

ІННОВАЦІЙНІ ПРОЦЕСИ ХАРЧОВИХ ВИРОБНИЦТВ

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KINETICS OF HEATING OF CAKE PRODUCTS WITH PUMPKIN SEEDS AND BUCKWHEAT FLOUR

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Abstract. *The use of non-traditional raw materials to give flour confectionery new consumer properties and to increase its nutritional and biological value enables a change of the rheological properties of dough semi-finished products and the need to adjust the technological parameters of the production. The purpose of the work is to study the influence of the use of non-traditional raw materials, in particular, pumpkin seeds and buckwheat flour on the kinetics of heating of cake products and to establish rational parameters for baking dough semi-finished products. The change in temperature of the samples during the heat treatment was measured by means of chromel-droplet thermocouples. To measure the temperature of different layers of dough semi-finished products, thermocouples were placed at different heights of the dough semi-finished product. The results of the study showed that the use of non-traditional raw materials (pumpkin seeds and buckwheat flour) causes a change in the kinetics of heating of dough semi-finished products. Therefore, this non-traditional raw material affects the processes that occur during the baking of semi-finished dough. A study of cake products with pumpkin seeds and buckwheat flour revealed that they need 3 minutes longer of baking time than products using traditional technology. At the same time, it might be useful to reduce the temperature in the working oven by 5°C to ensure better height formation of the products and to avoid their burning. Thus, a slight increase in baking time will not cause excessive energy consumption. Based on the obtained results, the recommended parameters for baking of cake products with pumpkin seeds and buckwheat flour are determined as the following: baking time – 28 minutes at 205 ... 210°C.*

Key words: *flour confectionery products, cake dough, pumpkin seeds, buckwheat flour, kinetics of heating, heat treatment.*

Problem statement. Enrichment of flour confectionery with non-traditional raw materials can significantly reduce the cost of traditional raw materials (wheat flour, butter, egg products) and give products new consumer properties, as well as increase the nutritional, biological value and functional peculiarity of their properties. Since the turn of the century, the issue of using a wide range of non-traditional raw materials in order to enrich flour confectionery products with biologically active components has become relevant. When introducing it to traditional technologies, it is necessary to take into account not only the role of individual prescription components that provide products with a certain structure, but also technological features of the process: intensity and duration of mechanical impact, baking conditions, etc. The difficulty of studying the baking process is that when the dough is heated, it undergoes a number of processes of different nature (physical, chemical, biochemical, microbiological, etc.), which have a quantitative and qualitative impact on each other. Thermal regimes for

baking products belonging to different groups differ significantly. The use of new unconventional raw materials can dramatically change them.

Recent research and literature review. Heat treatment of semi-finished cake dough products is the final stage of their production, which finishes the formation of organoleptic, physicochemical, structural and mechanical parameters. This stage determines the quality of the finished product [1]. The recipe of cakes, namely the use of non-traditional vegetable raw materials affects the processes that occur during heat treatment. Replacing traditional raw materials with new ones can lead to the change of temperature regime of baking semi-finished products and significantly affect the quality of baked cakes. A number of works by both domestic and foreign scientists are devoted to the study of this issue. For example, V.V. Dorokhovych and N.P. Lazorenko [1] studied the influence of gluten-free types of flour (rice, buckwheat, corn) on the kinetics of cake baking. The researchers found that the mechanism of

dough heating is similar to the mechanism of wheat flour heating. However, they note the difference in the duration of baking cupcakes on different types of flour. The results of research of foreign scientists [7] confirm that introduction of unconventional flour (in particular, red beans and rice flour) in technology of cake products also affects the process of baking.

N. Hesso, C. Loisel, S. Chevallier [8] studied the interaction between different components of cake dough using differential scanning analysis and X-ray diffraction of different model systems. The results showed that the model systems of ingredients can explain the various phenomena that occur during the baking of cupcakes. In case of the presence of sugar and fat in a limited aqueous system, starch gelatinization occurs in two stages, most of which are combined with denaturation of protein at high temperature. Scientists [3; 5; 9] studied the kinetics and dynamics of heat and mass transfer processes of cake baking and determined the optimal heat treatment conditions depending on the type of raw material and the weight of the dough. It was found that the process of baking a cake on fructose with the addition of lactulose intensifies by (6–7)% [2]. Research results of É.T. Campos, B.T. Cardoso and S.R. Ramos indicate an increase in the time of baking cakes with 20% replacement of wheat flour with lyophilized pumpkin (pulp and peel) and the addition of corn starch [6]. The results of the literature review show that the introduction of non-traditional vegetable raw materials to the technology of cake products should take into account changes not only physico-chemical processes of dough, but also the kinetics of heating of dough semi-finished products during baking.

