

Comparison of selected sensory properties of wholemeal breads

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ABSTRACT

The aim of this study was to compare textural (firmness) and sensory properties (surface colour, crumb colour, crumb texture, appearance, appearance and colour preferences) between whole breads made from conventional wheat (*Triticum aestivum*, L.) and whole breads made from unconventional wheat (*Triticum aestivum*, L., winter variety Skorpion, grains with blue aleuron). Wholemeal breads (control samples with marks C1, C2 and C3) were prepared of 100, 90 and 80 % amount of conventional wholemeal wheat flour to 0, 10 and 20% amount of smooth white flour made from conventional wheat using baker's experiment. Wholemeal breads (experimental samples with marks S1, S2 and S3) were prepared of unconventional wholemeal wheat flour to smooth white wheat flour in same ratio as control samples of breads. Our results showed, that negative evaluation of some sensory attributes of breads made from unconventional wheat correlated with increasing addition of wholemeal flour of this wheat. It was found that breads made from conventional wheat (100, 90 and 80% amount of conventional wholemeal flour) were more acceptable in surface colour, colour and appearance preferences than these sensory attributes of breads made from unconventional wheat (same amount of wholemeal flour). Appearance and crumb colour of breads made from conventional wheat (100 and 90% amount of wholemeal flour) were evaluated better than these attributes of breads made from blue coloured wheat (same amount of wholemeal flour). Appearance and crumb colour of both groups of whole wheat breads (80:20) was similarly evaluated. Crumb texture of breads made from conventional wheat (90% and 80% amount of wholemeal flour) was worse than crumb texture of breads produced of same ratio of flour, but made from unconventional wheat. Breads with addition of 80% of wholemeal flour milled of blue coloured wheat were most acceptable in all of sensory attributes for evaluators. Significant difference ($p < 0.05$) of crumb firmness of breads were demonstrated between samples of breads (80:20) made from conventional or unconventional wheat. Crumbs of breads (100:0 and 80:20) made from blue coloured wheat had higher firmness than crumbs of breads (100:0 and 80:20) made from conventional wheat. But crumbs of breads (90:10) made from conventional wheat were firmer than crumbs of breads (90:10) made from unconventional wheat. Breads produced of blue coloured wheat were also more friable than breads made from conventional wheat. Although evaluation of wholemeal breads made from unconventional wheat had not better scores than evaluation of wholemeal breads made from conventional wheat, but evaluation of breads produced of unconventional wheat wholemeal flour were not below average and its market position could be very high in the future, due to the content of health benefit substances, which will be the subject of further research.

Keywords: wholemeal wheat flour; blue aleuron; firmness; sensory evaluation

INTRODUCTION

Whole grain foods are rich source of fiber, antioxidants and other nutrients, which have positive impact on human health. Fiber, mineral substances, vitamins (especially vitamin E), phytoestrogens and phenol acid are located in bran and germ of cereal grains, therefore, whole-grains products have greater benefits for human health than products made from the inner parts of cereal grain (Chaturvedi et al., 2011; Shepherd et al., 2012).

Wheat varieties with unconventional coloured grains (blue aleuron, purple pericarp and yellow endosperm) contain anthocyanins, which also protect the human body against free radicals. It is estimated that the long-term and regular consumption of products made from wheat with coloured grains would be beneficial to human health, and

thus it would be possible to define these grains as functional foods (Martinek et al., 2013).

Recent scientific studies have shown reduced risk of cardiovascular diseases, carcinogenesis, type 2 diabetes and obesity as a consequence of consumption of whole grains and foods of whole grains (Yu et al., 2013). But consumption of whole grain breads versus white breads is limited by consumers, because these products achieve lower volume, they have a rougher texture and faster staling as reported Rosell et al. (2009).

The relationship between foods and health has an increasing influence on the development of foods with functional properties (Peressini and Sensidoni, 2009). Balestra et al. (2011) reported that development of functional food is important, particularly in development of bread which will have not only physiological efficiency

for the consumer, but it will be also organoleptically acceptable for them.

