USE OF HEMP RAW MATERIALS IN COMMON BAKERY PRODUCT RECIPES

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Abstract: This paper deals with the possibilities of using products derived from industrial hemp in creating recipes of common bakery products. The food industry may use only industrial hemp products containing less than 0.3% of THC. Nine recipes were created during testing, in which addition of hemp oil, hemp grits, hemp flour and hemp protein added to wheat flour, or combinations thereof, were evaluated. The influence of the recipe composition on the bakery product characteristics was evaluated by the baking test (Rapid-Mix-Test or RMT). Lowest baking loss (10.62%) and the highest yield of bread (147.81%) was in recipe with 10% share of hemp flour. The highest volume yield was recorded after the addition of hemp oil. Index number that characterizes arching of baking goods was highest for variants with 5% and 10% of hemp grits. Sensory analysis evaluated descriptors of shape, crust colour, aroma, elasticity of the crumb, crumb colour, ease of bite, mouthfeel after brief chewing, consistency, crumb moisture, taste and overall impression. Addition of the hemp oil in seven descriptors out of eleven achieved a better evaluation than in the control variant. The addition of hemp flour and protein has positively influenced the crumb moisture.

Key Words: hemp flour, hemp grits, hemp protein, hemp oil, baking test, sensory analysis.

INTRODUCTION

Bakery products belong to the base of our diet. Lately, we have been encountering enrichment of traditional flours with alternative products containing substances beneficial to health. Enrichment of recipes with new raw materials gives a product a higher nutritional value (Pejcz et al. 2015). It is important to modify the recipe so that there is not much change in the technological process of baking and the sensory quality of the product is similar to or even better than the original product.

Hemp is an annual dioecious herb, having both male and female plants. The main two types of hemp we can encounter are Indian hemp (Cannabis indica, Lam) and “common” hemp (Cannabis sativa L.). Indica is grown exclusively for narcotic substances, which are contained in the green parts of plants, predominantly in the resin of female inflorescences. Sativa is the most widespread variety, which is grown for strong fibres and forms a very little resin (Šnobl and Pulkrábek 2005).

The common hemp contains 533 compounds including 103 monoterpene phenolic compounds that are present only in this plant.

Hemp is a crop used since ancient times. It was used for its therapeutic effects and technical applications. In the Czech lands, it appeared as early as the Middle Ages. It was normally used for the production of hemp fabrics, paper, or oil extraction. Recently, there have been efforts to use hemp in food and medicine. In the food industry, we can now encounter products that contain it, such as chocolates. Currently, the food industry may use products such as hemp protein, flour, seeds, or flowers.

Hemp seeds contain a number of bioactive substances, such as flavones, polyphenols, albumin and edistinproteins (Norajit et al. 2011), manganese, potassium, iron, zinc, or magnesium (Cozea et al. 2015).
vitamins A, B, C, and E (Pejcz et al. 2015). It is known that hemp seeds lower blood pressure, reduce cholesterol, and boost the immune system (Pejcz et al. 2015). Hemp oil contains high amounts of linoleic acid as well as α-linoleic and oleic acids (Galasso et al. 2016). The ratio of linoleic acid and α-linoleic acid is 3:1 (Leizer et al. 2000). Hemp seeds contain a number of essential oils such as myrcene, trans-caryophyllene, trans-β-octimene, and α-humulene (Novak et al. 2000). By adding hemp flour we can increase the amount of protein, as it succeeded in the energy bars from extruded rice (Norajit et al. 2011). The above facts support the idea of using hemp products for fortification of bakery products. Due to the composition of hemp seeds, we can expect technological and nutritional, as well as sensory benefits. This paper also validates these assumptions as it is focused on enriching traditional recipes of bakery products with hemp products, namely flour, protein, oil, and grits.

**MATERIALS AND METHODS**

The test was carried out according to the outline presented in Table 1. The baking used ordinary fine-grain wheat flour, water, yeast, sugar, salt, oil, and hemp component in different proportions.

