Evaluation of Chemical and Technological Properties of Grain and Milling Franctions of Hulless Barley for Bakery Use

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EVALUATION OF CHEMICAL AND TECHNOLOGICAL PROPERTIES OF GRAIN AND MILLING FRACTIONS OF HULLESS BARLEY FOR BAKERY USE

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INTRODUCTION

Enrichment of leavened wheat bread and other baked products with dietary fibre, vitamins, antioxidants and other nutritionally valuable compounds using underutilized cereals, particularly barley, is mostly accompanied by problems in dough processing due to different chemical composition of their grain. Therefore, traditional baking processes and standard raw materials, especially wheat and partially rye flour, still dominate in the baking industry. Wider use of barley with great food potential due to its high nutritional value of grain is constrained by lack of knowledge about the functionality of barley grain components in terms of processing and food products development. Though barley in baked products begins to appear on market already in the Czech Republic, there is little information about the quality of initial raw material (i.e. individual barley cultivars), suitable technological processes as well as unusual processing methods.

MATERIALS AND METHODS

Materials: samples of spring barley with hulless grain: cv. AF Lucius, new breeding lines KM 1057, KM 2084 and KM 2283 with light grain, and a genetic resource Nudimelanocrithon with black grain. Standard wheat fine mill from company PENAM.

Grain characterisation and processing: grain was measured using volume weight (VW in kg/hl, ČSN ISO 7971-2). Milling was done on the laboratory Perten Laboratory Mill 3100 (whole grain meal for chemical and technological analyses) and on the laboratory mill CD1 (Chopin firm) to obtain the following milling fractions: break flour (<140 µm), break bran (>710 µm) and semolina (<710 µm).

Chemical analyses: macro-minerals (in %, according to Zbíral J. et al., 2005: P - using a spectrophotometer, K and Ca on flame AAS), starch (in %, ČSN EN ISO 10520), crude protein (CP in % = N×6.25, ICC Standard No. 167), β-glucans (BG in %, Megazyme kit – KBGLU 04/06).

Rheological properties: were determined on a farinograph (ICC Standard No. 115/1, making dough with water to the consistence of 500 FU) and on an extensograph (ICC Standard No. 114/1) at three resting times (45, 90 and 135 minutes).

Statistical evaluation: using software Statistica 8.0 (StatSoft, Inc., Tulsa, Oklahoma, USA): GLM, analysis of variance, LSD test. Variability was assessed by coefficient of variation (CV, in %).

RESULTS AND DISCUSSION

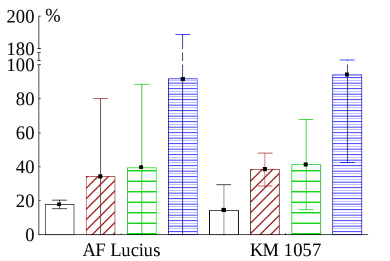
The aim of the present study was to increase knowledge about chemical composition and partial technological (especially breadmaking) parameters of grain and milling fractions in selected barley genotypes, and thus to contribute to its wider food use.

- There were statistically significant differences between barley genotypes in all examined nutrients and macro-minerals P and Ca (Tab. 1).
- The set differed most in β-glucans content. The lowest values of starch and BG content were measured in line KM 1057, which was also characterized by the lowest volume weight (69.4 kg/hl). The highest content of BG was found in lines KM 2084 and KM 2283 (6.3% and 5.8% respectively).
- AF Lucius has the highest starch content (64.8%), average proportion of BG and the lowest content of minerals (together with line KM 2283).
- There were great differences in content of nutrients and macro-minerals between individual milling fractions.
- Milling of selected barley materials (AF Lucius and KM 1057) on a CD1 mill demonstrated differences in the yield of milling fractions of individual genotypes affected by VW as well as the content and structure of chemical substances in grain (Fig. 1).

Table 1 Grain chemical composition of selected barley genotypes (2008-2010)

Name	Starch, %		BG, %		CP, %		P, %		K, %		Ca, %	
	1[1), 2)]	2	1	2	1	2	1	2	1	2	1	2
AF Lucius	64.8[b]	2.4	4.5[b]	6.4	12.0[a]	5.9	0.459[ab]	2.8	0.500[a]	12.3	0.050[a]	4.2
KM 1057	58.3[a]	2.7	2.8[a]	21.4	13.1[a]	5.0	0.492[b]	1.0	0.529[ab]	4.8	0.068[b]	1.7
KM 2084	62.7[b]	2.7	6.3[c]	12.0	12.7[a]	9.8	0.476[b]	6.7	0.496[a]	7.5	0.055[a]	7.3
KM 2283	63.7[b]	3.1	5.8[c]	5.4	12.1[a]	11.0	0.434[a]	8.2	0.519[ab]	13.0	0.051[a]	3.0
Nudimelanocrithon	56.4[a]	3.7	5.3[bc]	19.9	15.6[b]	8.5	0.535[c]	1.5	0.590[b]	5.8	0.071[b]	9.2
stand. wheat flour	80.7	-	0.3	-	11.6	-	0.105	-	0.089	-	0.034	-
barley break flour[3)]	85.9	-	1.7[4)]-2.0		7.4	-	0.124	-	0.139	-	0.031	-
barley semolina	65.8	-	4.1[4)]-5.8		11.6	-	0.314	-	0.308	-	0.050	-
barley break bran	54.0	-	4.2[4)]-5.0		14.3	-	0.488	-	0.454	-	0.068	-

1) - 1=mean, 2=CV in %; 2) - data in the column with different upper letters significantly differ at $P_{0.05}$; 3) - from cv. AF Lucius, 4) - from line KM 1057