The aim of present study was to assess textural (firmness) and sensory properties (surface colour, crumb colour, crumb texture, appearance, appearance and colour preferences) between whole wheat breads produced of conventional wheat (*Triticum aestivum* L.) or unconventional wheat (*Triticum aestivum* L., winter variety Skorpion, grains with blue aleuron).

MATERIAL AND METHODOLOGY

Preparation of whole wheat breads and baking (baker's experiment)

All samples of whole wheat breads were prepared by direct way using baker's experiment in laboratory conditions of Department of Vegetable Foodstuffs Hygiene and Technology, FVHE UVPS Brno, Czech Republic. The preparation of whole wheat breads and baking were performed in three repeating. Wholemeal flour of wheat with blue kernels (winter wheat variety Skorpion; provided by Mendel University Brno) was milled on laboratory mill LM 3100 (Perten Instruments AB, Sweden). Wholemeal flour (Voženílek Mills Inc., CZ) of conventional wheat were bought in supermarket. Breads dough were prepared of 100, 90 and 80 % amount of wholemeal flour (breads of unconventional flour: control samples with marks S1, S2 and S3; breads of conventional flour: experimental samples with marks C1, C2 and C3) to 0, 10 and 20 % amount of smooth white flour (Voženílek Mills Inc., CZ) using yeast (UNIFERM GmbH&Co.KG, Germany), sunflower oil (Usti Oils Inc., CZ), salt (Salt Mills PLC, CZ) and lukewarm drinking water. The amounts of ingredients for making breads are represented in Table 1. Recipe we gain from Penam a.s. Breads dough were prepared by mixing ingredients in a kneading machine Vorwerk (Vorwerk & Co. KG, Germany) for 8.5 minutes. After that, doughs matured at 31 °C in humid conditions for 15 minutes (temperature and time according recipe). Matured doughs was divided into 40 g pieces, they were hand-moulded and after that, they matured at 31 °C in humid conditions for 30 minutes. Risen pieces of doughs were placed on baking sheets, sprayed by water and they were baked at 250 °C for 15 minutes in the oven. Pieces were also sprayed by water in half of baking time and 5 minutes before ending of baking. After baking, each loaves of breads were placed on plates and they cooled in room temperature for 1 hour. Subsequently, the

determination of textural properties and sensory evaluation of breads were performed.

Texture properties of breads

The texture profile analysis (TPA) was performed with TA-XT Plus Texture Analyzer (Stable Micro Systems Ltd., Surrey, UK). The samples were examined using a Stable Micro Systems Type (version 5.0, 9.0). The firmness of bread crumbs was determined on loaves of breads samples according to modification of AACC Method 74-09 (AACC, 1996). Modification of this method was in usage a cylindrical-shaped piston, 38 mm in diameter, for compression of all samples to 40 % of their original height. For each compression test, three loaves of bread (each sample) were used. Whole loaf of breads sample were placed centrally under the cylinder probe, avoiding any irregular or non-representative areas of crumb. A three-inch diameter compression plate was installed to the 25 kg load cell of the analyzer. A 5-kg weight was used to calibrate the 25 kg load cell prior to analysis and the setting was adjusted at a pretest speed of 1.0 mm/s, a test speed of 1.7 mm/s and a posttest speed of 10.0 mm/s.

Sensory analysis

The finished whole wheat breads were evaluated by 15 evaluators (6 males and 9 females – staffs and students of doctoral study programme of two Departments of FVHE UVPS Brno: Department of Meat Hygiene and Technology and Department of Vegetable Foodstuffs Hygiene and Technology), 24 hours after baking, using an organoleptic questionnaire. All the instructions were given to evaluators before evaluation. Prior to the sensory test, each loaf of whole wheat breads was cut into slices of 10.0 mm thick and immediately placed in plastic bags. Each bag was codified arbitrarily with three digits numbers. The bread samples were evaluated for attributes such as surface colour, crumb colour, crumb texture, appearance, appearance and colour preferences by using a five-point scale ranging from like extremely (1) to dislike extremely (5).

