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INFLUENCE OF ARTICHOKE POWDER ON MICROBIOLOGICAL AND BIOCHEMICAL PROCESSES IN THE DOUGH IN THE PROCESS OF MANUFACTURING BAKERY PRODUCTS

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ABSTRACT

Nowadays, there is a significant shortage of dietary fiber in human nutrition. Dietary fiber performs an important function — the excretion of harmful substances. This deficiency is especially relates the diet of people with diabetes. However, for this disease, products in the diet should have a low glycemic index. This problem can be solved by enriching traditional products, in particular bakery products, with nutrients that, along with increasing the nutritional value of products, will reduce their glycemic index. Such product is Jerusalem artichoke, the main part of the dietary fiber of which is inulin. However, due to the different chemical composition of Jerusalem artichoke and wheat flour as the basis of bakery products, it can be predicted that this raw material will affect the course of the technological process of manufacturing bakery products and the quality of finished products. Therefore, it was advisable to study the effect of Jerusalem artichoke on the main processes in the dough — microbiological and biochemical.

In the manufacture of bakery products in the diet of patients with diabetes various sugar substitutes are used to replace sugar. The study of the complex effect of the sugar substitute fructose and Jerusalem artichoke in the form of powder on the microbiological and biochemical processes in the dough during the manufacture of bakery products was provided.

Jerusalem artichoke powder contains 4 times more dietary fiber than premium wheat flour, and 77% of it is inulin, which significantly increases the nutritional value of products with fructose.

The intensity of dough fermentation in terms of the amount of carbon dioxide released during fermentation increased by 9—39.7% with increasing dosage of the additive, which indicated an improvement in the nutrition of yeast and caused their increased fermentation activity.

It was found that the addition of Jerusalem artichoke powder in the dough stimulated the fermentation activity of the microflora, which increased the accumulation of sugars in the dough during its fermentation and their fermentation by the dough microflora by 3—3.5%.

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ВПЛИВ ПОРОШКУ ТОПІНАМБУРУ НА МІКРОБІОЛОГІЧНІ ТА БІОХІМІЧНІ ПРОЦЕСИ В ТІСТІ ПРИ ВИГОТОВЛЕННІ ХЛІБОБУЛОЧНИХ ВИРОБІВ

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У наш час в харчуванні людей спостерігаються значний дефіцит харчових волокон. Харчові волокна виконують важливу функцію — виведення з організму шкідливих речовин. Особливо цей дефіцит стосується раціону осіб, хворих на цукровий діабет. Разом з тим при цій хворобі продукти в раціоні повинні мати низький показник глікемічності. Це питання можливо вирішити за рахунок збагачення основних продуктів харчування, зокрема хлібобулочних виробів, корисними речовинами, які поряд із підвищенням харчової цінності продуктів знижуватимуть їхній глікемічний індекс. Одним із таких продуктів є топінамбур, основну частину харчових волокон якого становить інулін. Однак, зважаючи на різний хімічний склад топінамбуру та борошна як основи хлібобулочних виробів, можна передбачити, що ця сировина впливатиме на хід технологічного процесу виготовлення хлібобулочних виробів та якість готових виробів. Тому доцільно провести дослідження впливу топінамбуру на основні процеси в тісті — мікробіологічні та біохімічні.

При виготовленні хлібобулочних виробів у харчуванні хворих на цукровий діабет для заміни цукру використовують різні цукрозамінники. У статті проведено дослідження комплексного впливу цукрозамінника фруктози та топінамбуру у вигляді порошку на мікробіологічні та біохімічні процеси в тісті в процесі виготовлення хлібобулочних виробів.

Порошок топінамбуру містить у 4 рази більше харчових волокон, ніж пшеничне борошно вищого сорту, причому 77% становить інулін, що значно підвищує харчову цінність виробів з фруктозою.

