THE USE OF COLOR WHEAT SPENT GRAIN AS AN INGREDIENT FOR THE PRODUCTION OF BAKERY PRODUCTS

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Abstract: The cereals grains are excellent sources of digestible carbohydrates, dietary fiber, and proteins in addition to providing vitamins (group B and vitamin E) and minerals (zinc, phosphorus, selenium, and iron). The whole grain cereals contain high levels of bioactive phytochemicals, such as antioxidants that could provide protective effects against human chronic diseases. Its enrichment with more amount of anthocyanins, allows a better use of its potential bioactive property. For this reason, the state authorities are seeking functional foods to mitigate health problems as cancer, diabetes and heart diseases. They would like to create functional foods that satisfy the function to nurture and to prevent. This research focuses on the use of the brewer spent grain (BSG) varieties of colored wheat, which are enriched genetically with anthocyanins, to its use in bakery products.

Key Words: colours wheat, spent grain, bread, sensory evaluation

INTRODUCTION

The effort to increase the nutritional value of the commercial bakery products is considered a worldwide trend. As is well known the wheat per se, is a rich source of dietary fiber in particular the arabinoxylans and hemicelluloses. The consumption of whole wheat leads to a better absorption in the small intestine (increased fecal volume) and decreased bulk pH, which enhances the elimination of cholesterol and potential toxins or carcinogens (Rotimi 2012).

But there are more genotypes (Triticum aestivum) that have different colour than common caryopses (Dostalova et al. 2015). The colored grain wheat is one kind of new germoplasm resource in cereal crops, which are rich in beneficial anthocyanins (Zifeng et al. 2011). These dyes are present in different parts of the caryopsis. The main varieties are the purple pericarp and blue aleurone, which contain larger amounts of dyes (Vaculova et al. 2010).

The purple pericarp or purple wheat grain contains mainly 3-glucoside of cyaniding and peonidin 3-glucoside anthocyanins (Knievel et al. 2009). The cyaniding has various effects on the cells, most of which can be described as being anti-diabetic and possibly slightly benefit other parameters associated with 'metabolic syndrome' (anti-inflammatory, anti-oxidant, etc.); while Peonidin 3-glucoside is important for its relation with the inhibition of tumor cell growth and reduction of metastasis of lung cancer cells.

Also the blue aleurone or blue wheat grain, the aleurone layer contents 3-glucoside of delphinidin and 3- rutinoside of delphinidin (Knievel et al. 2009). The 3-glucoside of delphinidin or Myrtillin tends
to stabilize the blood sugar, which otherwise fluctuates widely, and that it spares insulin; while 3-rutinoside of delphinidin has anti-inflammatory, antioxidant and antimicrobial effects. Furthermore, the blue wheat grains tend to have higher anthocyanin contents, compared with the wheat with purple pericarp (Martinek et al. 2012).

Due to the antioxidant activity of the anthocyanins on the caryopsis of the wheat, its inclusion could thus provide in the long-term beneficial effects on human health (Kienevel et al. 2009). The use of wheat with purple or blue aleurone, is mainly used in whole meal flours or by the addition of bran (Vyhnanek et al. 2015). In this study the brewer spent grain (BSG) is used as an adjunct for the production of commercial bread (Hernández et al. 2016).

Along this research barley spent grain variety Malz was used, which has favorable protein content and excellent extract content during the malting (Hernández et al. 2016). But its use was not limited to the technical characteristics of the product itself, but also to its beneficial effects. Having a diet rich in barley or β-glucan extracts is known to have beneficial physiological effects, because of the soluble state and high molecular weight of this polysaccharide. β-glucan has been shown to increase daily fecal bile acids output, which leads to lower blood cholesterol and lipoprotein concentrations in human subjects (Rotimi 2012).

The main aim of this research is to combine the positive effects of the barley spent grain and the blue aleurone containing purple wheat in a bakery product. This new bakery product should contain more anthocyanins and fiber.