**Table 1 Type and amount of hemp component in the recipe**

<table>
<thead>
<tr>
<th>Variant</th>
<th>Wheat flour [g]</th>
<th>Hemp flour [g]</th>
<th>Hemp oil [ml]</th>
<th>Hemp grits [g]</th>
<th>Hemp protein [g]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>500</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>475</td>
<td>-</td>
<td>-</td>
<td>25</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>450</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>400</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>400</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>7</td>
<td>475</td>
<td>25</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>450</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>475</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>10</td>
<td>450</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>-</td>
</tr>
</tbody>
</table>

The dough was prepared from all raw materials mixed together at once. It was kneaded in a high-speed kneader for approximately one minute. Rising took place at a temperature of 32 °C ± 1 °C and humidity 80 ± 5% for 20 minutes. After removal from the proofer, the dough was let to rest for 10 minutes and then weighed. The dough was shaped into 80-g loaves and again allowed to rise at 32 °C ± 1 °C and humidity 80 ± 5% for 25 minutes. Before loading them into oven, the loaves were sprinkled 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.

A baking test was subsequently carried out. It evaluated dough yield (%), baking loss (%), yield of bread (%), volume yield (ml/100 g), and bread arching characterized by an index number. One hour after baking a sensory analysis by experienced sensory evaluators (n = 10) was carried out. The bakery products were evaluated for shape, crust colour, aroma, crumb elasticity, crumb colour, ease of bite, mouthfeel after brief chewing, consistency, crumb moisture, and taste. Graphic evaluations used 100-mm unstructured scales, where 1 mm on the scale corresponded to one point.

Statistical evaluation of the gained data was carried out using Microsoft Excel and Statistica 12. The calculation used the one way ANOVA method, which is used for evaluation of the analysis of variance. It calculated averages and standard deviations of gained data and determined conclusiveness of the differences in individual evaluated descriptors.

**RESULTS AND DISCUSSION**

**Baking test**

The results shown in Table 2 indicate that the highest dough yield was achieved after adding hemp oil (166.3%) and a very good yield was achieved in recipes with the added hemp flour (164.46–165.38%), and 5% of hemp protein (163.91%). The achieved yield of these variants corresponds to the
results indicated by Dvořáková et al. (2005) in assessing the standard recipes for making bread and common pastries. In her case, the yield ranged from 155 ± 10%. This means that the addition of hemp material did not have a negative influence on the dough yield.

The addition of hemp flour at a level of 10% influenced mostly the loss of water through baking. In this variant, the water loss was very low and amounted to 10.62%. However baking loss may be very variable related to used raw materials. Dvořáková et al. (2005), who also addressed this issue, provided a relatively wide range of 15 ± 5%.

The lower loss through baking in this variant was also positively reflected in the bread yield, which significantly exceeded the control variant, which used only wheat flour (147.81%).

Table 2 Results for the baking test

<table>
<thead>
<tr>
<th>Variant</th>
<th>Dough yield (%)</th>
<th>Baking loss (%)</th>
<th>Bread yield (%)</th>
<th>Volume yield (ml/100 g)</th>
<th>Index number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>163.85</td>
<td>14.99</td>
<td>139.29</td>
<td>402.00</td>
<td>0.61</td>
</tr>
<tr>
<td>2</td>
<td>166.03</td>
<td>15.85</td>
<td>139.72</td>
<td>424.00</td>
<td>0.69</td>
</tr>
<tr>
<td>3</td>
<td>159.35</td>
<td>12.44</td>
<td>139.52</td>
<td>370.00</td>
<td>0.72</td>
</tr>
<tr>
<td>4</td>
<td>156.02</td>
<td>15.06</td>
<td>132.52</td>
<td>388.00</td>
<td>0.72</td>
</tr>
<tr>
<td>5</td>
<td>143.59</td>
<td>14.87</td>
<td>122.23</td>
<td>294.00</td>
<td>0.67</td>
</tr>
<tr>
<td>6</td>
<td>148.01</td>
<td>12.97</td>
<td>128.82</td>
<td>296.00</td>
<td>0.64</td>
</tr>
<tr>
<td>7</td>
<td>164.46</td>
<td>14.77</td>
<td>140.17</td>
<td>396.00</td>
<td>0.63</td>
</tr>
<tr>
<td>8</td>
<td>165.38</td>
<td>10.62</td>
<td>147.81</td>
<td>344.00</td>
<td>0.65</td>
</tr>
<tr>
<td>9</td>
<td>163.91</td>
<td>15.37</td>
<td>138.72</td>
<td>416.00</td>
<td>0.69</td>
</tr>
<tr>
<td>10</td>
<td>162.24</td>
<td>12.71</td>
<td>141.62</td>
<td>277.00</td>
<td>0.61</td>
</tr>
</tbody>
</table>