Інтенсивність бродіння тіста, зважаючи на кількість виділеного діоксиду вуглецю в процесі бродіння, підвищується на 9—39,7% зі збільшенням дозування добавки, що свідчить про покращення живлення дріжджів та зумовлює їх підвищену бродильну активність.

Встановлено, що додання порошку топінамбуру у тісто стимулює бродильну активність мікрофлори, що зумовлює збільшення накопичення цукрів у тісті під час його ферментації та їх зброджування мікрофлорою тіста на 3—3,5%.

Ключові слова: *хлібобулочний виріб, фруктоза, порошок топінамбуру, інтенсивність бродіння, кінетика цукрів.*

Formulation of the problem. Nowadays, there is a significant shortage of dietary fiber in human nutrition, which performs an important function — the excretion of harmful substances. This deficiency is especially takes part in the diet of people with

diabetes. In this case, products in the diet should have a low glycemic index. This problem can be solved by enriching traditional products, in particular bakery products, with nutrients that, along with increasing the nutritional value of products, will reduce their glycemic index. Such product is Jerusalem artichoke, which is based on inulin. However, it can be predicted that such raw material will affect the technological process of manufacturing bakery products. Therefore, it is advisable to study the action of Jerusalem artichoke on the main processes in the dough — microbiological and biochemical.

Analysis of recent research and publications. Jerusalem artichoke is a valuable raw material that contains up to 87% of inulin polysaccharide by weight of dry matter. Substances such as the enzymes β-fructofuranosidase, polyphenol oxidase (Lattanzio, Kroonb, Linsalatac & Cardinali, 2009), and mannose-specific lectin (Cardinali *et al*, 2011) are also available in it. Ir also contains vitamins, organic acids and dietary fiber. Inulin is easily broken down into fructose, the absorption of which requires less insulin than the absorption of glucose (Lattanzio, Caretto, Linsalata, Colella & Mita, 2018). Jerusalem artichoke has no local and general toxic and allergic effects (Barta & Pátkai, 2007).

Serbian scientists conducted studies on the effect of Jerusalem artichoke powder on the quality of wheat bread to obtain product of high nutritional value with a low glycemic index. There was an intensification of the technological process due to increased gas formation and intensification of other processes with its addition and high quality of finished products (Radovanovic, Milovanovic, Kipic, Ninkovic & Cupar, 2014).

The effect of Jerusalem artichoke on ozonated wheat flour products was studied. In the study of non-ozonated flour, along with increasing the biological value of bakery products, the additive significantly reduced the strength of flour and impaired the structural and mechanical quality of bread. The technology of bakery products with the use of Jerusalem artichoke powder and puree was substantiated. The combined use of ozonated flour and Jerusalem artichoke additives allowed to intensify the fermentation process of the dough, to improve the organoleptic quality of the products (taste and aroma), as well as to improve some structural and mechanical properties of bread (Сафонова, Холодова, Голота & Шуліка, 2012).

However, given the products for diabetics, in the recipe of which sugar is replaced by sugar substitutes, there is insufficient data on the effect of Jerusalem artichoke on the processes occurring in the dough during the production of bread.

That's why **the purpose of the research** was the research of complex influence of fructose and artichoke powder on microbiological and biochemical processes in the dough during manufacturing bakery products.

Materials and methods. Samples with high quality wheat flour, yeast, salt, and fructose were prepared for research. Fructose was dosed in an amount of 5% by weight of flour. As added ingredient there was artichoke powder (sort "Interes" TM "Malva", Ukraine, 3.5%, 5.3% and 7.0% by weight of flour — the amount which provides 20, 30, 40% of the daily requirement of food fiber when consuming 277 g of bread). A product without artichoke powder was used as a control sample.

Microbiological processes in the dough were determined by dynamics of gas formation and gas-holding capacity. Biochemical processes in the dough were determined by the kinetics of sugars during maturation of the dough.

The kinetics of sugar accumulation was determined by the accelerated iodometric method without hydrolysis in terms of maltose. Its content was established in yeast and non-yeast dough after mixing and after 1.5 and 3 hours of fermentation.