**MATERIALS AND METHODS**

**Characteristics of the use spent grain**

For the production of the bakery products BSG from 100 liters of brewer beer was used BSG from the microbrewery located at Mendel University in Brno. The brewer spent grain (BSG) from barley, variety Malz was used; and wheat varieties with purple pericarp and blue aleurone; individually and jointly in a proportion of 50 : 50 were used.

**Baking experiment**

The recipes were prepared using four varieties of color wheat spent grain: Rosso with purple pericarp; also Skorpion with blue aleurone; and barley. For comparison, for the control sample a special wheat flour, T530, was used, which contains 0.53% of ash in dry matter. This flour also is known as 00.

To prepare 500 g of dough, 500 g (for variant 1) and 450 g (for the rest of the variants) of flour was used. Also 7.5 g of salt, 5 g of sugar, 5 g of oil, 25 g of fresh yeast and 330 ml of water was used. The development of all the experiment the Rapid mix test was followed. To control of the volume, in all the variants, baking powder was used. It was required due to the presence of fiber that could affect the development of the gluten network. The baking powder had a composition of diastase, malted wheat flour, sugar E332. E472e, guar gum, ascorbic acid, dextrose and E450.

**Table 1 Dough formulation for each sample**

<table>
<thead>
<tr>
<th>Variety</th>
<th>BSG content and its modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0% (without brewer spent grain)</td>
</tr>
<tr>
<td>2</td>
<td>10% whole BSG from purple wheat</td>
</tr>
<tr>
<td>3</td>
<td>10% cut BSG from purple wheat</td>
</tr>
<tr>
<td>4</td>
<td>10% whole BSG from blue wheat</td>
</tr>
<tr>
<td>5</td>
<td>10% cut BSG from blue wheat</td>
</tr>
<tr>
<td>6</td>
<td>10% whole BSG from purple wheat and barley (50 : 50)</td>
</tr>
<tr>
<td>7</td>
<td>10% cut BSG from purple wheat and barley (50 : 50)</td>
</tr>
<tr>
<td>8</td>
<td>10% whole BSG from blue wheat and barley (50 : 50)</td>
</tr>
<tr>
<td>9</td>
<td>10% cut BSG from blue wheat and barley (50 : 50)</td>
</tr>
</tbody>
</table>

BSG- brewer spent grain

Later, BSG was used in a proportion of 10% of baker’s percentage, because previous studies carried out in this department showed this is the most favorable proportion. According to Huige (1994), the addition of 10% of spent grain increase the amount of protein and amino acids and also double the fiber content in comparison with the traditional bread. In addition, the bread made with spent grain
contains around 7% less calories than the standard one. The caloric value of the spent grain is about 50% lower than the caloric value of the cereals.

The variant 1 was the control sample for this baking experiment (baked without spent grain). The rest of variants used moist BSG (whole grain and coarsely cut). A summary of the tested formulations are shown in the following table (Table 1).

The dough was prepared by mixing all raw materials at once. The dough was kneaded in a dough-kneader for about one minute. It was raised in a proofer at 32 ± 1 °C and humidity of 80 ± 5% for 20 minutes. After the removal from the proofer, the dough was rested for 10 minutes and weighted. Then it was shaped into the desired pieces weighing 80 g and it was allowed to rise again at 32 ± 1°C and humidity of 80 ± 5%, for 25 minutes. Before loading the pieces into the oven, they were sprinkled it with water, and baked at 230 °C to 240 °C in a laboratory oven with a proofer. At the beginning of the baking, the oven was steamed with 50 ml of water. The baking time was 20 minutes.

