THE EFFECT OF DIFFERENT METHODS FOR PRODUCTION OF CRACKERS ON THEIR PHYSICAL AND SENSORY CHARACTERISTICS

ORIGINAL SCIENTIFIC PAPER

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ABSTRACT:

The aim of this study was to compare the physical and sensory characteristics of crackers obtained by three different methods. To obtain the crackers by the first method, the dough was allowed to ferment for 16 h at 26 ^{0}C. In this method, fat (shortening) was added in the form of an oil-based semi-finished product. The second formulation differs from the first formulation by the time of fermentation (2 h) and the way in which the oil was added. Using this method of cracker production, fat was added in the form of lumps in the dough itself. The difference between the third and the first two methods was the raising agents used (the third method uses $NaHCO_3$ and the first two pressed yeast) and the lack of fermentation. The following were examined: temperature and pH before and after fermentation, fermentation loss, thickness, diameter, volume, color and sensory characteristics of the crackers obtained. The results showed that the temperature during fermentation increases and the pH decreases. The crackers obtained from the dough, which fermented for 2 hours, had the greatest thickness, diameter and volume. From the sensory analysis, it became clear that the crackers obtained by first method was the most appreciated.

KEYWORDS: crackers, physical characteristics, biscuits.

INTRODUCTION

Cereal products, especially those used for baking and pastry, are the most widely used in people's daily lives. Their use helps to improve the quality of bakery and pastry. In addition, they increase the functionality of the products and ensure the health of the body [1]. Crackers are dry bread products and they are consumed as breakfast or instead of bread. They can be consumed with butter, cheese and more.

Various types of crackers are known, which are mainly divided into unsweetened (salted) and slightly sweetened [2]. The main raw materials for crackers are wheat flour, water, fat and yeast. The most commonly used flour in the bakery and confectionery industry is white wheat flour T-500. This type of flour contains a large amount of starch (about 70% of the flour composition) [3]. The T-500 flour gives better gluten than the higher type flours. Due to the good properties of gluten and low enzyme activity, obtained dough is elastic, stable and easily stretchable [4]. On the other hand, gluten is a key ingredient that influences the texture of crackers [5]. There are different methods for making crackers. The first crackers that were produced were laminated [2]. Chonova and Karadjov [6] presented a method for obtaining the same crackers. Pressed yeast is used in it as a swell. Many authors also use the soda crackers method [7], [8], [9]. This method is also known as *"all in method"*, which means that all raw materials are mixed at the beginning of the process. With this technology, since soda bicarbonate ($NaHCO_3$) is used, the dough does not ferment, and the dough is immediately baked. The purpose of this article is to determine the physical characteristics of crackers obtained by three different methods. Additionally, by means of sensory analysis, the best method for cracker production was selected.

EXPERIMENTAL

MATERIAL

The following raw materials were used to make the crackers: flour type 500 (Sofia Mel), Salt (Familex), Pressed yeast (Yuva), Soda - $NaHCO_3$ (Radicot), Margarine (Kaliakra) and water from the water supply network of Razgrad.

METHODS

Production of crackers

To obtain the sample 1 crackers, flour (100 g), yeast (2.5 g), salt (1.2 g), margarine (15 g) and water (32.5 mL) were mixed to form dough at 27 °C. The dough was then left to ferment for 16 h at 27 °C.

Flour (25 g) and margarine (12.5g) were mixed separately to obtain an oiled semi-finished product which was stored at 4 °C until used. After the fermentation time has elapsed, the dough was laminated in order to obtain the same thickness over its entire length and an oiled semi-finished product was placed on it. The dough was laminated twice. This was followed by the formation of crackers using a circular shape form (d=44mm). The formed crackers was baked at 180 °C for 12 minutes.

To obtain sample 2 crackers, flour (100 g), yeast (3 g), salt (1.5 g), margarine (20 g) and water (38.00 mL) were mixed to form dough at 27 °C. The dough was then allowed to ferment for 2 hours at 27 °C. The other operations were the same as for sample 1 crackers.

The third type of crackers (sample 3) were the so-called soda crackers. For their preparation flour (100 g), $NaHCO_3$ (0.6 g), salt (1 g), margarine (10 g), water (45 mL) and sugar (2 g) were mixed by the "all in" method. After the dough was created, it was laminated to obtain the same thickness. Round-shaped crackers were formed and baked at 180 °C for 30 minutes.

Analysis of the parameters during the technological process

The temperature of the dough before and after fermentation was determined using an automatic thermometer. The pH values before and after fermentation was determined using a LovibondMicrodirect manual pH meter. The losses obtained during fermentation were calculated using equation (1):

$$Fermentation\ losses = \frac{m_b - m_a}{m_b} \times 100\ [\%] \quad (1),$$

where:
m_b- mass of dough before fermentation (g) and
m_a- mass of dough after fermentation (g).