The purpose of the article. The purpose of the article is to study the influence of the introduction of non-traditional raw materials, in particular, pumpkin seeds and buckwheat flour on the kinetics of heating cake cake and to establish rational parameters for baking dough semi-finished products.

Presentation of the main material of the study. The results of previous studies have shown the feasibility of introducing pumpkin seed cakes in the recipe. It is known that pumpkin seeds, depending on the variety contain up to 55% fat. The traditional recipe for cupcakes involves the use of butter as a fat component. Its fat is in the emulsified state, in contrast to the fat component of pumpkin seeds. Its replacement causes significant changes in the quality of cake products and requires adjustment of the manufacturing process. Based on the results of previous studies [4], samples were prepared by replacing 30% of wheat flour with pumpkin seeds and 7% of buckwheat flour with dry matter. It has been proved that the introduction of pumpkin seed and buckwheat flour cakes in the technology does not cause significant changes in the organoleptic properties of finished cake products. However, the rheological properties of the dough are

a little bit different. As a result, dough semi-finished products with unconventional raw materials are characterized by other properties of shaping during baking. There is a need to study the adequacy of heating the central layers of the product.

In order to determine the duration of baking cakes with non-traditional vegetable raw materials, a change of temperature of the central layers of the dough was studied. The change of temperature of the samples during the heat treatment was determined using chromel-droplet thermocouples. To record changes of temperature in different layers of dough, thermocouples were placed at different height of the dough semi-finished product. When studying the heating kinetics of the cake dough, the temperature in different layers of the dough with the interval $\lambda = 1 \times 60$ sec. was recorded in the experimental samples. The kinetics of heating of semi-finished dough according to the new technology was studied in comparison with semi-finished products made according to the traditional recipe of the cake “Stolychnyy” (Fig. 1).

The results of research showed that the required heating temperature (in the central part – 103 ... 104°C) traditional products reach after 25 minutes of baking. This time is considered as restrictive.

A study of cake products with pumpkin seeds (Fig. 2) as well as with pumpkin seeds and buckwheat flour (Fig. 3) showed that they require a slightly longer baking time. Probably, this is due to a change in the recipe composition of the dough, namely, the introduction of non-traditional vegetable raw materials.

Adding 30% of pumpkin seeds to the cake recipe slows down the temperature rise in the central part of the product. Even after 26 minutes of baking, the required temperature is not reached (Fig. 2), unlike during the baking of traditional products (Fig. 1). The temperature in the central part of the cake (curve № 3) for 24 minutes of baking is close to 100 °C. The required temperature value is provided only after 28 minutes of baking semi-finished products.

Comparing the baking of the central layers of the dough of the cake “Health” (Fig. 3), it should be noted that the curves in the nature of changes are quite similar to the cake “Emerald” (Fig. 2). The temperature while baking new products is lower by only 2...3°C compared to traditional ones. Nevertheless, it takes much longer to bake to reach the required temperature in the central layer of new products.

Conclusions of the study and prospects for further research. The results of the study showed that the introduction of non-traditional raw materials (pumpkin seeds and buckwheat flour) causes a change in the kinetics of heating of dough semi-finished products according to the new recipe. Therefore, this raw material affects the processes that occur during the baking of semi-finished dough. A study of cake products with pumpkin seeds and buckwheat flour

