TECHNOLOGICAL PROPERTIES OF SPELT – AMARANTH COMPOSITE FLOURS

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Abstract: *Interest of consumers in natural, unconventional and nutritional foods led to the development of new specialty foods based on grain blends. Components of such foods are often so-called „ancient wheats "which were never the subject of modern breeding programmes. Grain amaranth provides an ideal amino-acid composition for human consumption and therefore interest in fortifying wheat flour is evident. Composite fours were prepared by mixing spelt flour (Tr. spelta L.) with amaranth flour at substitution levels of 5, 10, 15 and 20 % (w/w). Pure spelt flour was used for comparison. Indirect baking parameters and rheological properties of dough were investigated in four replicates. Wet gluten content was determined according to ICC Standard No 155 by the Glutomatic 2200 (Perten), sedimentation index – Zeleny Test according to ICC 116/1 and ISO 5529, extensibility of gluten was determined using STN 461011-9. To assess the rheological properties of composite flours, Brabender farinograph and standard procedures ICC No 115/1 was used. The following parameters were derived from farinographs: water absorption, stability, softening of the dough, quality number. The analyses were performed in four replicates. Wet gluten content, its extensibility and sedimentation values are indicators related to the baking quality of flour. The content of wet gluten in spelt flour was very high (42.7%) and substitution of spelt four with amaranth flour significantly and proportionally lower its content in composite flours. With increasing share of amaranth flour increased the gluten extensibility from 16.7% (pure spelt flour) to 20.7 cm (20% amaranth flour). The water absorption of composite flour increased with amaranth substitution rate also the stability time increased and was the highest for 20% amaranth rate (not significant). Significant improvement of quality number was observed with increasing rate of substitution. The amaranth addition to blends improve some indirect baking quality properties and rheological properties of flour. Amaranth can be attractive as blending source for processed food fortification for its high quality proteins, relatively high fat content, iron content, resulted in improvements of amino acid balance of baked products.*

Key words**:** *spelt – amaranth composite flour, technological properties*

INTRODUCTION

Spelt is an ancient cereal that was cultivated extensively in Europe and is now receiving a renewal interest for its nutritional and agronomic characters. Spelt possesses an unique flavour, a higher vitamin and mineral content and is more nutritious than common wheat.

Interest of consumers in natural, unconventional and nutritional foods led to the development of new specialty foods based on grain blends. Components of such foods are often so-called "ancient wheats" which were never the subject of modern breeding programmes. There is an interest in fortifying wheat flour with high quality protein material, to improve the amino acid balance of baked products. Grain amaranth provides an ideal amino acid composition for human nutrition. The content of lysine is high, remarkable is also the high content of arginine and histidine which makes amaranth interesting for child nutrition (BERGHOFER, SCHOENLECHNER, 2002). These characteristics, along with relatively high fat content, significant amount of squalene in oil, high iron content, make amaranth particularly attractive as a blending source for processed food fortification (PEDERSEN et al., 1987).

The aim of this work was to evaluate an indirect baking quality parameters and rheological properties of composite flours prepared by mixing spelt flour with amaranth defatted flour.

MATERIAL AND METHODS

Composite flour formulations: *Triticum spelta* varieties Bauländer Spelz, Franckenkorn, Rouquin were grown at Research experimental station Dolná Malanta, Slovakia on a Haplic Luvisol developed at proluvial sediments mixed with loess. The location has a continental climate with an average temperature during vegetative period 9,2°C and an average annual precipitations during vegetative period 518mm. *Tr. spelta* flour was prepared using laboratory Brabender Quadrumat Senior mill. *Tr. spelta* flour was composed of all three varieties. Amaranth defatted flour was obtained form the industry. Composite flours were prepared by mixing spelt flour with amaranth flour at substitution levels of 5, 10, 15 and 20 % (w/w). Pure spelt flour was used for comparison.

Indirect baking parameters and rheological properties were investigated in four replicates. Wet gluten content was determined according to ICC Standard No 155 by the Glutomatic 2200 (Perten), Gluten index by Glutomatic Centrifuge (Perten), sedimentation index Zeleny test according to ICC 116/1 and ISO 5529, extensibility of gluten using STN 46 1011-9, swelling of gluten by STN 46 1011-9. To assess the rheological properties of composite flours, Brabender farinograph and standard procedures ICC No 115/1 was used. The following parameters were derived from farinographs: water absorption, dough stability, softening dough, quality number.

Obtained data were statistically evaluated by analysis of variance (ANOVA), LSD test was used to determine the significance of the differences between the means. Significance level was $P \leq 0.05$.

RESULTS AND DISCUSSIONS

Wet gluten content and gluten index are indicators closely related to the baking quality of flour. Wet gluten is a cohesive visco-elastic proteinaceous substance obtained after washing out the starch granules from dough. Quality gluten, described by the degrees of strength and extensibility, allows a sufficient expansion, good distribution and retention of the gas cells with in fermenting dough (GROBELNIK MLAKAR et al., 2009). The content of wet gluten in pure spelt flour was very high and reached 42.7 %. The substitution of spelt flour with amaranth flour significantly and proportionally lower its content in composite flours to the value of 34.1 % in 20 % substitution of amaranth (8,6 % decrease of wet gluten content). With increasing share of amaranth flour increased the extensibility of gluten, from 16.7 cm in pure spelt flour to 20.7 cm in composite flour with 20 % of amaranth. Differences are significant (table 1).

