THE USE OF HEMP AND COLOR WHEAT FLOUR AS BAKING INGREDIENTS

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Abstract: This paper deals with the application of flour, obtained by milling wheat varieties with colored pericarp (Rosso, Karkulka) and blue aleurone (Scorpion); and hemp products (hemp grits, hemp protein) for the production of bakery products. For testing purposes nine recipes ware created, 10% of hemp grits or 5% of hemp protein were added to the wheat flour. The influence of the recipes on the bakery product properties was evaluated by the bakery experiment - RMT test. The highest yield of the dough was measured in variants where hemp protein was added. The specific bread volume was higher in those variants which contained flour wheat from Scorpion variety (368 ml/100g). On average, the lowest loss at baking was determined after the addition of hemp protein. The addition of hemp grits supports the convexity of the baked goods. The use of this recipe also affected other sensory characteristics of the product associated with its consumption.

Key Words: color wheat, hemp grits, hemp protein, baking experiment, sensory analysis

INTRODUCTION

Currently there is a growing interest in the functional properties of food and also in the role of antioxidants, which are able to scavenger free radicals (Pasqualone et al. 2015). From this perspective, the anthocyanins and carotenoids are interesting. They are characterized by their antioxidant activity and are found in the caryopses of the color wheat (Janečková et al. 2015). A positive fact is, the inclusion of color wheat in the food, with a higher content of antioxidants in the diet may have beneficial effects on the human health (Knievel et al. 2009). There is a certain evolutionary theory, but it’s effects are not yet supported by clinical tests (Martinek et al. 2010). It is true that the anthocyanins contribute to have better resistance against diseases (Havrleťová et al. 2014). Also, it is scientifically documented that they are physiologically active substances which promote health and reduces the risk of chronic diseases. The presence of these substances in the raw materials of the food, which include colored varieties of wheat, could significantly affect the nutritional value of the resulting food product (Chabinová et al. 2011). It has been demonstrated that the consumption of foods that contain anthocyanins reduces the risk of cardiovascular diseases and protect the body against oxidative stress. Also, they prevent DNA damage, the aggregation of thrombocytes and the oxidation of lipoproteins as well as possess anti-inflammatory effects (Hrnčířová 2011). The blue caryopsis differs from the purple caryopsis in the composition and content of individual anthocyanins; as well as the storage in different anatomical layers (Abdel-Aal a Hucl 2003). The same as the color wheat also cannabis could be used in the baking technology. The hemp seed contains essential amino acids and fatty acids. The seed also contains 25 to 30% of oil, 20–25% of protein, 20–30% of carbohydrate and 10–15% of fiber
approximately. Further, the hemp seeds contain a number of bioactive substances, such as flavones, polyphenols, proteins, albumin and edestin (Norajit et al. 2011); manganese, potassium, iron, zinc and magnesium (Cozea et al. 2016) and vitamins A, B, C and E (Pejcz et al. 2015). Also they contain a number of essential oils such as myrcene, trans – Caryophyllene, trans-β-Ocimene and α-humulene (Novak et al. 2000). Moreover, the hemp seeds lower the blood pressure and cholesterol and also strengthen the immune system (Pejcz et al. 2015). On the other hand, the hemp oil contains a high amount of linoleic acid. Furthermore, contains α-linolenic and oleic acids (Galasso et al. 2016) with the ratio of linoleic acid and α-linolenic of 3 : 1 (Leizer et al. 2000).

By the addition of hemp flour the amount of proteins could be increased in those products that have less, such as for example the rice (Norajit et al. 2011). The advantage of both materials, mentioned above, is that they could be processed and modified for use in bakery production. Their combination could contribute to the creation of new, nutritive and better balanced food products.

MATERIAL AND METHODS

Wheat flour was used in every recipe. The flour was obtained by milling the purple varieties of Karkulka and Rosso, and the blue aleurone (Scorpion variety). Into the preparation of the dough a percentage of hemp semolina and hemp protein were added. The representations of the individual components are shown in the Table 1.

Table 1 Overview of the variants

<table>
<thead>
<tr>
<th>Variety</th>
<th>Combination*</th>
<th>Wheat flour [g]</th>
<th>Hemp grits [g]</th>
<th>Hemp protein [g]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scorpion</td>
<td>Flour</td>
<td>500</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rosso</td>
<td>Flour</td>
<td>500</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Karkulka</td>
<td></td>
<td>500</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Scorpion</td>
<td>Flour + grits</td>
<td>450</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>Rosso</td>
<td>Flour + grits</td>
<td>450</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>Karkulka</td>
<td></td>
<td>450</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>Scorpion</td>
<td>Flour + protein</td>
<td>475</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Rosso</td>
<td>Flour + protein</td>
<td>475</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Karkulka</td>
<td></td>
<td>475</td>
<td>-</td>
<td>25</td>
</tr>
</tbody>
</table>

*Note: for each variant was also used: an addition of salt – 7.5 g, sugar – 5 g, oil – 5 g and yeast – 25 g.