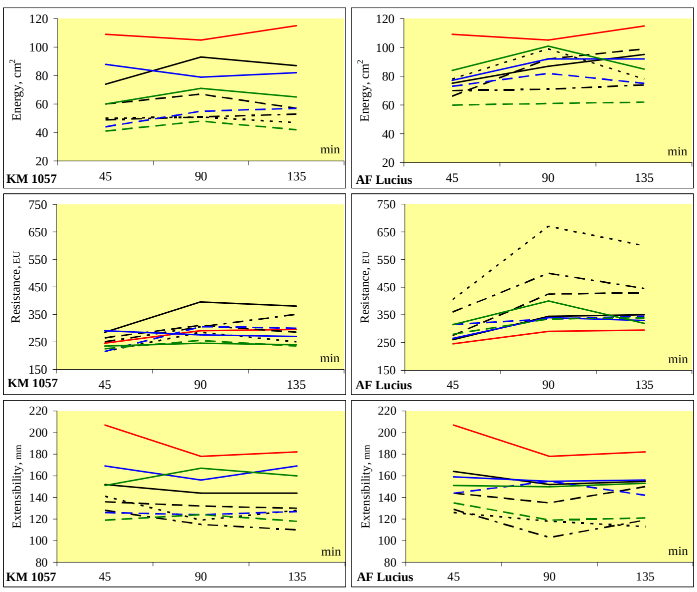
break flour, break bran, semolina, total yield

Fig. 1 Yield of milling fractions using a CD1 mill in two hulless barley genotypes

- Barley flours had on average higher water absorption (water absorption at 14%, measured with a farinograph) than standard wheat flour (Tab. 2). The highest level was determined in a sample of whole grain meal from barley line KM 2084 (72.8%).
- Very strong dough structure was determined in whole grain meal of cv. AF Lucius with the highest development time and stability and the lowest parameters of a degree of softening. Different results were obtained in milling fractions of cv. AF Lucius and line KM 1057 and in blends with wheat.
- In general, the addition of milling fractions of barley grain did not affect values of farinograph parameters more considerably.
- A higher addition of barley flour affected increasing values of water absorption at 14% and degree of softening (ICC).
- The addition of barley flour (15-30%), barley semolina (10 and 20%) and bran (10 and 20%) from selected barley samples to standard wheat flour were evaluated at three resting times (45, 90 and 135 minutes). Extensograph parameters were affected by both the proportion of barley fraction and its interaction with a rest period, depending on a selected barley genotype (Fig. 2).
- In comparison with standard wheat flour, values of parameters at resting for flour and semolina of both genotypes were low, especially for energy (by 10.5-16.2 %), resistance at constant deformation (by 8.2-16.9 %) and extensibility (by 8.4-15.9%).
- When the rest period was longer (90 min), even higher additions of semolina (20%) or bran (10%), especially using grain of cv. AF Lucius, were technologically acceptable.

Table 2 Rheological properties of barley grain samples and milling fractions measured with a farinograph

Name	Milling fraction	Barley addition, %	Water absorption at 14%, %	Development time, min.	Stability, min.	Degree of softening, FU	Degree of softening (ICC), FU
Standard wheat	flour	0	58.7	2.5	3.5	65	90
AF Lucius	whole grain meal	100	63.7	13.0	17.5	5	0
KM 1057	whole grain meal	100	65.1	1.0	19.0	70	65
KM 2084	whole grain meal	100	72.8	7.5	9.5	20	100
KM 2283	whole grain meal	100	65.7	1.0	1.0	95	115
Nudimelanocrithon	whole grain meal	100	69.9	1.0	0.6	60	70
KM 1057	flour	15	57.7	2.0	2.0	75	90
KM 1057	flour	20	57.7	1.5	1.5	80	95
KM 1057	flour	25	58.9	1.5	1.0	100	110
KM 1057	flour	30	57.8	1.5	1.0	100	120
KM 1057	flour	100	57.0	1.0	0.5	80	85
KM 1057	semolina	10	59.4	2.5	5.5	30	55
KM 1057	semolina	20	60.3	4.5	4.0	40	105
KM 1057	semolina	100	64.7	16.5	14.5	55	0
KM 1057	bran	10	59.1	5.0	4.5	30	70
KM 1057	bran	20	61.2	6.0	3.0	30	95
AF Lucius	flour	15	57.5	2.0	1.5	80	105
AF Lucius	flour	20	57.9	1.5	1.0	95	115
AF Lucius	flour	25	58.5	2.0	1.5	75	100
AF Lucius	flour	30	56.6	1.5	1.0	110	130
AF Lucius	flour	100	54.4	1.0	1.0	120	125
AF Lucius	semolina	10	59.3	2.5	5.5	40	65
AF Lucius	semolina	20	60.9	3.0	5.5	45	80
AF Lucius	semolina	100	58.7	4.0	17.0	125	55
AF Lucius	bran	10	58.2	8.0	8.0	15	60
AF Lucius	bran	20	58.7	7.0	6.5	15	65



standard wheat flour, break flour, 15%, break flour, 20%, break flour, 25%, break flour, 30%,
semolina, 10%, semolina, 20%, break bran, 10%, break bran, 20%

Fig. 2 The effect of resting on rheological properties of the addition of milling fractions of hulless barley to standard wheat flour

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CONCLUSIONS

Though the results, compared to standard wheat flour, give impression that there are no bigger differences in barley materials in relation to bakery use regardless of differences in protein content and composition, the detailed study of rheological properties of individual milling fractions of barley grain documents that it is not true. Due to lack of functionality of barley protein (absence of gluten) for making leavened bread and other baked products, it is not possible to use barley separately. Thus the content of desirable nutrients and also technological properties of used milling fractions are a significant factor which can affect not only final nutritional quality of baked goods, but generally of other food products with barley.

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