Statistical analysis

Data from three different experiments are reported as the means \pm standard deviation (SD) of three measurements, which were performed on three wholemeal breads (each sample). The data of texture profile analyses were subjected to Student's t-test by using Unistat software version 6.0 (Unistat Ltd., England). Differences were

Table 1 Ingredients for making breads using conventional or unconventional wholemeal flour.

Component	Samples of breads					
	C1	S1	C2	S2	C3	S3
Wholemeal flour * [g]	200	200	180	180	160	160
Smooth white flour [g]	0	0	20	20	40	40
Water [mL]	120	120	120	120	120	120
Yeast [g]	8	8	8	8	8	8
Sunflower oil [g]	8	8	8	8	8	8
Salt [g]	4	4	4	4	4	4

* wholemeal flour of conventional wheat or wheat grains with blue aleuron

considered significant at $p < 0.05$. Kruskal-Wallis one-way analysis of variance (Unistat software version 6.0, Unistat Ltd., England) were used to compare of each sensory attributes of sensory evaluations of breads made from conventional or unconventional wheat.

RESULTS AND DISCUSSION

Sensory analysis

The results of the sensory evaluation of whole wheat breads stored for 24 h at room temperature are shown in Figures 1 – 3.

Colour of surface

The surface colour of bakery products made from wholemeal flour of conventional wheat was evaluated better than surface colour of same products made from unconventional wheat. Specifically, average values for whole wheat breads made from conventional wheat were 1.9 for 100%, 1.8 for 90% and 1.7 for 80% amount of wholemeal flour. The surface colour of breads made from

unconventional wheat flour were evaluated: 2.7 for 100%; 2.6 for 90% and 2.1 for 80% of flour amount. Breads made from 80% of wholemeal flour of both conventional and unconventional wheat was evaluated as samples with the best surface colour. The worst surface colour had whole breads made from 100% of both conventional and unconventional whole wheat flour.

Appearance of breads

The appearance of breads made from 100% amount of wholemeal flour of conventional wheat was evaluated better (average points: 2.2) than the appearance of breads made from 100% amount of wholemeal flour of unconventional wheat (average points: 2.73). Whole breads made from 90% amount of conventional wholemeal flour was evaluated 1.75 points, ie. more acceptable than breads made from 90% amount of wholemeal flour of unconventional wheat (3.0 points). The appearance of bread made from 80% amount of both wholemeal flour of conventional and unconventional wheat was evaluated similarly: 2.4 for breads produced of unconventional

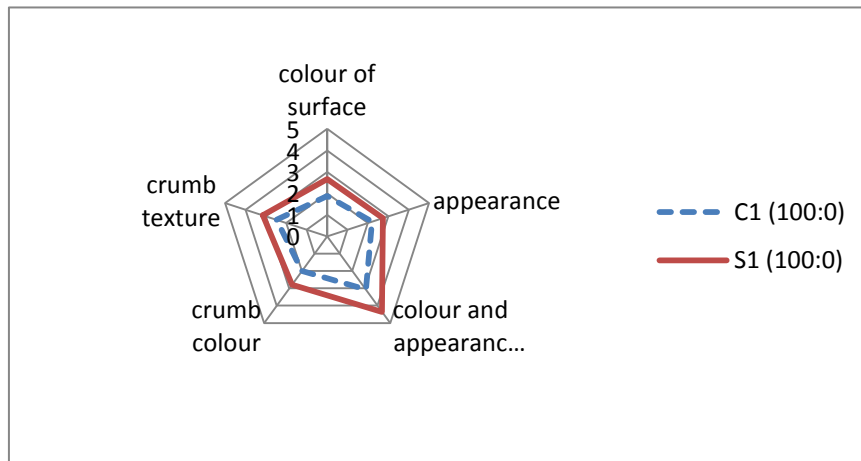


Figure 1 Comparison of sensory properties between breads made from conventional (C1) or unconventional (S1) wholemeal flour.