Physical characteristics

The thickness and diameter of the crackers obtained were determined using an automatic caliper (Power Fixprofi, electronic digital calliper). The volume was determined by the AACC 10-05 method [10]. The color of the crackers was determined using a Minolta Chroma Meter CR-400 (Konica Minolta, Tokyo, Japan) via the CIE *Lab* system. The change between the color of the dough and the baked crackers (ΔE) was determined by equation (2):

$$\Delta E = \sqrt{(L^* - L_0)^2 + (b^* - b_0)^2 + (a^* - a_0)^2} \quad (2),$$

where:
L_0, b_0, a_0 – raw dough color data;
L^*, b^*, a^* – baked crackers color data.

Sensory analysis

Sensory analysis was performed by 26 untrained assessors. Each sample was evaluated by parameters: color, texture, odor, taste and overall acceptance. Each parameter was rated with points from 1 to 6, where 1 - I do not like it at all and 6 - I like it a lot.

Statistical analysis

Analysis of variance (ANOVA) and Fisher`s Least Significant Difference test (LSD) at $p<0.05$ were performed with the software's XLSTAT 2017 (Addinsoft Inc., Long Island City, NY, USA) and Office Excel 2013 (Microsoft, Redmond, WA, USA).

RESULTS AND DISCUSSION

The dough for crackers should be at an average temperature of 25-26 °C and should be subjected to continuous fermentation at almost the same temperature [6]. Figure 1 shows the initial and post-fermentation test data from which the three types of crackers were obtained.

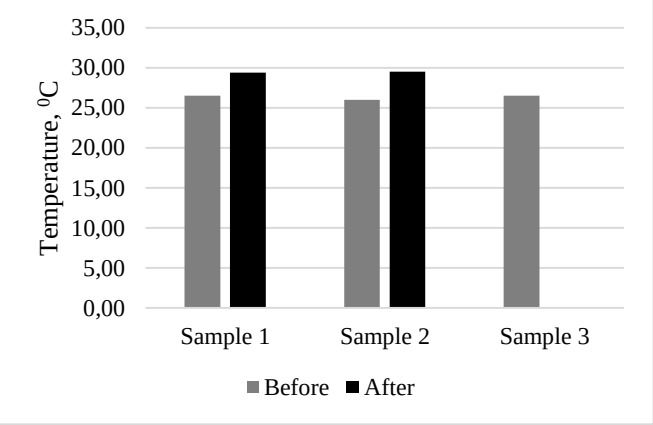

Figure 1. Dough temperature before and after fermentation

From the results presented in Figure 1, it can be seen that the dough temperature before fermentation is lower than that determined after fermentation. Because the crackers of sample 3 were not fermented, only the initial temperature was determined. The low temperature of the dough slows down the processes that take place during the fermentation of the dough, which leads to the prolongation of the final fermentation [11]. The ANOVA (not presented) highlighted

significant differences ($p < 0.05$) for pre- and post-fermentation temperatures.

The increase in temperature during fermentation depends primarily on the raising agent used. Most commonly, fermentation yeast *Saccharomyces cerevisiae* is used to prepare fermented dough. Bread yeast in the production of bread and bakery products has a dual role: it is responsible for increasing the volume of dough and helps to create the specific taste and aroma of the products. The taste and aroma depend mainly on the ingredients that are included in the recipe composition of the products (flour, yeast, sugar and salt) [12]. Baking soda crackers use baking soda bicarbonate ($NaHCO_3$). It is activated by heat when the crackers are baked.

During the fermentation of the dough there is an increase in its acidity (lower pH values), which contributes to the improvement of the shelf life, aroma, color and rheological properties of the products [13]. Figure 2 shows the pH values of the dough for crackers - before and after fermentation.

