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IMPACT OF AMARANTH (*AMARANTH* SP.) ON TECHNOLOGICAL QUALITY OF BAKERY PRODUCTS DURING FROZEN STORAGE

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ABSTRACT

Frozen baking semi-finished meals and dough bring to consumer daily fresh products with the added value from the point of view of comfort and storage, as well as fresh products of comparable quality with baking yeasts products. The aim of this study was to observe the impact of adding 30% of flour from amaranth to the wheat flour T 650 on the quality of immediately baked products stored one, three and six months in a freezer at the temperature of -18°. The overall quality of baked loaves from frozen dough was declining gradually depending on the length of storage in the freezing box, while the highest decline in quality was recorded after three and six months of storage. Specifically, after one month there was a decline in the loaf volume - the one of the most important indicators for bakery quality - by 10.5% and after three and six months by 26.3% in comparison to fresh loaves. The decline in bakery quality was caused mainly by decreasing activity of yeast cells which were damaged by crystals of ice, by the afterward loss of their ability to yeast and by gradual decrease of dough firmness.

Keywords: freezing, frozen, baking yeasts, quality of baking products

INTRODUCTION

Cooling and freezing are the anabioz conservation methods characterized as an indirect inactivation of microorganisms **(Revenue Ministry of Agriculture and Rural Development and the Ministry of Health of the Slovak Republic No 981/1996-100).** Deep-freezing is such a method of preservation that affects less the taste changes but improper defrosting can cause visible changes to the structure and consequently deterioration of the nutritional value (**Drdák *et al.*, 1996).**

The composition of the amaranth grain is characterized by a very interesting nutrition potential, its foundation lies mostly in the high content of albumins and globulins (66–76%) from the total amount of proteins (16–18%) (**Muchová *et al.*, 2000; Tovar-Pérez *et al.*, 2009**). **Petr (1997)** published results, which revealed approximately two times higher content of lysine in comparison to wheat and rye, and three times higher than in corn. The composition of protein of amaranth is characterized by a low proportion of prolamins (1.0–3.2%), therefore important in the diet of celiac people **(Petr *et al.*, 2003, Alvarez-Jubete *et al.*, 2010**). However, this means also the absence of gluten and in bakery practice this leads to use of the amaranth flour only as additional flour. Carbohydrates in the amaranth grain consist mainly from starch (50–60%), the main proportion made by amylopectin and the content of amylose ranges from 0–20%. The waxy type of starch (almost 100% of amylopectin) is characterized by specific physical-chemical properties and in comparison to the wheat starch (20% amylose and 80% amylopectin) it has a higher solubility in water, it binds more amount of water with the interval of gelatinization at temperatures from 62-72°C and has resistance against mechanical strain and stability while freezing and defrosting. The grain of amaranth, besides majority of starch consists from 1.67% sucrose and 0.34% maltose (**Halásová *et al.*, 1997**). Nutritionally important component of flour consists from roughage, which is present in the amaranth flour in average approximately two times more (4.4%) than in the wheat flour. The importance of roughage lies mostly in fermentation of bacteria in the colon, while short-chain fatty acids are produced, which are desorbed in the mucous of the colon and which represent energy for enterocytes. In the case of amaranth, this transformation is realized to 86–91% (**Zadák *et al.*, 1998**). The content of fat ranges between 0.8% and 8%, and thus is higher in comparison to other cereals except oat. The highest concentration is in the germ (**Michalová, 1999**). The highest proportion is created from linoleic acid (48%) and oleic acid (25%). According to **Baker *et al.* (1998)**, the addition of amaranth influenced the increase in stability of frozen and defrosted dough, therefore its usage in bakery technologies to improve technological characteristics and overall sensory perception was highlighted.

The aim of this study was to observe the impact of adding 30% of flour from amaranth to the wheat flour T 650 on the quality of immediately baked products stored one, three and six months in a freezer at the temperature of -18°.

