CITRATES OF METALS IN TECHNOLOGY OF DIABETIC BAKEGOODS

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Abstract: Enrichment of bakegoods with mineral elements is a vital task of our time, as they contribute health improvement.

In diabetic diet therapy are recommended products, which together with a low glycemic index, enriched with zinc, magnesium, calcium, iron, selenium, iodine.

As the functional ingredients for enrichment it is advisable to use citrates of macro- and microelements received via nanotechnological methods.

Changing sugar to fructose in bakedgoods and addition of zinc, magnesium, calcium, iron citrates (singly or in combination) in an amount providing 50% of the daily requirement causes improving yeast activity, intensifying fermentation of dough products, increasing sugar accumulation and fermentation during dough maturation process. Test citrates improve the flour elasticity and resilience resulting in dough elasticity improvement and slightly increase dough dilution. It has a positive effect on the bread porosity and volume development.

Therefore, the studied citrates are effective additives for the diabetic bakegoods enrichment with mineral elements.

Keywords: citrates of metals, technology, diabetic bakegoods, enrichment, mineral element, dough, bred.

INTRODUCTION

Health benefits of bakegoods is determined by their content in vitamins and minerals, along with proteins and carbohydrates content.

Minerals are involved in biological processes occurring in the body, have their specific activity, and can be considered as genuine bio-elements with a variety of functions [1-5].

Like vitamins, they function as coenzymes.

Bakegoods are a source of essential mineral elements such as calcium, phosphorus, magnesium, zinc, iron and others, but they are not enough to supply the physiological needs of a human, that determines the necessity of enrichment with minerals both staple food and health food. For example, mineral deficiency in the body is considered as one of the risk factors for diabetes [6].

According to the Committee of Experts of WHO, diabetics need food with a low glycemic index, containing ingredients that increase the immunodefence.

The concept of creation these products involves changing their chemical composition by adding ingredients in the food recipes that can correct the complex of metabolic disorders in the patient body. Such ingredients include microelements. They are zinc, calcium, magnesium, iron, selenium, iodine. It is determined that zinc is a part of insulin, that stabilizes its structure, and is a component of several enzymes promoting decrease of blood glucose. Zinc is essential for the synthesis of pancreatic enzymes. Researches has shown that diabetics have reduced level of zinc in the blood. Zinc deficiency reduces cell sensitivity to insulin. Replenishing the body with zinc helps to stabilize the immune system. The daily requirement for zinc - 15 mg.

Magnesium takes part in the functioning of over 300 enzymes, cell permeability regulation, glucose metabolism. protein synthesis, nutrients transportation; increases stress resistance. The daily nutrient requirement for magnesium - 400 mg.

Calcium, along with participation in the formation of bones and teeth, activates enzymes involved in the formation of neurotransmitters, takes part in the nutrients transportation through the cell membrane. Calcium is essential for strengthening the immune system, many hormones synthesis. The daily requirement for calcium – 1000-1200 mg.

Iron is involved in the formation of hemoglobin and some enzymes, directly participates in the transport of oxygen to all tissues of the organism, stimulates blood-forming, plays an important role in immune function. The daily human requirement in the iron - 15 mg [6].

At the present time, for food enrichment with macro- and microelements are used inorganic acid salts of these elements - carbonates, sulfates, phosphates; rarer organic - lactates, citrates.

Inorganic acid salts have a low bioavailability, assimilate badly by the organism, in a specific amount can be toxic.

Perspective is the use of organic compounds of, mineral elements, in such form as they function in the body.

With the development of nanotechnology was developed technology of obtaining food acids carboxylates, particularly citrates of biogenic metals. These compounds are completely safe to the body and can be used for foodstuffs enrichment, including diabetics food [7,8].

The diabetic bakegoods technology, along with sugar substitutes such as sorbitol, xylitol, lactitol, fructose monosaccharide is used.

Study [9] found that by replacing white sugar with fructose reduces the intensity of dough fermentation, increases the duration of the proofing, relaxes the dough consistency. Bakegoods with fructose inferior slightly in quality to products with sugar.

Numerous studies have shown that the chemical composition recipe changing due to the inclusion of a physiologically functional ingredients influence on the technological properties of dough products and bakegoods quality.

Can assume that the diabetic products enrichment (bakegoods with fructose) with citrates of metals will change the course of manufacture processes and products quality.

METHODS OF EXPERIMENT

The aim of our study was to investigate the effect of zinc, magnesium, calcium, iron citrates, and their mixtures to the processes of dough maturation and the quality of bakegoods that contain fructose.

In conducting research used citrates of metals received via nanotechnology.

The dough was prepared from wheat flour by straight dough procedure with the pouring fructose of 6% by weight of flour. Citrates were added in quantity providing 50% of their daily requirement on condition of the consumption 277 g of bakegoods (the rate implicit in the "consumer basket", approved by the Cabinet of Ministers of Ukraine).Served as control the sample containing 6% of white sugar, without the addition of citrates.

RESULTS AND DISCUSSION

It was found (Fig. 1), that by replacing white sugar with fructose reduces the intensity of the dough fermentation, which was characterized by the amount of allocated carbon dioxide, due to the peculiarities of the yeast enzyme complex in fructose fermentation.