**Sensory analysis: Evaluation of the product**

The baked products were subject to sensory evaluation of the influence of the ingredients over the physical characteristics of the bread. The sensory evaluation was carried out by a team of trained tasters and the results were evaluated using a sensory analysis test (n = 10). The sensory analysis provides values of the following characteristics of the product: shape, color of the crust, aroma, flexibility of the crumb, color of the crumb, easiness of biting, sensation after chewing, consistency, moisture of the crumb, taste and overall impression. The sensory evaluation was made by unstructured graphic scales, which had a range of 10 cm, 10 cm which meant 10 points (100%), i.e. the best ratings.

**Evaluation of the results**

The statistical evaluation of the identified data was performed using Microsoft Excel and Statistica 12. The one-way ANOVA method was used, which is used for the evaluation of the analysis of variance.

**RESULTS AND DISCUSSION**

**The quality parameters of the bread rolls**

The results of this baking experiment are shown below in the Table 2. The highest loss (14.59%) was observed in the variant 1 (control), while the lowest loss (11.36%) was in the variant 7 (with cut BSG from purple wheat and barley 50 : 50). Hampl and Příhoda (1985) mentioned that the losses during baking of common pastries are ranged between 10 and 13%, depending on the shape and weight of the product, as well as baking time and temperature, dough moisture, or the type of flour. In this research, the loss could because of the effect of the dough moisture and the content of spent grain in the dough, because all the breadrolls were made under the same conditions.

Later, Müllerova and Skoupil (1988), mentioned that higher specific volume of pastry, the more suitable is the wheat variety for bakery production. In this study, the highest specific volume was achieved by the variety 2 which 10% whole BSG from purple wheat (324.9 ml/100 g) and by the variety 4 with around 300 ml. These samples also had the highest losses during baking, up to 14%. This loss could be caused by the enormous water evaporation, because the samples contained whole fresh spent grain. On the other hand the lowest losses, around 11.3%, were at sample 7, which had grind spent grain from red wheat and barley. As optimal shapes of the bread rolls were identified the samples 4, 6 and 8. These samples contained whole spent grain, so it could be said that the whole spent grain has a positive influence on the shape of the product. The most arched sourdough bread was the sample 4, with the addition of whole fresh spent grain of purple wheat.

This experiment also showed a great homogeneity. As it was mentioned before, for the preparation of the samples baking powder was used. The shape and the appearance of the bread were not significantly affected by the addition of various types of spent grain. All the bread rolls had a regular shape and color of the crust, without big differences between them. Also, the addition of different amounts of spent grain was barely noticeable during the cutting of the products. Some participants stated that the difference was not noticed at all, for the average consumer, these differences cannot be considered as significant.
Table 2 Quality parameters of the breadrolls

<table>
<thead>
<tr>
<th>Variety</th>
<th>Specific pastry volume/100 g of dough (ml)</th>
<th>Baking losses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>303.75</td>
<td>14.59</td>
</tr>
<tr>
<td>2</td>
<td>324.90</td>
<td>14.07</td>
</tr>
<tr>
<td>3</td>
<td>292.24</td>
<td>12.52</td>
</tr>
<tr>
<td>4</td>
<td>302.05</td>
<td>13.89</td>
</tr>
<tr>
<td>5</td>
<td>292.94</td>
<td>13.53</td>
</tr>
<tr>
<td>6</td>
<td>292.13</td>
<td>13.01</td>
</tr>
<tr>
<td>7</td>
<td>280.58</td>
<td>11.36</td>
</tr>
<tr>
<td>8</td>
<td>287.82</td>
<td>11.99</td>
</tr>
<tr>
<td>9</td>
<td>292.07</td>
<td>13.13</td>
</tr>
</tbody>
</table>

The sensory evaluation of the products

The analyzed characteristics of the bread rolls were: shape, color of the crust, aroma, flexibility of the crumb, color of the crumb, easiness of biting, sensation after chewing, consistency, moisture of the crumb, taste and overall impression.

Figure 1 shows that the shape of products that contains only color wheat spent grain (samples 2 to 4) were less regular in comparison than those which contained equal percentage of spent grain of wheat and barley (samples 6 to 9). The samples 2 and 3, which contained spent grain of purple wheat, were rated as the worst.