MATERIAL AND METHODS

Wheat flour T 650 in proportion of 70% (Country of origin: Slovak Republic, Pohronský Ruskov) was used in preparation of loaves with addition of 30% of amaranth (Country of origin: Hungary). Used flour mixture of 70% wheat flour and 30% amaranth flour was evaluated on *Farinograph-E*, Brabender OhG, Duisburg, Germany (**ICC - Standard 115/1, 1992, AACC Method 54-21, 1995**).

Experimental loaves were prepared from a mixture of flours (500 g of which 350 g was wheat and 150 g amaranth flour), sucrose (5), salt (9 g), yeast (20 g) (Country of origin: Slovak Republic, OLD HEROLD HEFE, Trenčín) and an addition of water on the basis of farinographic water absorption. The bakery experiment was carried out without using of enzymatically active preparations and other improving agents. The working-out of the dough was realized in the laboratory kneading machine of brand Diosna SP 12, subsequently the dough was worked out and formed into loaves, which yeasted in a yeasting room for 20 minutes at temperature of 30°C and were baked and mashed at temperature of 240°C for 20 minutes in a furnace of brand Miwe Condo.

Baked loaves were evaluated by objective methods used for valuation of baking quality during freezing storage. The following parameters were evaluated: loaf volume (cm^3), specific loaf volume ($cm^3.100g^{-1}$), volume efficiency ($cm^3.100g^{-1}$ of flour), yield of bread (%),yield of bread loss (%) and *ratio* between the height and width of loafs (cambering). Valuation was made by standard processes and calculations which are ordinarily used by the research institute. Remaining dough was immediately frozen and stored (for one, three and six months) at -18°C, (AFG 070 AP, company: Whirlpool Slovakia spol. s.r.o.). After defrosting at temperature of 22±2°C, it was yeasted in a yeasting room for 20 minutes at temperature of 30°C and the loaves were baked with mashing for 20 minutes at temperature of 240°C. Ready baked loaves were also evaluated by the same objective methods used for immediately baked products.

RESULTS AND DISCUSSION

The best results of breads baking from frozen dough were achieved with using of medium strong flours with content of proteins from 11% to 13% (**Marston, 1978**). Practical significance of gluten for bakery technology lies in the fact, that while working-out of the dough thin films are facilitated to be created from it, by which yeast gas is retained, yeasting of the dough, its overall-baking and pore structure is provided (**Bojňanská, 2004**). **Wolt *et al.* (1984)** as first pointed out that it is the quality of proteins in the flour that is very important in bread production made from frozen dough. Also **Neyreneuf *et al.* (1991)** and **Inoue *et al.* (1992)** agreed with this opinion. In Table 1 individual farinographical characteristics of the pure wheat flour and the mixture produced from 70% wheat flour and 30% amaranth flour are compared.

Table 1 Farinographical evaluation of used flour mixture

Samples	Water absorption capacity, %	Development time, min	Stability, min	Degree of softening, FU	Number of quality
flour T 650	60.1	2.2	8.0	65.0	66.0
T 650 (70%) + A(30%)	69.8	4.5	2.9	117.0	65.0

Legend: A - amaranthus

Based on data from farinography measuring of pure flour and flour mixture and their comparison, it can be concluded that wheat flour achieved moderate strong to high quality, therefore it is predetermined for individual use as well as for improvement in mixtures of weaker flours. The value of water absorption capacity and dough development time for the mixture of flour T 650 and amaranth flour was higher than for the pure wheat flour, what allows it to be classified according to **Muchová *et al.* (2011)** as a strong mixture of flours. This fact can be derived from a higher content of proteins of the amaranth flour, by which the wheat flour was enriched. However, the value of degree of softening was in comparison to the wheat flour significantly higher, and this value corresponds to low quality flour. The significant degree of softening was a manifestation of instability during kneading. The achieved stability of the dough was for the mixture of wheat and amaranth flour significantly lower in comparison to wheat flour, which practically means that the optimum of technological properties of the mixture of flours is lost relatively fast.
Results of the bakery experiment and changes of individual indicators of bakery quality during deep-freeze storage of experimental loaves at temperature -18°C are listed in the Table 2. The conclusion is that the deep-freeze storage gradually worsened the bakery quality of the baked loaves.