Preparation of dough and baking process

The dough was prepared by mixing all raw materials at once. It 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.

During the baking experiment the yield of the dough (%), the baking losses (%), the height of the bread (%), the specific bread volume (ml/100 g) and the convexity of the bread characterized by a proportional number was evaluated.

Sensory analysis

An hour after baking the sensory analysis, by a team of sensory evaluators (n = 10), was carried out. During the sensory analysis the 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 and taste were evaluated. The sensory evaluation was made by unstructured graphic scales, which had a range of 100 mm, ten millimeters in the scale correspond to one point.

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. The average and the standard deviations of the observed data were calculated and the significant differences were determined for each characteristic.

RESULTS AND DISCUSSION

The baker’s experiment

Flours from different types of color wheat: Karkulka, Rosso and Scorpion were tested in this experiment. The Karkulka variety has a significant content of substances in the caryopses layers as well as in the endosperm, which could be used in the food industry. Also, it has a high protein content and a very high gluten content (Rückschloss et al. 2014). The Rosso wheat variety is also characterized by having valuable technological parameters, which increases significantly its use in bakery products (Hřivna et al. 2014). Generally, the blue grained wheat has higher levels of anthocyanins than the purple wheat pericarp (Martinek et al. 2012). Also from this perspective it could be considered that the growing of the Scorpion wheat as very appropriate. Moreover, with the exception of the crop weight, it has very satisfactory crop attributes (Hřivna et al. 2014). It is also assumed that the flour of blue grained varieties has more antioxidants, because the antioxidants are not in the pericarp but are located closer to the endosperm, in the aleurone layer.

Table 2 Results of the baking experiment

<table>
<thead>
<tr>
<th>Variety</th>
<th>Yield of the dough (%)</th>
<th>Baking losses (%)</th>
<th>Yield of the bread (%)</th>
<th>Specific bread volume (ml/100g)</th>
<th>Ratio number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>164.58</td>
<td>13.24</td>
<td>142.78</td>
<td>368.00</td>
<td>0.46</td>
</tr>
<tr>
<td>2</td>
<td>165.76</td>
<td>12.07</td>
<td>145.76</td>
<td>316.00</td>
<td>0.56</td>
</tr>
<tr>
<td>3</td>
<td>165.24</td>
<td>13.81</td>
<td>142.43</td>
<td>288.00</td>
<td>0.62</td>
</tr>
<tr>
<td>4</td>
<td>158.54</td>
<td>13.07</td>
<td>137.82</td>
<td>316.00</td>
<td>0.61</td>
</tr>
<tr>
<td>5</td>
<td>159.92</td>
<td>10.27</td>
<td>143.49</td>
<td>308.00</td>
<td>0.75</td>
</tr>
<tr>
<td>6</td>
<td>159.42</td>
<td>9.72</td>
<td>143.92</td>
<td>302.00</td>
<td>0.66</td>
</tr>
<tr>
<td>7</td>
<td>166.08</td>
<td>11.45</td>
<td>147.06</td>
<td>328.00</td>
<td>0.47</td>
</tr>
<tr>
<td>8</td>
<td>167.10</td>
<td>10.17</td>
<td>150.11</td>
<td>308.00</td>
<td>0.60</td>
</tr>
<tr>
<td>9</td>
<td>165.94</td>
<td>10.35</td>
<td>148.76</td>
<td>308.00</td>
<td>0.53</td>
</tr>
</tbody>
</table>

Var 1, 4, 7 – flour from the Scorpion variety, var. 2, 5, 8 – flour from the Rosso variety, var. 3, 6, 9 – flour from the Karkulka variety, var. 4, 5, 6 – addition of 10% of hemp grits, 7, 8, 9 addition of 5% of hemp protein.

The highest yield of the dough was observed when using the Rosso wheat variety, but there are not considerable differences among the other types of flour. It could be considered positive that the addition of hemp protein increased the yield in all variants. The increase was from 0.7 to 1.5% more than those, which contained only flour. On the other hand, the addition of hemp semolina decreased significantly the yield of the dough. Also a high proportion of oil in puffed cornmeal snacks (Pejcz et al. 2015) limited the water intake of the dough and reduced its yield (Table 2). It is also important to take into consideration that the yield of the dough depends on the water loss during the baking. According to Dvořáková et al. (2005), these losses are in the range between 15±5%. This was confirmed by this research. The lowest loss during the baking was determined in the recipe that contained Karkulka flour and hemp grits (var. 6). Furthermore, the highest water loss was detected in the var. 3, where the recipe had only wheat flour. The highest yield of bread was obtained in those varieties which contained hemp protein and used all kinds of flours (var. 7 to 9). The flour from the wheat variety Scorpion, scored the highest specific volume. The bakery products made from this type of flour score the lowest convexity of the pastries, often characterized by the ratio number or index gluten behavior. The highest ratio number was determined by the recipe which contained Rosso wheat flour and hemp grits.