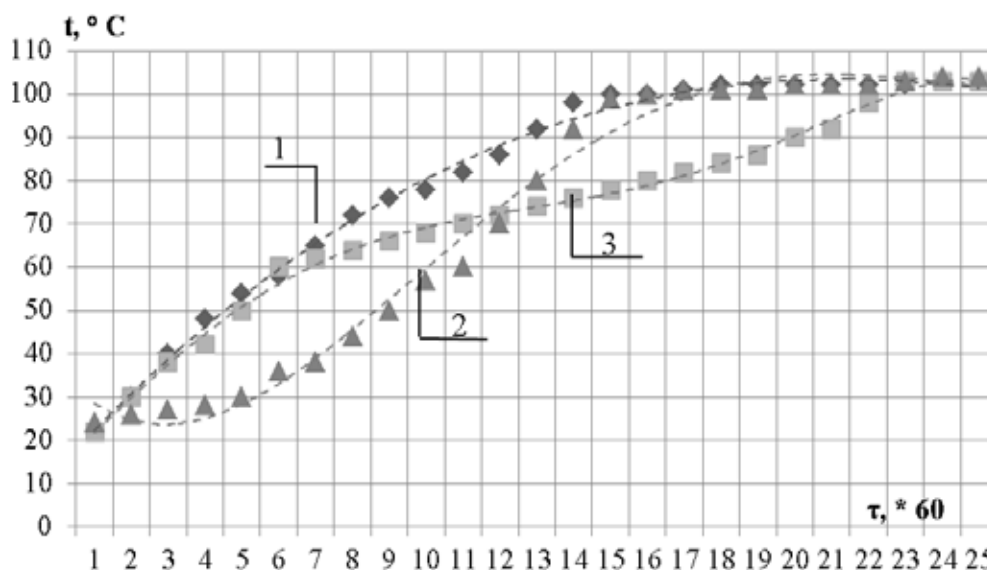


Figure 1. Kinetics of heating of semi-finished products according to the technology of cake “Stolychnyy” in layers:

1 – lower layer $h = 5 \text{ mm}$; 2 – middle layer $h = 15 \text{ mm}$; 3 – layer of the central part of the cake $h = 25 \text{ mm}$

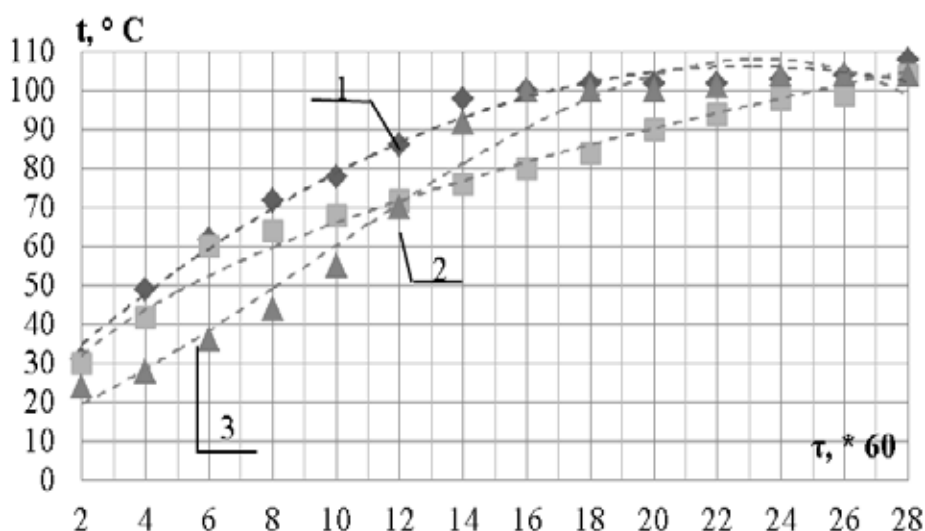


Figure 2. Kinetics of heating of semi-finished products according to the technology of cake “Emerald”

(cake with the replacement of 30% wheat flour with pumpkin seeds) in layers:

1 – lower layer $h = 5 \text{ mm}$; 2 – middle layer $h = 15 \text{ mm}$; 3 – layer of the central part of the cake $h = 25 \text{ mm}$

revealed that they need 3 minutes longer baking time than products using traditional technology. At the same time, it is advisable to reduce the temperature in the oven by 5°C to ensure better formation of the height of the products and to avoid their burning. Thus, a slight increase in baking time will not cause excessive energy consumption.