Note: Variant 1: control variant, Variant 2: 5 ml of hemp oil, Variant 3: 5% of hemp grits, Variant 4: 10% of hemp grits, Variant 5: 20% of hemp grits, Variant 6: 20% of hemp grits without oil, Variant 7: 5% of hemp flour, Variant 8: 10% of hemp flour, Variant 9: 5% of hemp protein, Variant 10: 10% of hemp protein.

Sensory analysis

Figure 1 shows that the shapes of the products were all similar. The colour of the crust has received conclusively the best evaluation in variants with added hemp oil (Table 3). Although it has a dark green colour, it did not show up in the crust colour. Samples with added hemp protein (variants 9 and 10) and hemp flour (variants 7 and 8) have received the worst evaluations. Hemp flour and protein are at first sight quite similar materials. Their colour is dark green, which is reflected in the colour of bread and lower ratings in sensory analysis. These materials are not light components and their use is to be expected to cause an atypical colour in the final product. The colour with an increasing amount of hemp flour was evaluated in studies by Apostol et al. (2015) and Pejcz et al. (2015). Their evaluations were also worse than the control, and even the addition of 5% of hemp flour was rated worse than adding 10 and 15%.

All hemp raw materials have worsened the aroma of the product. This is because hemp ingredients have strong, typical aroma due to the presence of essential oils, such as α-humulene, caryophyllene, or caryophyllene oxide (Bertoli 2010).
The best crumb flexibility was found in the control and variants with added hemp oil. Addition of 10% of hemp flour and protein was manifested in less crumb flexibility. In the study by Apostol et al. (2015), the flexibility of the sample with 5 and 10% of hemp flour compared with the control was unchanged. The worse flexibility was in variants with a higher content of hemp flour (15, 20, and 100%). Flexibility in the study by Pejcz et al. (2015) was similar in variants with 5 and 15% of hemp flour, but with 10%, it was worse.
Just as in the case of the crust colour, the *crumb colour* was evaluated worst for variants with higher content of hemp flour and protein (Figure 1). So it was in the studies by Apostol et al. (2015) and by Pejcz et al. (2015).

The *ease of bite* was not significantly affected by the recipe composition. Variants with added hemp flour and protein received only slightly worse ratings. These constituents most likely cause greater firmness of the product.

*Mouthfeel after brief chewing* was evaluated very well especially in the variant with the addition of hemp oil and 5% of hemp grits.

Hemp oil and the addition of 20% of hemp grits improved *product consistency*, while the addition of hemp ingredients in other variants was worse than in the control.

Very good *crumb moisture* occurred after the addition of hemp grits. Likewise, it was so with the *taste* descriptor. Hemp grits are used as additives in chocolates or are eaten separately, so consumers may be already accustomed to their taste.

Best *overall impression* was achieved by variant 3 (Figure 2) with 5% addition of hemp grits. In contrast, Apostol et al. (2015) sees as ideal from a sensory perspective the recipe with % addition of hemp flour. However, they see the increase of its portion negatively, which was confirmed in our tests. Likewise Pejcz et al. (2015) indicate worsening of the overall sensory quality of the product with increasing amounts of hemp flour.

**CONCLUSION**

Baking test confirmed higher dough yield and volume yield compared to the control after the addition of hemp oil. The addition of hemp flour up to 10% reduced baking loss and increased bread yield. Adding hemp grits most affected bread arching and index number.

The most suitable hemp ingredient in sensory analysis proved hemp oil, which improved crust colour, crumb elasticity, ease of bite, crumb moisture, consistency and overall impression when compared to the control variant. The addition of hemp grits also had a very good effect. Parameters related to aroma and look received the worst evaluations. Green colour and the typical, strong odour of hemp pose certain disadvantages when used for baking.

If we look at the results of the RMT test and sensory analysis comprehensively, we can conclude that hemp oil appears to be an ideal addition. In terms of technology but also nutrition, hemp flour as supplement is also recommended, however the amount should not exceed 5%.

**ACKNOWLEDGEMENT**

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**REFERENCES**


