by 3.3-20.0% due to consumption of barley products has been demonstrated in several studies. Lipid-associated barley components (vitamin E and tocotrienols) may also be responsible for reduction of serum cholesterol as well as functioning as antioxidants. Barley food products have a very low glycaemic index and are recommended in diets for type II diabetics (Newman and Newman, 2004). Comparison of covered and HB showed that the latter generally contained more protein, starch, and β-glucan. This was due to removal of the fibrous hull which has a dilution effect on these components (Bhatty, 1999). Varieties with waxy endosperm also have higher β-glucan contents than varieties with normal starch (Washington *et al*., 2000; Oscarsson *et al*., 1997). Nutritious and tasty breads can be made with up to 40-50% barley flour replacing wheat flour, the darker color and smaller loaf being more acceptable to consumers than in the past (Newman and Newman, 2004). The sensory scores for texture, flavor, and overall acceptability were not significantly different when 26% HB bread was compared with 26% whole wheat bread, with no significant differences in specific volumes (Berglund *et al*., 1992). Addition of HB flour increases the content of β-glucan and arabinoxylans in bread products (Trogh *et al*., 2004).

Materials and methods

β-glucan content was determined in various HB and covered barley genotypes grown in two locations (Stende and Priekuli) during 2004-2005. In 51 barley genotypes from Stende (27 two-row, 10 six-row, 37 covered, 14 HB), but only 19 genotypes from Priekuli (5 covered and 9 HB, 5 normal starch and 9 waxy starch) were analyzed. Eleven HB lines obtained from the breeding program in Priekuli (variety 'Merlin' in pedigree) were analyzed for β-glucan content in 2005.

The (1→3), (1→4) β-D-glucan content was determined enzymatically using commercial kits from Megazyme (Megazyme International Ireland Ltd.) according to the method developed by McCleary and Glennie-Holmes (1985). Vitamin E content was determined in seven HB accessions (two normal starch, five waxy starch), the covered barley 'Idumeja', rye, triticale, wheat and oats (AOAC Official Method 971.30).

The experimental recipe used for production of whole grain wheat bread in a private bakery was used for breadmaking. Wheat flour substituted with 50% and 30% whole grain HB flour was compared to 100% wheat bread. The taste, color and structure of the loaves were evaluated by 23 independent assessors. No information about the content of bread samples was provided to participants. A scale 1-5 was used for assessment (5-very good, 1-very bad).

Results

The variation in β-glucan content of two-row, six-row, covered and HB genotypes in Stende during 2004-2005 is presented in Table 1. Only small differences were found between the two-row and six-row barleys. The results of a t-test showed no significant differences between the mean β-glucan contents of two-row and six-row barleys (p-value=0.14). For six-row genotypes this ranged from 35.9 to 47.1 g kg^{-1} with a mean value of 41.4 g kg^{-1}, but for the two-row genotypes from 33.2 - 44.9 g kg^{-1} with a mean of 38.0g kg^{-1}.

Table 1. Comparison of β-glucan contents of barley types (g kg^{-1}, 2004-2005, location Stende)

Genotypes	Mean value	Standard deviation	Minimum value	Maximum value	Coefficient of variation, %
2-row	38.0	3.2	33.2	44.9	8.4
6-row	41.4	4.2	35.9	47.1	10.8
Covered	38.9	3.7	33.2	47.1	9.7
Hulless	49.3*	6.4	38.7	62.0	13.5

The hulless genotypes had significantly higher β-glucan contents than the covered varieties (49.3 g kg^{-1} and 38.9 g kg^{-1} respectively, p-value=0.005). The standard deviation of the mean values and the coefficient of variation of β-glucan content were lower for covered varieties than for the hulless ones (Table 1).

The range of β-glucan content of the HB samples grown in Priekuli during 2004-2005 was 37.3-77.5 g kg^{-1}, but for covered barley varieties it was 26.1-39.4 g kg^{-1}. Low mean β-glucan contents were determined for the covered variety 'Kompact' and Czech HB line KM-1910 (2.61 and 3.73 g kg^{-1}), but the highest β-glucan content was found in the waxy HB 'Wanubet' and 'Azhul' (73.7 and 77.5 g kg^{-1}).

The β-glucan content of 11 HB breeding lines selected from crosses with the waxy HB variety 'Merlin' in 2005 was 54.2-76.8 g kg^{-1} and it was also comparatively high for check variety 'Taiga' (5.87 g kg^{-1}). The yields of the lines ranged 54-96% of that of the covered standard variety 'Ansis', which suggests that breeding of HB varieties with acceptable yields and high β-glucan content is possible.

The vitamin E content determined for seven HB samples ranged 32.8-40.6 mg kg^{-1}, being lower in covered barley, rye, triticale, wheat and oats (31.2, 19.8, 31.2, 27.1 and 19.8 mg kg^{-1}, respectively). The highest vitamin E content was present in varieties 'Washonubet' and 'Lawina'.

The taste, color and loaf structure of 30% HB bread were scored equally to that of wheat bread, but bread samples with 50% HB flour content had lower mean scores (Table 2). Our results therefore indicate that HB can be successfully used for health-promoting food products.

Table 2. Evaluation scores of breads with different contents of HB flour

Parameters	50% HB flour	30% HB flour	100% wheat flour
Taste	3.8	4.5	4.6
Color	4.2	4.6	4.7
Loaf structure	3.9	4.7	4.6

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