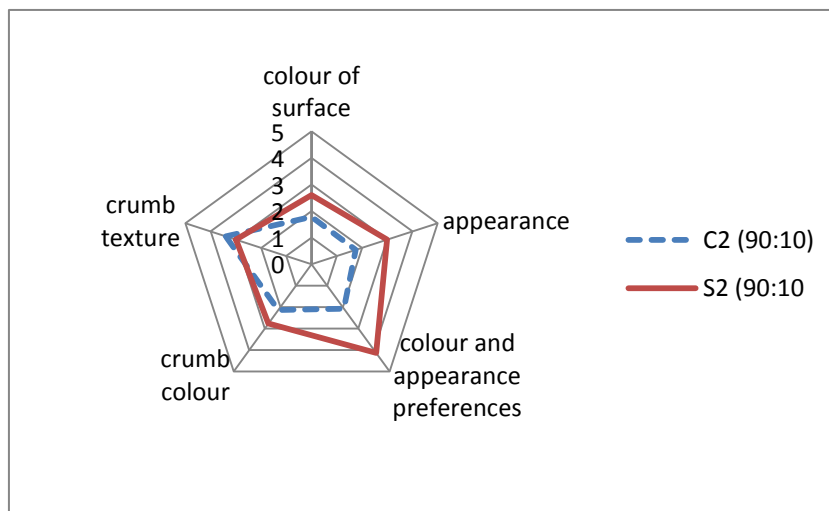


Figure 2 Comparison of sensory properties between breads made from conventional (C2) or unconventional (S2) wholemeal flour.

wheat, 2.46 for breads made from conventional wheat. The best design properties according to sensory evaluation had samples produced of conventional wheat (90% amount of flour) and samples made from unconventional wheat (80 % amount of flour). The worst appearance of breads had breads made from 80% amount of wholemeal flour of conventional wheat and samples made from 90% amount of wholemeal flour of unconventional wheat. The appearance of baked products made from unconventional wheat (samples S1, S2 and S3) with decreasing addition of wholemeal flour were evaluated more positively (data not shown), because the majority of evaluators were probably people who white wheat breads most frequently consumed. It is not accordance with work of **Challacombe et al. (2011)** who produced crackers and breads using flour of red wheat. They reported that the appearance of products (crackers and breads) made from red wheat were more acceptable than same products produced of white wheat. In their work, the majority of consumers were people who whole wheat bread most frequently consumed. They said, that it could be a contributing factor, why products of red wheat had greater acceptability for appearance.

Colour of crumb

The crumb colour of breads made from unconventional wheat was evaluated more negatively: 2.8 (100% amount of flour), respectively 2.8 (90% amount of flour) than crumb colour of breads made from conventional wheat: 2 (100% amount of flour), respectively 2.13 (90 % amount of flour). Breads made from 80 % amount of wholemeal flour of conventional wheat was rated lower (2.3) than breads made from same amount of wholemeal flour, but flour milled of unconventional wheat (2.2). The best crumb colour had breads made from 100% amount of flour (conventional wheat) and breads made from 80% amount of flour (unconventional wheat). Breads made from 90% amount of flour of conventional wheat and breads made from 100% amount of flour of unconventional wheat had the worst crumb colour. **Duchoňová et al. (2012)** evaluated crumb colour of breads made from coloured

wheat varieties (purple wheat variety: Konini and blue wheat variety: RU 440-6) and with and without the addition of β -glucans. The pleasantest crumb colour had a loaf of bread made from purple wheat variety (Konini) without the addition of β -glucans. A little less pleasant evaluation of colour of crumb (compared to the previous evaluation) had bread made from purple wheat variety with addition of β -glucans. Crumb colour of breads made from blue wheat variety with and without the addition of β -glucan was less acceptable than crumb colour of breads made from purple wheat variety.

