

# Changes in Hulless Barley Nutritional Quality During Grain Processing and Utilisation

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## INTRODUCTION

Products from barley or oats are often marketed as healthy because of the dietary fibre composed mainly of (1-3),(1-4)-beta-D-glucans. Besides the well-known hypocholesterolemic effects, the importance of barley dietary fibre consumption by patients diseased by type II diabetes has been highlighted in specialised literature in recent years (Behall et al. 2005). Maximum use of its potential is affected, besides selection of a suitable genotype (variety), by the applied grain processing methods.

In the Czech Republic, the percentage of barley for direct food consumption is low similarly to most European countries (Vaculova et al. 2004). The objective of the projects focused on food use of non-traditional and minor cereals, i.e. including hulless barley, is to find and develop appropriate methods for grain processing and to propose technological processes of food production with improved nutritional benefit to healthy nutrition for a variety of consumers.

Table 1 Characteristics of the hulless and waxy lines and varieties for food purposes (Kromeriz, 1998-2001)

Source of variability	Grain yield t.ha <sup>-1</sup>	* Protein % DM	* Starch % DM	* B-glucans % DM
Line, variety (specific characteristics)				
KM1057 (high lysine)	4.94	ab	13.5	cd
KM1910	6.58	c	11.4	a
KM2082	6.27	bc	12.5	bc
KM2283	6.99	c	11.6	ab
Wabet (waxy)	4.4	a	14.0	d
Wanubet (waxy)	3.76	a	13.5	cd
Washonubet (waxy)	3.96	a	13.8	d
Milling fractions**				
Break flour		10.57	a	76.08
Reduction flour		10.31	a	76.38
Break bran		15.00	c	52.04
Scratch bran		13.06	b	61.38

\* - different letters for the same trait mean significant difference at P<sub>0.05</sub>, \*\* - see Materials and Methods

Table 2 Chemical composition of grain milling fractions (line KM2283)

Fraction	Protein	Starch	B-glucans	P	K	Ca	Mg	Ash
Break flour	8.61a	76.56a	2.70a	0.21b	0.20a	0.05a	0.05a	0.88a
Reduction flour	8.62a	76.97a	2.90a	0.20a	0.20a	0.04a	0.05a	0.84a
Break bran	13.55b	54.51c	7.25b	0.44c	0.39b	0.06b	0.15b	1.84b
Scratch bran	14.24c	57.42b	7.28b	0.49d	0.43c	0.07c	0.16c	2.20c

Table 3a Results of malting the grain of hulless barley lines KM1910 and KM2283 under different malting technologies

Parameters	Unit	KM1910		KM2283	
		6/45*	4/38	6/45	4/38
Extract	%	87.6	85.0	85.1	83.2
Soluble N	mg.100 ml <sup>-1</sup>	62	51	49	40
B-glucan in malt	mg.l <sup>-1</sup>	616	1640	1411	2866
Friability	%	54.0	15.0	30.0	7.0
Rel. extract at 45°C	%	37.3	22.4	27.1	20.6
Sugars	g.100g <sup>-1</sup>	5.52	2.58	4.21	2.97

\* - see Materials and Methods

Table 3b Results of malt parameters evaluation after 25% and 50% addition of unmalted grain of the line KM1910

Parameter, sample	Unit	Addition of unmalted grain		CM
		25%	50%	
Water content	%	7.1	9.4	4.9
Saccharifying	min.	15-20	30-35	10-15
Wort haze 15°	EBC units	5.85	3.15	3.57
Wort haze 90°	EBC units	6.09	2.79	5.92
Viscosity	mPa.s <sup>-1</sup>	1.57	1.81	1.48
pH		5.95	5.92	5.95
Fine grind extract	%	81.3	83.6	80.3
Rel. extract at 45°C		32.4	29	31.9
Final attenuation	%	75.6	71.2	78.8
Soluble N	mg.100 ml <sup>-1</sup>	71	33	82
B-glucan content	mg.l <sup>-1</sup>	434	779	117

CM - check malt - a laboratory internal standard

Table 4 Chemical composition of processed grain and food products with hulless barley