Gas-holding capacity was determined using equipment AG-1. The content of released CO_2 from the dough was evaluated every 30 min during 5 hours of fermentation.

The statistical processing of the result values was performed using the Microsoft Excel XP and Origin Pro8 software.

Results and discussion. When adding additives to the product, the determining factors of their influence on the technological process were their chemical composition. Therefore, first of all it was necessary to determine the chemical composition of the studied Jerusalem artichoke powder (Table 1).

Table 1. **Chemical composition of Jerusalem artichoke powder and premium wheat flour**

Components	Premium wheat flour	Jerusalem artichoke powder
Mass fraction of moisture, %	14.3	4.5
Mass fraction of protein (in dry matter), %	10.3	7.0
Mass fraction of fat, %	1.1	0.7
The content of dietary fiber, %	2.6	10.2

Comparing the chemical composition of Jerusalem artichoke powder and wheat flour, it can be concluded that the content of dietary fiber in the additive was much higher, which allowed to predict not only a significant impact on the process, but also increase the nutritional value of finished products, especially considering that most (77%) of dietary fiber was inulin.

The fermentation intensity of the dough was determined by the amount of carbon dioxide released during the maturation of the dough and keeping of the dough pieces (Table 2).

Table 2. **The amount of carbon dioxide released during fermentation and aging**

Sample	The amount of released CO_2, cm^3/100 g of flour
Control sample	1192
With artichoke powder, 3.5% by weight of flour	1312
With artichoke powder, 5.3% by weight of flour	1337
With artichoke powder, 7.0% by weight of flour	1564

It was found that with increasing dosage of Jerusalem artichoke powder the introduction of sugars and other water-soluble substances increased which were a nutrient medium for yeast, resulting in increasing the intensity of dough fermentation by 9—39.7%, which improved yeast nutrition and caused their increased fermentation activity.

Improving the fermentation activity of yeast affected the dynamics of carbon dioxide evolution during the fermentation of the dough and keeping of the dough pieces (Fig. 1).

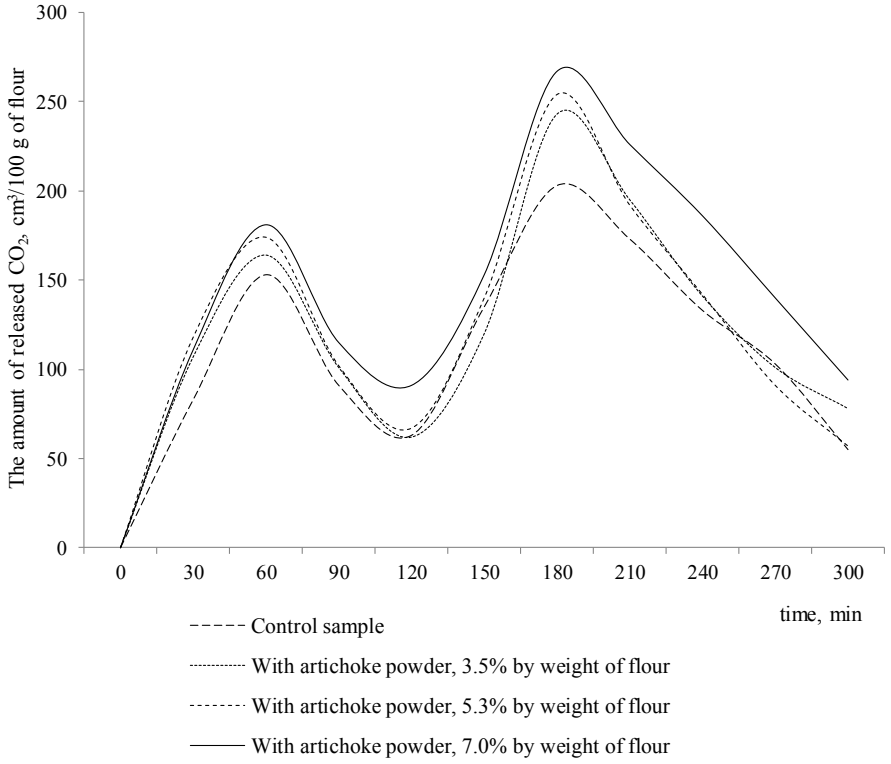

Fig. 1. Dynamics of carbon dioxide release in samples with Jerusalem artichoke powder, cm^3/h per 100 g of flour