Figure 1 The shape of the bread rolls (Vertical column indicates a confidence interval of 0.95)

Also, it was perceptible that the best aroma was founded on those samples which contained purple wheat spent grain, samples 2 and 3 (Figure 2). Further, as good samples were evaluated those products which contained purple wheat spent grain and barley. Also some evaluators mentioned that the sample 8 had no sharp smell. Ktenioudki et al. (2013) in his study writes that the addition of 10% of spent grain strongly changes the smell of the product, because some roving materials are created and released.

Figure 2 The aroma of the bread rolls (Vertical column indicates a confidence interval of 0.95)

As it is shown in Figure 3, the effects of the different types of spent grain on the flexibility of the crumb doesn’t have a unique effect. The values ranged from 8 to 8.8 points. In general, it could be said that, the crumb was compared with the control sample which has a tougher crumb.

The tastiest samples (Figure 4) were the samples 4 and 5, which contained only spent grain of purple wheat and were evaluated to more than 8 points. The samples which contained some amount of spent grain from barley and from blue wheat, samples 8 and 9, were also evaluated better than the samples which contain spent grain only from purple wheat. The taste is significantly affected whether the samples contained whole or cut spent grain as it is demonstrated in this study.

Figure 3 The flexibility of the bread rolls (Vertical column indicates a confidence interval of 0.95)

Figure 4 The taste of the bread rolls (Vertical column indicates a confidence interval of 0.95)
Figure 3 The flexibility of the crumb (Vertical column indicates a confidence interval of 0.95)

Figure 4 The taste of the bread rolls (Vertical column indicates a confidence interval of 0.95)

Figure 5 The overall impression of the bread rolls (Vertical column indicates a confidence interval of 0.95)

Figure 5 shows the overall impression. The best score (8.8 points) was received by sample 8 that contains whole purple wheat spent grain and barley in a proportion 50:50. The second best rated sample was the sample 5, which contained only cut spent grain from blue wheat. The worst sample was number 4, where the value of the overall impression reached only 7.8 points.

Only small differences should be noticed between all the samples. The values related with the overall impression were ranged from 7.8 to 8.8. For this reason, it is not clear if exist a significant difference between the type of spent grain (barley or wheat) and the size (whole or coarsely cut) of spent grain on the overall impression. Moreover, this experiment shows that the addition of wheat color spent grain is perceived positively by the consumer. It could be said that this addition improves the ethical value of the bread but it is necessary to choose the appropriate type and amount of spent grain.

CONCLUSION

The aim of this research was to evaluate the use of various types and proportions of color wheat spent grain for use in bakery products. Subsequently, these products have been evaluated by sensory evaluation by their form, and were studied their quality characteristics. The trial was conducted in the laboratory of the Institute of Food technology of Mendel University in Brno.

It can be noted that, the participants rated the products which contained fresh spent grain, very pleasant. The best samples were those which contained whole or cut fresh spent grain. The samples were enriched with baking powder. Their overall impression was rated from 7.8 to 8.8. Their total sensory profile was balanced.
The experiment was conducted by the addition of fresh spent grain to the samples, where different types of spent grain were used, which contained various colors of wheat, genetically modified, and barley, used separately or in proportion of 50 : 50. There was no difference in the evaluation of the individual parameters that were considerable. The biggest difference could be found in the evaluation of the color of the crust, but this could be caused by irregular baking.

As the best and the most consistent sample was that one which contained whole spent grain from blue wheat and barley in proportion 50 : 50. It was rated with 8.8 points. As the second best sample was rated the one which contained fresh cut spent grain from blue wheat. The worst sample was considered the one which contained whole spent grain of blue wheat. It is overall impression was evaluated to 7.8 points.

ACKNOWLEDGEMENT

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REFERENCES