Sensory analysis

The influence of the recipe was analyzed during the sensory evaluation of the products. The most important parameter, in terms of sensory evaluation, is the shape of the product. Often it decides the
consumer’s interest in the product, which is mainly influenced by the convexity of the baked good and its volume. In some of the measurements carried out in this study, this characteristic was shown through the scores. The best score for the shape of the product was achieved by the sample 3 and 5 (Table 3), although the sample 5 scored the highest ratio number.

Moreover, the color of the crust depends on the composition of the dough and on the baking mode. The non-enzymatic browning, which is the result of a chemical reaction between amino acids and reduced sugars, followed by the caramelization of the sugars and the color of the ingredients, could significantly influence this characteristic. The typical color was only found, where the dough was made only of flour or it contained hemp grits. The addition of hemp ingredients, especially hemp protein, has a negative influence on the color. Further, the worse evaluated color was on those samples which contained a high amount of hemp flour as well as in the studies of Apostol et al. (2015) and Pejcz et al. (2015), who mentions that the color of the crust was worse on those samples which contain hemp as ingredient.

Also, the formulation has a significant influence on the aroma (p > 0.95) of the product. In this study was found that the Scorpion wheat flour has a significant effect on the aroma. In general, the additions of hemp ingredients have a negative effect on the aroma of the products.

The springiness of the crumb was evaluated evidently (p > 0.95) as the best (7.9) for those samples which used flour from the Scorpion wheat variety. Moreover, the addition of hemp ingredients has a bad effect on this characteristic independently on the type of flour. A similar conclusion was reached by Apostol et al (2015). Mainly, the technical parameters of the used wheat flour were manifested. The results (of this study) are related with the specific volume of the bread. The highest value was obtained in those variants which contained milled grain wheat from the Scorpion variety (Table 2).

The color of the crumb was highest scored (8.2) for the products with wheat flour from Scorpion variety (var. 1). It was not possible then the influence of the pigments, located at the aleurone (Martínek et al. 2012).

A positive aspect to consider is that there were not found any significant differences related with the consumption of the product through the easiness of biting in the mouth. Similar results were obtained on the consistency and moisture of the crumb (Table 3).

Figure 1 Appearance and shape of the best rated product

<table>
<thead>
<tr>
<th>Variety 1</th>
<th>Variety 2</th>
</tr>
</thead>
</table>

Furthermore, the taste might be affected by the technology and the formulation of the product. The influence of the technology is related with the baking process or the damage of the raw materials; which could also manifest as a weak flavor (Příhoda 2012). The best score in the taste was achieved with those variants where only flour was used. The addition of hemp grits has influence on the taste more than the hemp protein. The best overall impression was achieved by variants 1 and 2 (Figure 1). The added hemp ingredient was evaluated as the worse on the overall impression. The negative influence of the added hemp ingredients on pastries were mentioned by Apostol et al. (2015), who recommend as ideal recipe that, from the sensory analysis perspective, the addition of 5% of hemp flour. Similar results were obtained by Pejcz et al. (2015).

Table 3 The results of the sensory analysis

<table>
<thead>
<tr>
<th>Var.</th>
<th>Form</th>
<th>Color - crust</th>
<th>Aroma</th>
<th>Springiness - crumb</th>
<th>Color - crust</th>
<th>Easiness of biting</th>
<th>Sensation after chewing</th>
<th>Consistency</th>
<th>Moisture - crumb</th>
<th>Taste</th>
<th>Overall impression</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.1a</td>
<td>6.5a</td>
<td>7.8b</td>
<td>7.9c</td>
<td>8.2a</td>
<td>6.8a</td>
<td>6.6a</td>
<td>6.6a</td>
<td>7.0</td>
<td>7.5b</td>
<td>7.5a</td>
</tr>
</tbody>
</table>
CONCLUSION
The results of the research and the sensory evaluation of the bakery products showed that the application of flour from colored wheat might be a possible to improve the bakery products nutritional quality. By the use of hemp products in the recipe, they contribute to increase the diversity of bakery products. Along this study it was possible to confirm the value of the purple wheat (Karkulka and Rosso varieties) and blue aleurone (Scorpion) as flour. Also, the use of these wheat varieties depends on their baking quality. Because of this, it is possible to achieve satisfactory values in all the studied parameters. Through this research it could be concluded that the best flour is that which is obtained from Scorpion variety. Also, it was positively evaluated the use of cannabis products, which increased the nutritional value of the bread. On average, the lowest baking loss was achieved after the addition of hemp protein. Also, the addition of grits promoted the convexity of the baked goods. The flour obtained by the milling of colored wheat grains, enriched with an acceptable quantity of cannabis products, contributes to the expansion of functional foods in bakery products.

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