Product	Specific.**	Protein	Fat	Ash	TDF	B-glucans
Lagris abrading	2-fold	10.99	2.42	1.21	7.93	5.05
	4-fold	11.76	2.26	0.98	6.96	4.35
Polished grain Lagris		13.31	2.02	1.33	ND*	3.00
Puffed grain	sample 90	11.31	2.00	1.31	12.28	5.09
	sample 113	10.86	2.12	1.21	12.83	5.57
Salt sticks	W	10.42	38.61	2.37	5.21	0.10
	Mx	8.90	37.13	2.36	ND	ND
Bread	WBMa	9.19	37.20	2.13	6.01	0.96
	W	7.10	7.20	1.93	8.20	0.31
	B	7.90	7.00	1.72	5.40	0.72
Gingerbread	Ma	10.00	6.00	1.90	8.60	1.15
	W	6.07	18.78	1.91	4.68	0.07
	Mx	5.94	19.13	2.14	5.70	0.48
Biscuits	B	6.40	20.69	1.90	6.99	0.81
	Ma	6.31	19.52	2.00	5.17	1.58
	W	7.43	36.52	0.66	5.24	0.09
Pasta	B	7.06	40.34	0.89	6.41	1.33
	Mx	8.77	38.03	0.74	6.28	1.01

\* - ND=no data, \*\* - Recipe specifications: W=wheat flour, B=part of barley flour, Mx=mixture wheat:barley flour=1:1, WBMa = wheat:barley:malt=2:1:1, Ma=part of barley malt