Table 1

Indirect baking quality parameters of composite flours

Composite flour (spelt: amaranth in %)	Wet gluten (%)	Extensibility (cm)	Gluten index (%)	Swelling (cm^{-3})	Zeleny test (cm^3)
100 : 0	42,7 e	16,7 a	41,03 e	5,66 c	34,5 d
95 : 5	41,6 d	17,7 ab	36,83 d	5,50 c	28,0 c
90 : 10	39,3 c	18,3 bc	31,14 c	5,33 b	26,0 b
85 : 15	36,7 b	19,3 cd	27,99 b	4,50 b	25,0 b
80 : 20	34,1 a	20,7 d	21,83 a	4,33 a	22,5 a

Values within columns followed by different letters are significantly different (LSD test, α =0.05).
n.s. – not significant

Determination of the gluten swelling is based on hydrophilic character of gluten. During hydration gluten swells according to protein content. Weak gluten swells too quickly and after that melt. Swelling of gluten was significantly influenced by the content of amaranth in composite flour, similarly as in wet gluten, increasing share of amaranth lowered and worsen the gluten swelling. The gluten strength was expressed through the sedimentation volume according to Zeleny test. Zeleny sedimentation index in pure spelt was high and corresponded with the improving class of winter wheat according to STN 46 1100-2. Substitution of spelt flour with amaranth flour significantly lowered the sedimentation index the 20 % share of amaranth decreased this parameter under the requirements of standard wheat flour. Wheat of good bread making quality is characterized by gluten index of 60-90. Flour with the gluten index below 60 are considered as too weak while those with values over 95 are too strong for the bread production (TAŠNER, ČEPON TROBEC, 2007). Gluten index of pure spelt flour was low, only 41.03 %. Substitution of spelt flour with amaranth significantly lower the gluten index up to 21.83 % in 20 % share of amaranth flour. ALSO SCHOBER et al. (2006) have come to the conclusion that the gluten content in spelt is higher, but it tends to be more extensible and less elastic than gluten of modern wheat varieties. Consequently, it has lower gluten index which results in typical weaker spelt dough.

To assess the rheological properties of composite flours, the Brabender farinograph was used. Flour absorption is a function of protein content, starch (damaged starch in particular), pentosans and gluten strength. Flour absorption is the amount of water required to develop a dough that centers the trace on the 500 FU line. The water absorption of composite flours increased with amaranth substitution rate, but did not exceed 60 % (table 2).

Table 2

Rheological parameters of composite flours

Composite flour (spelt: amaranth in %)	Water absorption (%)	Dough development (min)	Dough stability (min)	Degree of softening (FU)	Quality number
100 : 0	55,6	3,20 n.s.	2,90 n.s.	100,0 n.s.	48,5 a
95 : 5	56,7	3,15 n.s.	2,90 n.s.	100,0 n.s.	48,5 a
90 : 10	57,2	3,10 n.s.	2,95 n.s.	95,0 n.s.	49,0 b
85 : 15	58,5	3,10 n.s.	2,95 n.s.	95,0 n.s.	49,0 b
80 : 20	59,0	3,05 n.s.	3,00 n.s.	95,0 n.s.	52,5 b

Values within columns followed by different letters are significantly different (LSD test, α =0.05).
n.s. – not significant

GROBELNIK MLAKAR et al (2009) reported similar results to those of the present study, the reason can be explained by higher water – binding capacity of the amaranth starch (127 %) as compared with wheat starch (71.8 %).

Slight decrease of dough development time (not significant) was observed with addition of amaranth flour in the blend. The dough stability time slightly increased from 2.9min. to 3.0% min., but the difference was not significant. Stability parameter is a relatively good indicator of the overall quality of the protein in the flour. Flours that are formulated for gentler processes tend to show a shorter stability portion of the trace. Degree of softening slightly decreased, with not significant difference. Quality number significantly increased with more than 10 % of amaranth substitution in spelt flour. These results are to some extent in agreement with the results of similar studies on spelt – amaranth composite flours. GROBELNIK MLAKAR et al. (2009) reported increased dough development time, dough stability, up to 20 % of amaranth in the blend. According to extensogram parameters, the amaranth addition strengthened the dough, by increasing the dough resistance to extension. The phenomenon is presumably due to the gluten dilution in composite flours and to those constituents in amaranth flour that might be involved in the dough strengthening.

CONCLUSIONS

Indirect baking quality parameters were significantly influenced with the share of amaranth in spelt – amaranth composite flours. Wet gluten significantly decreased due to the gluten dilution by amaranth. Extensibility of gluten increased, swelling of gluten decreased, sedimentation value according to Zeleny and gluten index decreased with substitution rate of spelt flour with amaranth flour. Most of the rheological parameters (dough development time, dough stability time, degree of softening) were not influenced by addition of amaranth flour up to 20 % in blend. Water absorption of composite flours increased, dough development time slightly decreased what led to quicker blend hydration. Dough stability slightly increased and degree of softening decreased. Considering the obtained results, the spelt substitution with amaranth up to 10-20 % in blend can improve some rheological properties of dough. Spelt substitution with amaranth has the potential to improve also nutritive value of products.

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