The accumulation and fermentation of sugars in the dough is due to the activity of flour and yeast enzymes (Table 3).

Table 3. **Kinetics of sugars during fermentation of the dough**

Indicators	Control sample	Added artichoke powder, % by weight of flour		
		3.5	5.3	7.0
Yeast-free dough				
After mixing	7.30±0.1	8.10±0.1	8.30±0.1	8.60±0.1
After 3 hours of fermentation	9.40±0.1	10.27±0.1	10.68±0.1	11.22±0.1
Accumulated sugars	2.10±0.1	2.17±0.1	2.38±0.1	2.62±0.1
Yeast dough				
After mixing	7.60±0.1	8.20±0.1	8.40±0.1	8.66±0.1
After 3 hours of fermentation	6.30±0.1	6.94±0.1	7.04±0.1	7.39±0.1
Fermented sugars	3.40±0.1	3.43±0.1	3.74±0.1	3.89±0.1

The obtained data indicated that in the presence of powder the process of amylolysis was more intense than in the control sample. After 3 h of fermentation of the dough with additives, the accumulation of sugars was greater by 3.0—3.5%, which indicated

a positive effect on the enzyme complex of yeast and caused an increase in sugar-forming ability due to depolymerization of carbohydrate additives.

Conclusions

Jerusalem artichoke powder contains 4 times more dietary fiber than premium wheat flour, and 77% of it is inulin, which significantly increases the nutritional value of products with fructose.

It was established that the addition of artichoke powder to the dough stimulated the intensification of microbiological and biochemical processes in it during manufacturing bakery products.

The intensity of dough fermentation in terms of the amount of carbon dioxide released during fermentation increased by 9—39.7% with increasing dosage of the additive, which indicated an improvement in the nutrition of yeast and caused their increased fermentation activity.

Fermentation activity of the yeast microflora caused an increase in the accumulation and fermentation of sugars in the dough during its fermentation by 3—3.5%.

References

Сафонова О. М., Холодова О. А., Голота В. І. & Шуліка О.Ю. (2012). *Озонування борошна: Монографія.* Харків: ХДУХТ.

Barta J., Pátkai G. (2007). Chemical Composition and Storability of Jerusalem Artichoke Tubers, *Acta Alimentaria*, 36(2), 257—267.

Cardinali A., Tursi N., Ligorio A., Giuffrida M. G., Napolitano L., Caliandro R., Sergio L., Venere D. D., Lattanzio V., Sonnante G. (2011). Purification, biochemical characterization and cloning of a new cationic peroxidase isoenzyme from artichoke, *Plant Physiology and Biochemistry*, 49(4), 395—403.

Lattanzio V., Kroonb P. A., Linsalatac V., Cardinali A. (2009). Globe artichoke: A functional food and source of nutraceutical ingredients, *Journal of Functional Foods*, 1(2), 131—144.

Lattanzio V., Caretto S., Linsalata V., Colella G., Mita G. (2018). Signal transduction in artichoke [*Cynara cardunculus L. subsp. scolymus (L.) Hayek*] callus and cell suspension cultures under nutritional stress, *Plant Physiology and Biochemistry*, 127, 97—103.

Radovanovic A. M., Milovanovic O. Z., Kipic M. Z., Ninkovic M. B., Cupar S. M. (2014). Chracterization of Bread Enriched with Jerusalem Artichoke Powder Content, *Journal of Food and Nutrition Research*, 2(12), 895—898.