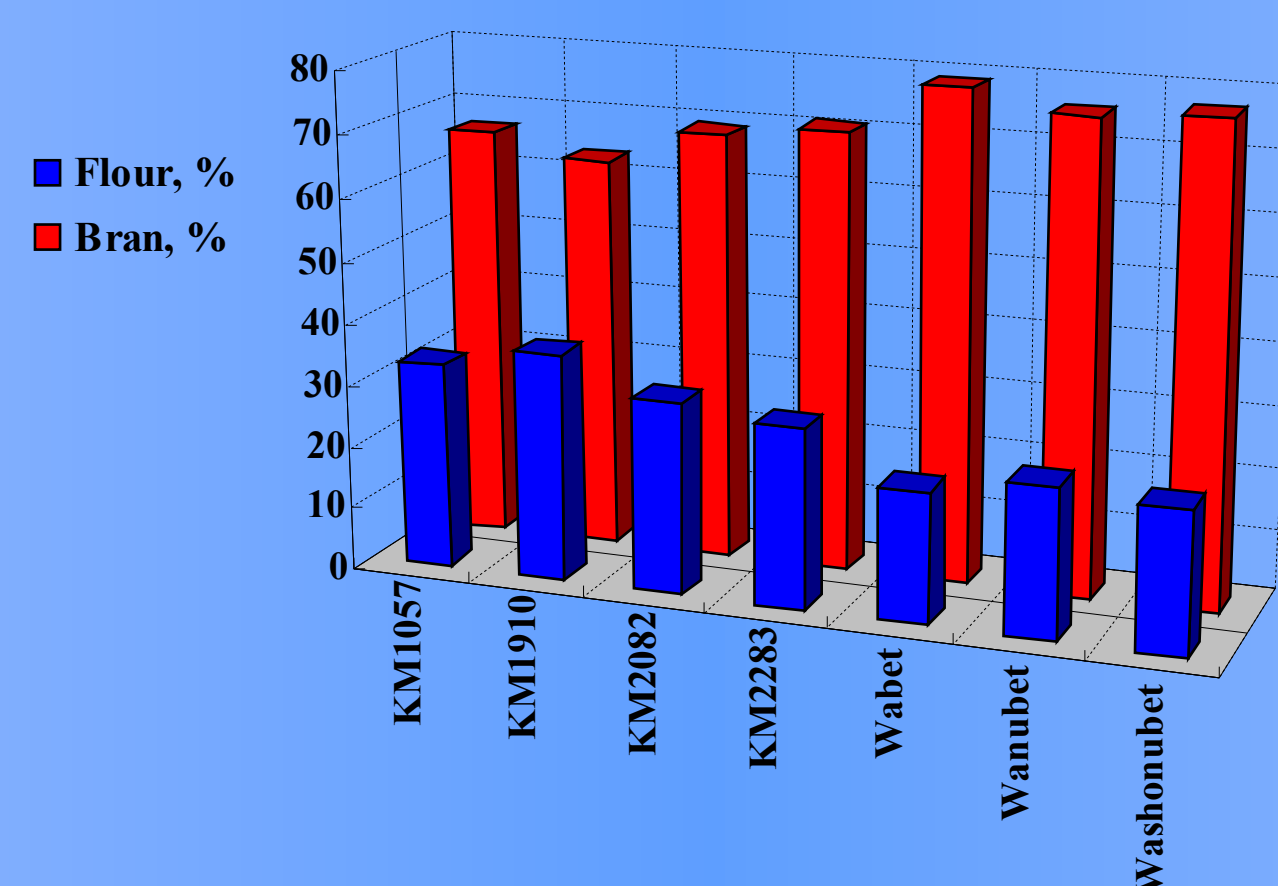
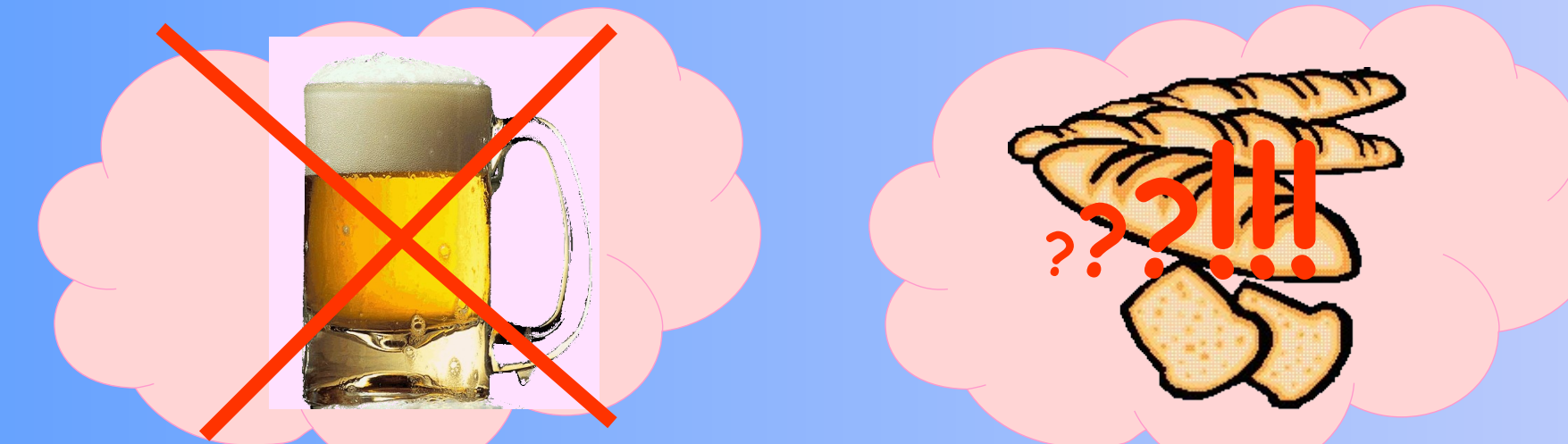


Fig. 1 Yield of the milling fractions (flour, bran) from hulless and waxy barley grain (Brabender Junior II mill)