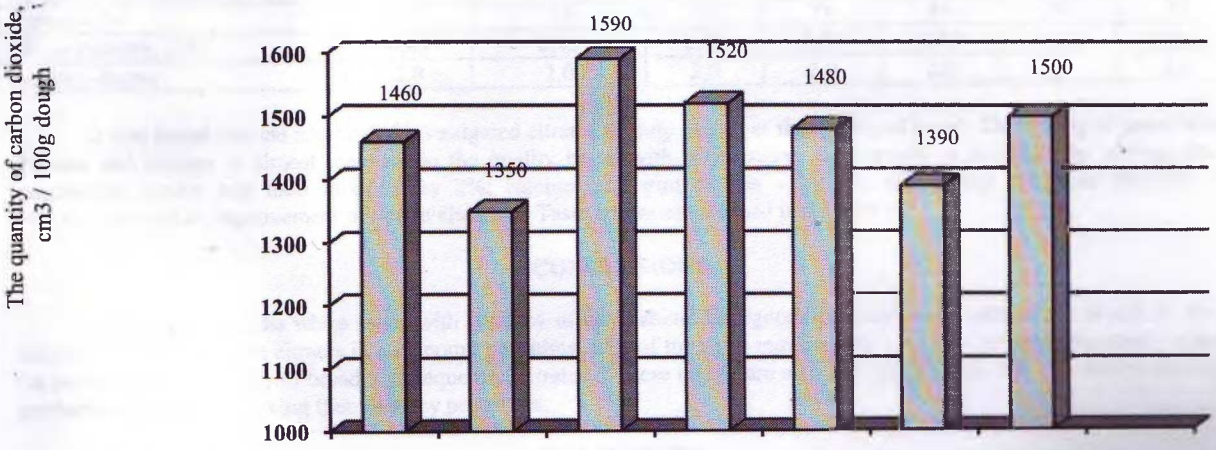

Fig. 1. Total carbon dioxide generation during the period of fermentation and dough maturation: *1 - control sample; 2 - with fructose; 3 - with zinc citrate; 4 - with magnesium citrate; 5 - with calcium citrate; 6 - with iron citrate; 7 - with a mixture of citrates.*

The samples with citrates compared to the sample with only fructose observed more intensive fermentation. Thus, in the sample with zinc citrate the amount of carbon dioxide has increased by 17%, magnesium - 11, calcium - 8 iron - 2. and in the sample with a mixture of citrates - 9.5%, which was close to or higher than that of control sample.

The most positive effect on the fermentation process has a zinc citrate, the smallest - iron citrate. These data correlate with the improvement of zymaze and maltase yeast activity in the presence of investigated citrates of metals (Table 1).

Table 1- Zymaze and maltase yeast activity

Parameters	Control sample	With fructose	With fructose and citrates				
			Zn	Mg	Ca	Fe	mix
Zymaze activity, min	37	42	32	30	35	40	34
Мальтазная activity, min	58	62	51	52	49	59	53

It obviously due to the ability of investigated metal ions to increase the activity of enzymes – fructose permease and maltose permease - which transport fructose and maltose in yeast cells, where by the action of enzymes fructose isomerized to glucose, maltose splits into two glucose. That causes the increase of the yeast fermentation activity and the dough fermentation intensification.

Studies of the citrates effect on sugars accumulation in the fermentation of dough maturation process showed that in presence of citrates in the dough increases the accumulation of sugars, in a greater extent in the presence of zinc and magnesium citrate. This, obviously, related with activation of amylolytic flour enzymes. This increases the amount of fermented sugars, which correlates with the data of carbon dioxide formation in the dough with citrates of metals.

Effects of the mixtures on the structural and mechanical properties of the dough was determined by farinograph. The amount and quality of gluten wash out from this dough was examined.

Was established (Table 2), that investigated microelements do not affect the water absorption dough capacity, several improve its flexibility and increase dough dilution.

Table 2-Rheological properties of the dough by farinograph test

Parameters	Control sample	With fructose	With fructose and citrates				
			Zn	Mg	Ca	Fe	mix
Baking absorption, %	58,6	57,9	57,4	58,2	58,4	58,0	58,3
Doughing-up time, min	2,0	2,0	2,0	2,0	2,0	2,0	2,0
Elasticity (dough resilience), FU	86	88	95	95	92	90	94
Dough dilution, FU	66	70	75	73	72	68	72

Adding of citrates does not affect the amount of wash out dough gluten. However, due to the redox process improves its elasticity and resilience that has a positive effect on the volume and porosity formation of the finished products (Table 3).

Table 3-Influence of single citrates and their mixtures on product quality

Parameters	Control sample	With fructose	With fructose and citrates				
			Zn	Mg	Ca	Fe	mix
Specific loaf volume, sm^3/g	3,12	2,98	3,16	3,14	3,04	3,02	3,13
Porosity, %	74	73	75	75	74	74	74
Shape stability, H/D	0,43	0,43	0,42	0,43	0,43	0,42	0,43
Acidity, degree	2,0	2,0	2,0	2,0	2,0	2,0	2,0

It was found that the addition of investigated citrates slightly improves the quality of bread. The quality of bread with fructose and citrates is almost identical to the quality bread with white sugar. Its porosity is increased by adding zinc, magnesium citrates and their mixtures by 2%; calcium and iron citrates – by 1%, due to the increased intensity of fermentation and an improvement of dough elasticity. Taste and smell of bread is not changed.

CONCLUSIONS

When replacing the white sugar with fructose in the diabetic bakegoods production and add in the dough in zinc, magnesium, calcium, iron citrates in an amount providing 50% of the daily requirement, and their mixtures positively affect the process and the quality of bread. Consequently, citrates of these metals are effective additives for the enrichment diabetic products with minerals, giving them healthy properties.

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