INFLUENCE ON TIME OF BAKING AND DIFFERENT ROLE OF BARLEY FLOUR ON THE COLOUR OF THE BISCUITS

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Abstract

Biscuits are products which contain large amount of fats and sugar. By increasing the temperature during baking, the Maillard reaction develops and there is a process of caramelization which leads to creating compounds that cause change of the color of biscuits. Changing wheat flour with barley flour when producing biscuits can result in acceptable and functional products.

In our research, change of the color of biscuits made from wheat flour and mix from wheat and barley flour has been followed (0%, 30%, 50%, 70% and 100% of barley flour) while baking for 5 -10 min. Some of the biscuits have been stocked in room temperature and change of color has been measured after 6 and 12 months of storage. Biscuits have been produced according to AACC 10-5D method. The color of the biscuits has been scanned (digitalized) with the help of a scanner Epson Perfection V500 photo.

With biscuits from 100% barley flour, a very visible change of color has been noticed even after 5 min. of baking (ΔE > 6), which reduced during expanding the time of baking. In biscuits from 100% of wheat flour, a very visible change of color has been noticed after 7 min. of baking and this change increased with expanding the time of baking. Increasing the part of barley in biscuits correlates when reducing the change of color of the biscuits during baking. From stored biscuits, the biggest change of color has been noticed with biscuits from 100% wheat flour after 6 (ΔE = 16.49) and 12 months (ΔE = 14.29) of storage.

From these results it can be concluded that with biscuits from barley flour, the entire change of color reduces during baking, whereas with biscuits from 100% wheat flour it increases during baking. By expanding the time of storage, the entire change of color of biscuits reduces.

Key words: Biscuits, Barley flour, Wheat flour, Baking, Color, Storage.

1. Introduction

Biscuits were type of cookies with cereals as a basic component, and contain a large amount of sugars and fats [1]. In the structure of biscuits there is large number of raw materials, different improvers and other additives, therefore they differ in: type, structure, mass, consistence, structure and technology of production [2].

Flour was one of the main raw materials for production of biscuits and white wheat flour was usually used. Types of wheat flour which were used for making biscuits had low level of 9 - 10% proteins, low level of gluten and plastic properties. If flour with high level of gluten is used, final products will be greatly deformed during baking and the surface will be rough and covered with bubbles [3].

Nowadays, on the market there are biscuits and different baker’s products made from mixing wheat flour and flour from other cereals such as: oat flour, rye flour, corn flour, buckwheat flour, barley flour etc. Lots of authors were presenting the positive effects of replacing barley flour with wheat flour on the qualitative properties of bread and biscuits [4 - 6].
Barley (Hordeum vulgare L.) was one of the oldest cultivated cereals worldwide. It was mainly processed in mash for beer and it was used in production of: whisky, yeast, surrogate coffee, barley gruel, etc. [7].

Arshad et al., [6], quoting other authors, points out that barley as well as barley flour have been gained more interest as food for human during the last couple of years due to the characteristic of being a rich source of proteins, minerals, and qualifies with high content of dietary fiber, especially β-Glucans. Literature data testify that consuming dietary fiber promotes beneficial effects on people’s health: reducing the glycemic index and cholesterol in blood, lower risk of developing diabetes type 2, and cardiovascular diseases [5, 6, and 8].

Basic and additional raw materials which were used when producing biscuits were responsible for: flavor, color and appearance of biscuits. Physical and chemical transformations of basic and additional raw materials which occur during the technological process help in improving the final product properties [3].

Color was an important characteristic of the food products. Change of biscuits color during baking was a dynamic process in which transitory colors occurred as result of baking. Browning development in biscuits begins when sufficient amount of drying has occurred. Moreover it was associated with the recipe (reducing sugars, leavening agents, salt, amino acids, etc.) and baking conditions (temperature and time) [9]. Browning was the final step of both the Maillard reaction and caramelization, one of the end-points of the baking process and the final result of sugar degradation during baking [10].

Regarding the previously stated, we considered that determining the influence of time of baking and different role of barley flour on the color of the biscuits was of special interest.