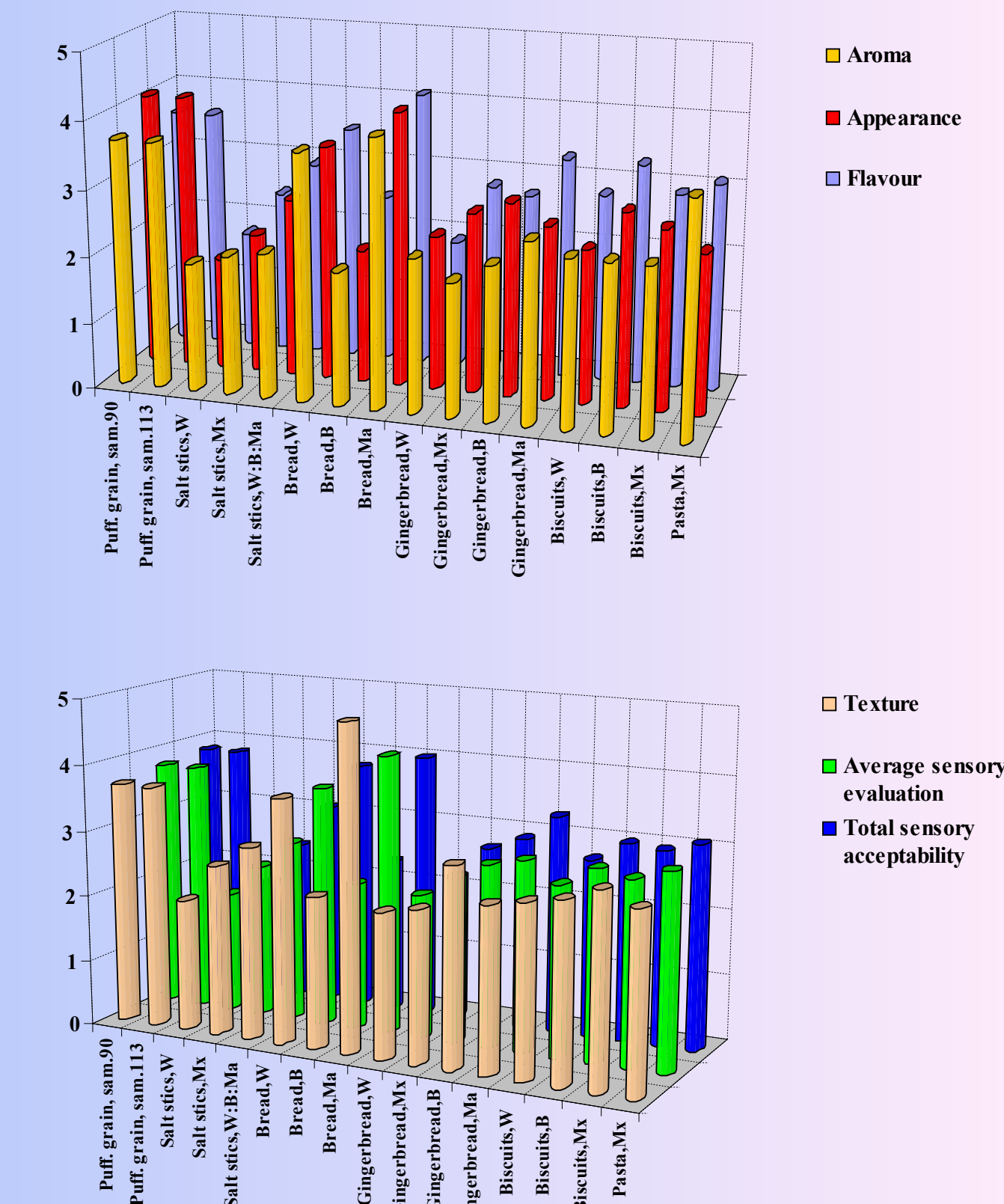


Fig. 2 Sensory evaluation of the new products with hulless barley. Composition of the products: W=wheat flour, B=part of barley flour, Mx=mixture wheat:barley flour=1:1, WBMa = wheat:barley:malt=2:1:1, Ma=part of barley malt; (Scoring scale: Materials and Methods)

## MATERIALS AND METHODS

**MATERIALS** (grown in field conditions of Kromeriz, Czech Republic, 1998-2003):

- 1) New spring **barley lines with hulless grain** from the Agricultural Research Institute Kromeriz, Ltd. - KM1057 (high lysine), KM1910, KM2082, KM2283 (regular starch barleys).
- 2) Donors of "waxy starch" ("waxy" donors) with genetically determined **increased beta-glucans** content and covered or hulless grain from Montana University, USA - Wabet, Wanubet, Washonubet.