Based on the obtained results, the recommended parameters of baking cake products with pumpkin seeds and buckwheat flour are the following:

baking time – 28 minutes with the temperature of $205\dots 210^{\circ}\text{C}$.

The prospect of further research is a detailed study of the processes of redistribution of moisture in semi-finished products during heat treatment. Also, to explain the different phenomena that occur during the baking of cakes according to the non-traditional technology, it is advisable to study in detail the functional and technological properties of new raw ingredients.

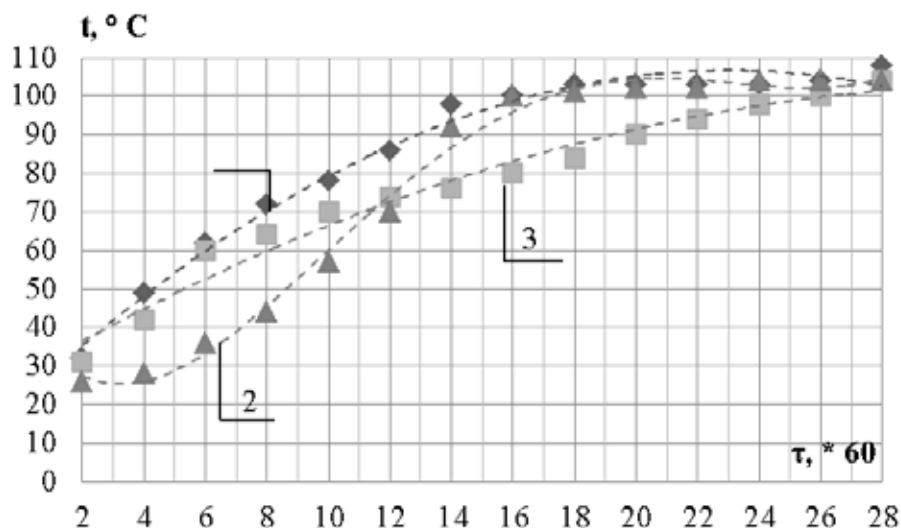


Figure 3. Kinetics of heating semi-finished products using the technology of the cake “Health” (cake with the replacement of 30% wheat flour with pumpkin seeds and 7% buckwheat flour with dry matter) in layers:

1 – lower layer $h = 5$ mm; 2 – middle layer $h = 15$ mm; 3 – layer of the central part of the cake $h = 25$ mm

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Анотація. Уведення нетрадиційних видів сировини для надання борошняним кондитерським виробам нових споживчих властивостей, підвищення їх харчової та біологічної цінності зумовлює зміну реологічних властивостей тістових напівфабрикатів і необхідність коригування технологічних параметрів їх виготовлення. Метою роботи є дослідження впливу введення нетрадиційної сировини, зокрема гарбузового насіння та гречаного борошна, на кінетику прогріву кексового тіста та встановлення раціональних параметрів випікання тістових напівфабрикатів. Зміну температури зразків у процесі термооброблення визначали за допомогою хромель-капельних термопар. Для вимірювання температури різних шарів тістових заготовок термопари розташовували на різній висоті тістового напівфабрикату. Отримані результати дослідження показали, що введення нетрадиційної сировини (гарбузового насіння та гречаного борошна) зумовлює зміну кінетики прогріву тістових напівфабрикатів. Отже, ця нетрадиційна сировина впливає на процеси, що відбуваються при випіканні тістових напівфабрикатів. У ході дослідження кексових виробів із гарбузовим насінням і гречаним борошном з'ясовано, що вони потребують на 3 хв довше часу випікання, ніж вироби за традиційною технологією. Встановлено доцільність зниження температури в робочому об'ємі шафи на 5°C для забезпечення більш якісного формування висоти виробів та уникнення підгоряння їх поверхні. Таким чином, незначне збільшення тривалості випікання не спричинятиме надмірні витрати електроенергії. Грунтуючись на отриманих результатах, встановлені рекомендовані параметри випікання кексових виробів із гарбузовим насінням і гречаним борошном: тривалість випікання – 28 хв за температури 205...210°C.

Ключові слова: борошняні кондитерські вироби, кексове тісто, гарбузове насіння, гречане борошно, кінетика прогріву, термооброблення.