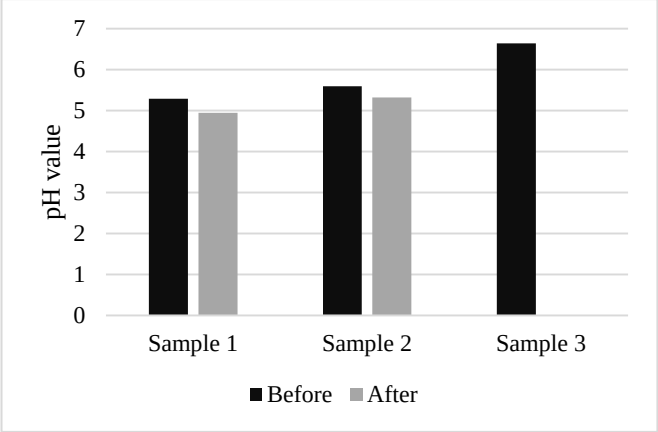

Figure 2. pH values of the dough before and after fermentation

The ANOVA (not presented) highlighted significant differences ($p < 0.05$) for pH value before and after fermentation of dough. The figure also shows that in the dough from which the crackers from sample 1 were obtained, the pH values decreased by 0.35, where as in the dough from which the crackers from sample 2 were obtained, the pH values decreased by 0.27. Of great importance is the duration of the fermentation of the dough. The sample cracker dough 1 fermented for 16 hours, while the sample cracker dough 2 fermented for 2 hours. In the first dough it is assumed that the alcoholic fermentation and the biochemical processes associated with the protein substances has proceeded completely, and in the second dough - partially.

As a result of the alcoholic fermentation, the carbon dioxide formed increases the proportion of the gas phase in the dough (the bubbles increase). As a result, the protein zippers tighten and the dough volume begins to increase. As a result of proteolysis, protein substances partially disaggregate and their solubility increases [11]. Enzymes break down some of the present starch and sugars. The acidity increases and affects the aroma of the baked crackers. The dough for the preparation of the classic oil crackers has an acidity of pH 6.0 [2].

During fermentation, the dough mass is reduced. The reason for this is that during fermentation in the dough, the gas phase increases and a porous structure is formed. Figure 3 shows the fermentation losses of the cracker dough.

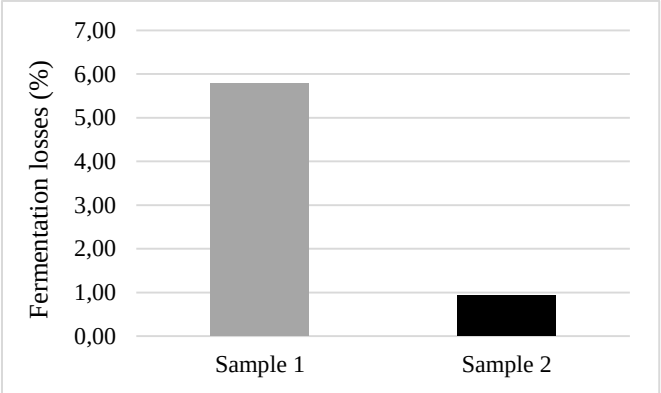

Figure 3. Fermentation losses

The ANOVA (not presented) highlighted significant differences ($p < 0.05$) in dough fermentation losses. The highest losses during fermentation were obtained with the sample 1 dough, which was allowed to ferment for 16 hours (5.79 %). In the test for the preparation of the sample 2 crackers, the fermentation losses were 0.92 %. During the process of maturing, the dough changes its structure, its physical properties and the content of aromatic substances. The dough is then suitable for forming and further processing. The matured dough should have: high intensity of gas formation; optimum physical formation properties; a sufficient quantity of finished and aromatic products, which determine the characteristic taste and aromatic properties of the crackers. These properties are acquired from the dough as a result of the simultaneous flow of various interrelated biochemical, colloidal and physical processes.

The biochemical processes occurring in the dough due to the activity of its microflora are fermentation and aerobic digestion of sugars. Alcohol fermentation accounts for the largest proportion of all fermentations in the dough. It is caused by the main microflora of the dough (yeast *Saccharomyces cerevisiae* of baker's yeast) [6].

Table 1. Physical properties of dough and crackers

	Thickness (mm)		Width (mm)		Volume (cm^3)
	Dough	Crackers	Dough	Crackers	Crackers
Sample 1	1.99 ± 0.04^b	1.40 ± 0.29^b	45.19 ± 0.08^a	40.53 ± 2.09^b	6.00 ± 0.70^a
Sample 2	4.78 ± 0.26^a	3.12 ± 0.24^a	42.35 ± 0.37^b	50.99 ± 3.42^a	7.00 ± 0.12^a
Sample 3	0.68 ± 0.20^c	3.69 ± 0.05^a	45.13 ± 0.01^a	37.81 ± 1.00^b	6.00 ± 0.02^a

Values are means SD ($n \geq 5$); values in the same row with different exponents have statistically significant differences ($p < 0.05$) following Fisher's LSD test.