**METHODS** (some grain and technological processing are described in more detail in the proceedings of the 8<sup>th</sup> and 9<sup>th</sup> International Barley Genetics Symposium - Vaculova and Erban 2000 and Vaculova et al. 2004):

- 1) **Milling** in a laboratory mill Brabender Junior II and wheat mill BÜHLER 59320 to obtain next milling fractions: flour (or break flour and reduction flour), and bran (or break bran and scratch bran).
- 2) **Abrading and polishing** of the grain of the selected line KM2283 on a plant device Bühler for rice processing by the firm Lagris Lovosice.
- 3) **Puffing** (or expansive drying) was performed on a device for expansive drying (developed and manufactured by the Food Research Institute Prague). The tests of treated grain were carried out at optimum range of parameters determined by previous experiments (pressure from 0.9 to 1 MPa, temperature of 550 °C, grain moisture around 17%).
- 4) **Malting** was made at the Research Institute of Brewing and Malting Prague, Malting Institute Brno using two malting methodologies differing in water content at germination and a total malting period (45% and 6 days and 38% and 4 days). The 25% and 50% addition of unmalted grain was also used for blending with hulless barley malt.
- 5) **Development of the recipes** for preparation of salt and sweet bakery and biscuit products (bread, salt sticks, gingerbread, biscuits, pasta, bulgur, etc.), based on traditional Czech recipes, were made in the Food Research Institute Prague from preprocessed barley products (flour, bran, barley-wheat flour mixture, malt, puffed grain, etc.) in the years 2003-2004.
- 6) **Sensory evaluation** of barley products and samples of puffed barley was performed in a specialised laboratory of the Food Research Institute Prague according to ISO 6658. Sensory evaluation was performed by trained assessors using a 1-7 scoring scale (from 1=excellent sample to 7=unacceptable sample). Sensory descriptors: appearance, aroma, texture, flavour, and total sensory acceptability.
- 7) **Chemical analyses** were carried out according to standard methodologies (EBC, AOAC, etc.): dry matter, ash, standard parameters of malt and wort, protein, starch, beta-glucans=BG, fat, total dietary fibre=TDF, minerals, and ash in grain and barley products, etc. (see References). The results were analysed by standard statistical methods using software STATISTICA 7.

## CONCLUSIONS

- Our own hulless barley lines showed to be suitable sources with different grain quality for potential food use. Their flour yield was significantly higher than in original "waxy" barleys with high BG content (on average max. 36.7% in the line KM1910 - Fig. 1).
- Separate milling of barley grain results in milling **fractions with differentiated nutritional composition**. Flour fractions differed from bran ones in all examined basic nutrients (Table 1).
- The analysis of chemical composition of milled grain of the line KM2283 showed that it was possible to separate **fractions with different contents of ash and minerals**. Flour fractions had 42.8 to 68% lower content of the examined minerals (Ca or Mg) than bran, particularly scratch bran (Table 2).
- Preprocessing of grain for puffing (expansive drying) in devices for rice treatment Bühler resulted in reduction in the BG content (by 24-55%) and decrease in TDF as compared to the original grain. However, the **increase in TDF and BG** (by up to half of the original content) was found in comparison with a starting raw material (abraded and polished barley grains) (Table 4).
- The level of both BG content and other malt parameters in hulless grain was significantly influenced by the starting material and malting methodologies. Due to modification of the duration of malt maintenance, the BG content reduced by 49.2 up to 62.4%. In the case of 50% addition of unmalted grain, not only higher viscosity, but also markedly higher BG content were measured (Table 3a and 3b).
- During the development and evaluation of nutritional quality of salt and sweet bakery and biscuit products, **barley addition affected a level of TDF and especially BG content**, which increased even more than ten-fold in gingerbread and biscuits (Table 4).
- Changes in organoleptic characteristics of products were observed by sensory evaluation. Some barley new products were accepted worse considering the distinctions in volume, structure, texture, colour, and other sensory characteristics. In comparison with pure wheat flour, **barley bread was scored best** (average sensory evaluation 2.23 for barley vs. 3.64 for wheat), **acceptable sensory quality** was also exhibited by **gingerbread** (2.50 - 2.88 vs. 2.18 for wheat), **biscuits** (2.79 - 2.88 vs. 2.59 for wheat), and **salt sticks** (Fig. 2).
- The **new developed recipes** of products with barley grain were applied to the Industrial Property Office in the Czech Republic as **use design no. PUV 2005 6738** dated on 16 June 2005.
- Regardless of that the higher proportion of barley clearly increases the content of nutritionally and health beneficial components in new foods, **it is necessary to consider an overall consumers' acceptability of final products** so that they were well marketable.

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