Table 2 Results of the bakery experiment of baked loaves

Period of deep-freeze storage	Loaf volume cm^3	Specific loaf volume cm^3.100g loaf	Volume efficiency, cm^3. 100g flour	Height/width ratio
Immediately baked/control	237.5	270.9	380.0	0.64
One month	212.5	231.9	340.0	0.47
Three months	175.0	191.2	280.0	0.47
Six months	175.0	201.2	280.0	0.47

Based on evaluation of bakery experiment by objective methods a decline in quality after one month of storage in freezer was observed. The most significant changes of the frozen dough were connected with the yeast cells, because dead cells damaged by ice released glutathione, which weakened the structure of gluten that subsequently lead to a worse retention of gases and a prolonged time of fermentation (**Kline *et al.*, 1968; Hsu *et al.*, 1979**; **Autio *et al.*, 1992; Pepe *et al.*, 2005**). A decline in volume by 10.5% in comparison to the control was observed after one month of storage in a freezer, and after three and six months of storage there was even a more significant decline by 26.3%, in comparison to immediately baked loaves as well. Similarly, a significant decline was observed in parameters of specific loaf volume and volume efficiency mostly after three and six months of freezing. Loaves frozen and baked after one, three and six months were evaluated as products with insufficient camber according to the results of **Muchová *et al.* (2011)** and **Hampel *et al.* (1981)**.
The following Figure 1 graphically depicts the total quality of loaves achieved by summary of chosen criteria during the whole period of storage in freezer.

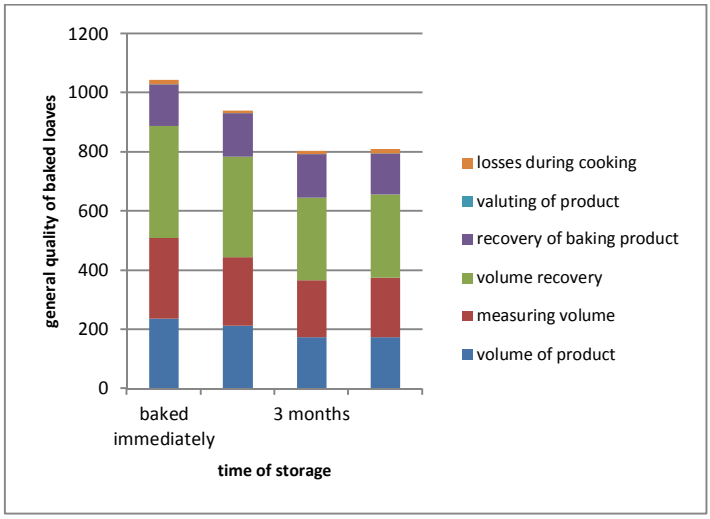

Figure 1 Evaluation of the total quality of loaves with an addition of amaranth during storage

From the figure implies that the resulting total quality of baked loaves with a longer storage was of a declining character. After one month storage a sufficient quality was achieved and the biggest decline was reported mainly after three and six months.

CONCLUSION

Addition of amaranth in amount of 30% had a significant influence on the nutritional and technological quality of the wheat dough. A significant growth in the severity in comparison to the wheat flour was showed by farinographical evaluation and also slower hydration of the dough was reported. After realization of bakery experiment based on objective evaluation we concluded that wheat loaves with addition of amaranth provided products of excellent technological quality, which was maintained even during one month deep-frozen storage. The most significant decrease in quality was reported after three and six months of storage. The results show the possibilities to improve the total quality even after longer freezing storage by an adequate application of additives with the aim to increase practical usage of amaranth since it offers significant nutritional benefits to consumers.

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