2. Materials and Methods

Hard-wheat white flour T-550 and barley flour produced by grinding barley (OSVIT) from the Agricultural Institute in Osijek, Croatia are used for biscuits production. The process of grinding barley was made in a laboratory mill (IKA MF10). The rest of the raw materials were bought from local shops.

Biscuits were produced at the laboratory at the Josip Juraj Strossmayer University of Osijek, Faculty of Food Technology, Food Technology, sub-department of Cereal Processing Technologies, Osijek, Croatia, in accordance with AACC Method 10-50D [11]. Five types of biscuits were produced: basic control biscuits (100% wheat flour) and biscuits in which a partial and complete substitute of wheat with barley flour (30%, 50%, 70% and 100% barley flour) was made.

The process of baking was done in a convection oven (Wiesheu Minimat Zibo, Wiesheu GmbH, Germany), in temperature of hot air inside the oven of 205 ± 1 °C. Biscuits were cooled in room temperature for 30 min. Color of the biscuits was analyzed every minute in time interval from 5 to 10 minutes of baking. Some of the biscuits baked for 10 min. were stored in room temperature and change of their color was determined after 6 and 12 months of storing.

Measuring the color of the biscuits in CIE L*a*b* system by using colorimeter (Konica Minolta Chroma Meter CR-400, Japan) and calculations to determine the change of color were made according to the method described from Budžaki et al., [10]. We were trying to cover large part of the surface during measuring, and the colour of the surface was measured on 5 different parts.

Ratio between the calculated value ΔE (total colour difference) and the tolerance of the human eye for noticing color difference was an important indicator for the change of color in processes with enzymatic and non-enzymatic browning (Table 1, [12]).

<table>
<thead>
<tr>
<th>Total colour difference (ΔE)</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.2</td>
<td>not visible</td>
</tr>
<tr>
<td>0.2 - 1</td>
<td>hardly visible</td>
</tr>
<tr>
<td>1 - 3</td>
<td>slightly visible</td>
</tr>
<tr>
<td>3 - 6</td>
<td>visible</td>
</tr>
<tr>
<td>&gt; 6</td>
<td>very visible</td>
</tr>
</tbody>
</table>

All types of biscuits are scanned (digitalized) with a scanner Epson Perfection V500 photo on the day of their production. The scanner was placed in a dark chamber in order to control lighting.

Data have been statistically processed and shown with the help of Microsoft Office Excel 2016. A correlation analysis has been made to determine the connection between the role of barley flour in produced biscuits and the change of color during baking. Connection between variables has been expressed through Pearson correlation coefficient (R) and then, statistical importance (p < 0.05) has been determined [13-15].

3. Results and Discussion

The major components of biscuits were cereal flour, sugars and fats. The dough was conventionally baked at high temperature (205 °C) for a few minutes (10 min.), in order to obtain low final water content and a brown surface. During baking simultaneous heat and mass transfer occur due to elevated temperatures. Heat was
transferred from the hot air to the product surface by convection and throughout the product by conduction while the moisture evaporates from the product. During thermal processing several reactions (Maillard reactions and caramelization) were taking place which had a direct impact on formation of biscuits colour [10].

Gained results from the analysis for color change between different types of biscuits during different baking time are graphically shown. Comparison was especially made for biscuits on the day of their production (Figure 1) and for part of the biscuits (those baked for 10 min.) which were stored for 6 and 12 months (Figure 2).

Figure 1 show results from the entire difference in color (ΔE) of biscuits made from different types of flour (control sample 0%, 30%, 50%, 70% and 100% barley flour) in relation to the time of baking on the day of their production.

Very visible change of color even after 5 min. of baking (ΔE > 6) can be seen with biscuits with 70% barley flour (ΔE = 8.41) and 100% barley flour (ΔE = 11.27). With other biscuits, this change can be seen later, during baking. Compared to control biscuits (100% wheat flour), a very visible change of color can be seen after 7 min. of baking (ΔE = 7.47) and this change increases by increasing the time of baking (8 min./ΔE = 22.21, 9 min./ΔE = 26.20 and 10 min./ΔE = 27.98) which was the opposite of the change of color of biscuits with 100% barley flour. Mainly, with biscuits with 100% barley flour, the entire difference in color reduces during baking (6 min. - 10 min./ΔE = 10.29 - 9.11).