The ANOVA (not presented) highlighted significant differences ($p < 0.05$) in thickness and width of dough. A decrease in the thickness of the crackers after baking is observed when using a biochemical method (pressed yeast) to swell the dough. Sample 1 crackers reduce their thickness by 0.59 mm and sample 2 crackers by 1.66 mm. On the other hand, crackers that use a chemical raising agent increase their thickness (become thicker) by 3.01 mm. One of the reasons for the increase in thickness could be the raising agent used. The chemical swelling mode is based on the ability of some compounds to decompose or interact with each other under the influence of heat, producing a large amount of gas [11]. During the heat treatment (baking), the diameter of the finished products was reduced. It can be seen from Table 1 that the diameter of the crackers of sample 1 decreases by 3.58 mm. Diameter reduction was also noticed for sample 3 crackers (7.3 mm). On the other hand, the diameter of the crackers of sample 2 increased by 10.64 mm. A round shape was used during the formation of the crackers. Due to the elasticity of the dough (sample 2), when forming the raw crackers, the latter lost their round shape. Data from the volume of crackers (Table 1) indicates that the crackers of sample 1 and 3 had a volume of 6.00 cm^3, while those of sample 2 had a volume of 7.00 cm^3. It is clear that the largest diameter crackers had the largest volume.

Table 2. Color determination

Dough	L^*	a^*	b^*	
Sample 1	75.48 ± 0.2^b	-6.92 ± 0.3^a	2.49 ± 0.1^b	
Sample 2	78.19 ± 0.4^a	-8.12 ± 0.5^a	4.52 ± 0.9^a	
Sample 3	71.66 ± 1.4^c	-8.46 ± 0.2^a	-4.93 ± 0.3^c	
Crackers	L^*	a^*	b^*	ΔE
Sample 1	71.90 ± 1.0^b	1.63 ± 0.2^a	24.58 ± 1.2^a	23.96
Sample 2	77.22 ± 0.1^a	3.51 ± 0.1^b	17.17 ± 1.3^b	17.21
Sample 3	69.31 ± 1.3^c	4.93 ± 0.6^b	15.64 ± 0.1^c	18.18

Values are means SD ($n \geq 5$); values in the same column with different superscripts are significantly different ($P < 0.05$) separately.

Table 2 presents the color data of the crackers through the CIE Lab model. The data presented in Table 2 shows that the values of parameter L^* decreased during baking and crackers became darker. The ANOVA (not presented) highlighted significant differences ($p < 0.05$) for L^* parameters of dough and crackers. Parameter values a^* decreased during baking for all samples and crackers turned red. An increase in values is also noticed for the parameter b^* after the heat treatment of the crackers. This parameter gives the yellow color of the crackers.

Due to browning caused by Maillard reaction, the dextrinisation of starch and caramelisation of sugars, significantly smaller colour differences have been noticed between dough and crackers, when compared with ΔE. These values between dough and crackers were considerably higher than 5, which is a colour difference value that observers could easily notice [14], [15].

The results of the sensory analysis performed are presented in Figure 4. Crackers from sample 1 had the best evaluation for all parameters tested.

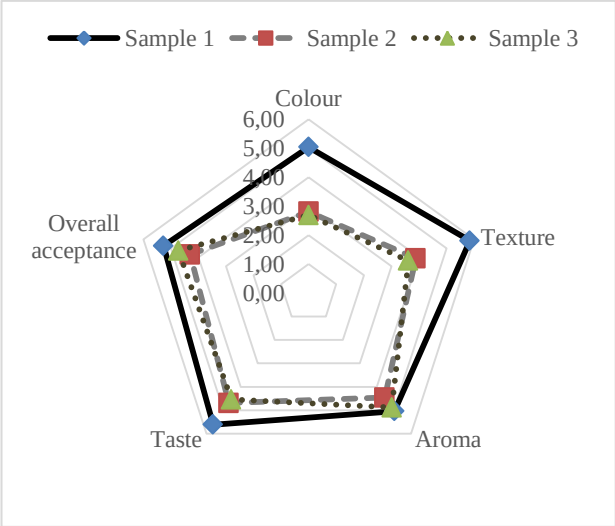

Figure 4. Sensory evaluation

At the end of the sensory analysis, we asked the cracker evaluators to choose one of the three types. 20 of them preferred sample 1 crackers, only 2 chose sample 2 crackers, and 4 preferred sample 3 crackers.

CONCLUSION

In the development of three different methods for making crackers, it has been shown that: the temperature during the fermentation of the dough increases and at the same time the pH value of the dough decreases (becomes more acidic); fermentation losses are greater with prolongation of fermentation time. From the crackers obtained, those of sample 2 have the largest thickness, diameter and volume. According to the color of the crackers it was found that there was a significant difference between the color of the dough and the crackers themselves. Sensory analysis revealed that sample 1 crackers were the most highly rated and preferred by the assessors.

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