Texture of crumb

Better evaluation of crumb texture showed breads made from 100% amount of wholemeal flour of conventional wheat (2.5 points) than crumb texture of breads made from 100% amount of wholemeal flour of unconventional wheat (3.2 points). The crumb texture of breads made from wholemeal flour of conventional wheat were evaluated worse (3.4 points for breads made from 90% amount of flour and 3.1 points for breads made from 80% amount of flour) than crumb texture of breads made from wholemeal flour of unconventional wheat (3 points for breads made from 90% amount of flour and 2.9 points for breads made from 80% amount of flour). The best evaluation of crumb texture had breads made from 100% amount of flour of conventional wheat and breads made from 80% amount of flour milled of unconventional wheat. On the other hand, breads made from 80% amount of flour of conventional wheat and breads produced of 90% amount of flour of unconventional wheat had the worst evaluation for this sensory attribute. **Duchoňová et al. (2012)** reported that more flexibility of bread crumb had bread made from purple variety of wheat (Konini) without addition of β -glucans. A little less pleasant evaluation of texture of crumb (compared to the previous evaluation) had bread made from purple wheat variety with addition of β -glucans. Crumb texture of breads made from blue wheat variety (both types of breads - with and without the addition of β -glucans) had less flexible crumb in

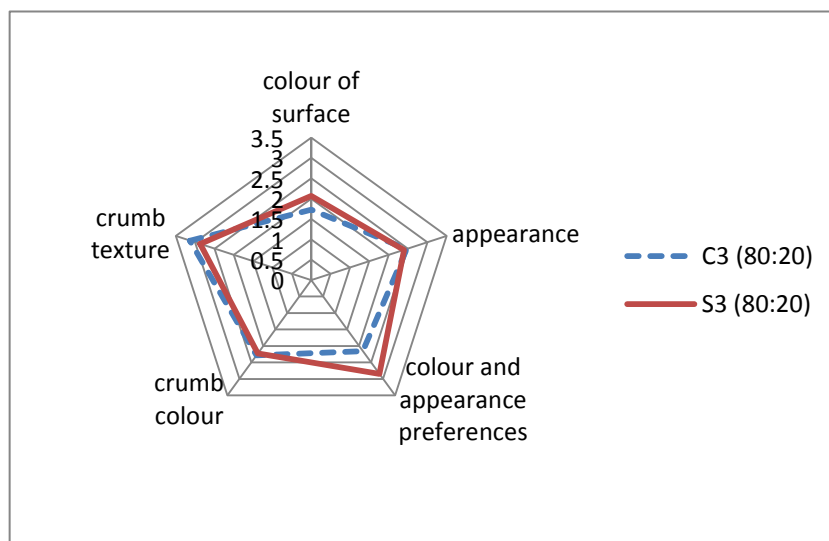


Figure 3 Comparison of sensory properties between breads made from conventional (C3) or unconventional (S3) wholemeal flour.

comparison of crumb of breads made from purple wheat variety.

Preferences of colour and appearance

Colour and appearance preferences of whole breads made from conventional wheat had better evaluation than evaluation of same attributes of whole breads made from unconventional wheat. Specifically, mean points of evaluation of breads made from conventional wheat were 3.1 (100% amount of flour), 2.1 (90% amount of flour) and 2.2 (80% amount of flour). Colour and appearance preferences of breads made from unconventional wheat were evaluated by these points: 4.4 (100% amount of flour), 4.1 (90% amount of flour) a 2.8 (80% amount of flour). Evaluators most preferred colour and appearance of breads made from conventional wheat (90% amount of flour) and same attributes of breads made from unconventional wheat (80% amount of flour). The worst acceptability of colour and appearance had whole breads made from 100 % amount of both conventional or unconventional wheat flour.