Figure 2 shows the achieved results from the total colour difference (ΔE) of biscuits which were baked for 10 min. and stored in room temperature for 6 and 12 months.

From the presented results, it can be seen that only biscuits with 50% barley flour have a visible change in color (ΔE = 3 - 6) after 6 and 12 months of storage (5.18 & 5.53, appropriately). With all the other biscuits, very visible changes of color can be seen (ΔE > 6) after 6 and 12 months of storage, whereupon the biggest biscuits prepared by 100% wheat flour (6 months/ ΔE = 16.49 and 12 months/ ΔE = 14.29).

Tendency in reducing the change of color by increasing the time of storage generally was showed in comparing the changes of biscuits color (baked for 10 min.) immediately after baking (Figure 1) with the change of color of those biscuits after 6 and 12 months of storing (Figure 2).

After baking and cooling, all types of biscuits were scanned (Figure 3). Figure 3 has showed that biscuits (control sample 0%, 30%, 50%, 70% and 100% barley flour) were changing color during baking. However, for all types of biscuits it can be concluded that by increasing the time of baking, yellow color intensifies and golden yellow color creates, which was distinctive for each type.
Achieved results from correlation analysis were shown graphically (Figures 4 - 9).

The achieved value of the coefficient of correlation between the content of barley flour in the examined samples of biscuits after 5 min. and 6 min. of baking and the total color change given in Figure 4 and Figure 5 (R = 0.8339 and R = 0.8482) shown that there was a strong positive correlation. It was means that high variable value of the content of barley flour in the biscuits goes with high variable value of the total color change (and vice versa). In both cases, there is no statistically significant correlation at 95% significance level.

The resulting correlation coefficient between the content of barley flour in the examined samples of biscuits after 7 min. of baking and the total colour difference (R = 0.6632), suggest a moderate positive correlation, meaning that there was a tendency for high variable value of the content of barley flour in the biscuits was gone with high variable value of the total colour difference and vice versa (Figure 6).

By increasing the content of barley flour in the biscuits the total colour change increases. The p-value is 0.2224. The result is not significant for p < 0.05.

Regarding the examined samples of biscuits after 8 min of baking, the value of R was -0.6932 (Figure 7). This was a moderate negative correlation, which means that there was a tendency for high variable value of the content of barley flour in the biscuits was gone with low variable value of the total colour difference (and vice versa). By increased the content of barley flour in the biscuits, the total colour change was decreased. From the resulting value of p (0.1943) it can be concluded that the result was not significant for p < 0.05.

The resulting coefficient of correlation between the content of barley flour in the examined samples of biscuits after 9 min. and 10 min. of baking and the total colour change is given in Figure 8 and Figure 9 (R = - 0.8084 and R = - 0.8034), and it refers to the strong negative correlation, which means that high variable value of the content of barley flour in the biscuits was related with low variable value of the total colour change (and vice versa). In both cases, there was no statistically significant correlation at 0.05 significance level.
4. Conclusions

- Based on the achieved results, it can be concluded that in biscuits prepared with 70 and 100% barley flour, change of color was a very visible even after 5th min of baking, while in other biscuits this change happens later during baking. In biscuits prepared by 100% wheat flour (control sample), change of the color increases by increasing the time of baking, which was opposite to biscuits prepared by 100 % barley flour where the entire differences in color reduced during baking.

- Achieved results showed about the total color change of biscuits stored for 6 and 12 months, and it can be concluded that generally, there is a tendency in reducing the color change by increased the time of storage.

- Based on the values of Pearson’s correlation coefficient (R) it can be concluded that there was a positive correlation between the content of barley flour in the examined samples of biscuits after 5, 6 and 7 min. of baking and the total color change. The total color change increased by increasing the content of barley flour in the biscuits.

- There was a negative correlation between the content of barley flour in the examined samples of biscuits after 8, 9 and 10 min. of baking and the total color change. The total color change decreased by increasing the content of barley flour in the biscuits. The received values for p were bigger than 0.05, so it can be concluded that the achieved results were not significant for p < 0.05.

5. References