Because products made from unconventional wheat are not available in the market network in the Czech Republic, we expected that the results of scores point of preferences colour and appearance of bread made from wheat with blue aleurone will be worse. According to **Baik et Ullrich (2008)**, who said that colour and appearance of products are the indicators of food safety and quality and first factors of selection before buying and consumption of foods. Consumers prefer a specific colour for each food product. If a food product has not colour, which is expected or has a deviation in colour, product losing popularity regardless of other quality characteristics.

Texture properties of breads

Texture is an important qualitative property for assessing the quality and acceptability of fresh and processed products of food industry (Chen and Opara, 2013). The results of the texture profile analysis (TPA) of whole wheat breads stored for 1 hour at room temperature are shown in Table 2. The firmness is an important factor in bakery products since it is strongly correlated with consumers' perception of bread freshness (Onyango et al.

2010). Breads made from flour of conventional wheat (90% amount of flour) and breads made from flour of unconventional wheat (90% amount of flour) had the firmest structure (41.56 N for breads made from conventional wheat and 40.26 N for breads made from unconventional wheat). A statistically significant difference (p 0.002) was proved between mean value of firmness of breads made from 80% flour amount (conventional wheat) and mean value of firmness of breads made from 80% flour amount (unconventional wheat). The value of firmness of breads made from 80% amount of flour of conventional wheat was 24.88 N and value of firmness of breads made from 80% amount of flour of unconventional wheat was 34.79 N. Crumbs of breads (100:0 and 80:20) made from unconventional wheat had higher firmness than crumbs of breads (100:0 and 80:20) made from conventional wheat. But crumbs of breads (90:10) made from conventional wheat were firmer than crumbs of breads (90:10) made from unconventional wheat.

Whole wheat breads produced of wheat with blue aleuron showed higher friability than whole wheat breads produced of conventional wheat (data not shown). It is not accordance with results of work by **Pasqualone et al. (2015)** who baked biscuits using flour of purple wheat. They reported that biscuits produced of purple wheat had lower friability than conventional biscuits, due to higher gluten index of starting meal.

CONCLUSION

Our results showed, that negative evaluation of surface colour, appearance, crumb colour, crumb texture, colour and appearance preferences of breads made from unconventional wheat correlated with increasing addition of wholemeal flour of this wheat, in comparison to breads made from conventional wheat. Nevertheless, breads with addition of 80% amount of wholemeal flour milled of unconventional wheat were most acceptable for evaluators in all of sensory attributes. Breads produced of 100 and 80% amount of flour (unconventional wheat) caused higher firmness of crumbs than breads produced of same amount of wholemeal flour made from conventional

Table 2 Results of firmness of bread crumbs and their comparison between control samples of breads (C1 – C3) and samples (S1 – S3) of breads from wheat kernels with blue aleuron on $p < 0.05$.

Samples	Firmness of samples ($\bar{x} \pm SD$) [N]	p value
C1	30.73 \pm 1.25	0.384
S1	32.77 \pm 3.15	
C2	41.56 \pm 2.94	0.578
S2	40.26 \pm 2.25	
C3	24.88 \pm 1.21	0.002
S3	34.79 \pm 0.47	

C – control samples of breads, S – samples of breads from wheat grains with blue aleuron, C1 – 100:0, C2 – 90:10, C3 – 80:20, S1 – 100:0, S2 – 90:10, S3 – 80:20, highlighted value – significantly difference between samples, SD – standard deviation.

wheat. But crumbs of breads (90:10) made from conventional wheat were firmer than crumbs of breads (90:10) made from unconventional wheat. However, statistically significant differences between values of firmness showed breads made of 80% amount of wholemeal flours. Breads made from unconventional wheat were also more friable than breads made from conventional wheat.

Although the evaluation of whole breads made from unconventional wheat had not better scores than evaluation of whole breads made from conventional wheat, but evaluation of breads produced of wholemeal flour made from unconventional wheat were not below average and its market position in the future could be very high, due to the content of health benefit substances, which will be the subject of further research.

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