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CALCIUM – PHYTIC ACID INTERACTION IN BREAD SUPPLEMENTED WITH CALCIUM.

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Scientific studies in the field of food technologies are related with creation of "healthy" food products. Such products should contain components showing specific physiological activity that completes their sensorial and nourishing properties. These products were named "functional physiologically".

As for bread, the main product in the human's nutrition, it's important supplementing with mineral substances, in special with calcium, as the most deficient mineral substance of food products for mass consumption [1].

Calcium is not only the most important mineral in human organism, it is necessary for proceeding (or taking place) of many enzymatic processes in neuromuscular excitability and transmission of neural impulses. Calcium also plays a predominant role in osteoporosis and hypertension prevention [2].

Deficit of calcium in nutrition comes from both insufficiencies of this mineral in food and from violations in absorption of this mineral in human body. The amount of calcium which is being absorbed depends on its contain in alimentary ration, physiologic factors (age, various diseases, drug substances, alcohol abuse) and also depends on chemical composition of alimentary products and their reactivity [3].

Fortification of food products with salts of calcium aims not only enlargement of calcium contain but it's bioavailability too, which can be characterized as ability of calcium to provide bone mineralization [3].

Bioavailability of calcium depends on combined effects of all components available in food regiment. So some components may increase the degree of calcium absorption (proteins, lactose and cholecalciferol), the others decrease calcium absorption in intestines by formation of insoluble complexes (phosphates, oxalates and phytates) [4, 5].

In this context, elaboration of process of bread fortification needs to study the interrelation of food components and supplements during baking process and in final product.

In the work the efficacy of supplementation process of bread products with the salts of calcium and evolution of fermentation process of supplemented dough was studied. The criterion of efficacy of supplementation process was containing of soluble calcium in the product. Evolution of fermentation process of dough was analyzed by general contain of accumulated ethyl alcohol.

Materials and methods

The subject for supplementation was wheaten flour produced local, which corresponds to state standards (GOST – 26574-85). The supplement was solution of calcium chloride (1 g of $CaCl_2$ in 10 ml of water), which was introduced in dough in necessary proportion [6].

Contain of soluble calcium was determined by complexonometric method with the help of trilon B in presence of murexide. Evolution of fermentation process of dough was studied by general contain of accumulated ethyl alcohol. [7] Contain of phytates expressed by phytic acid was determined by photocolourimetric method. [8] All the experiments were performed in triplex.

Results and discussions

Nutritive value of food products depends both on their chemical composition and on applied technological processing. Supplementation of wheaten flour with the salts of calcium, procedure applied in the USA, Great Britain and other countries, is little efficient because during the baking process calcium forms helate-type complexes with phytic acid (mioinozitol hexaphosphoric) which can be found in wheaten flour in impressing amounts [8]. They are insoluble in alimentary tract, so calcium absorption is greatly reduced. So when in ionic form or in form of soluble complexes with some small molecules (soluble calcium) calcium is

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available for gastrointestinal digestion. During the process of dough fermentation phytic acid is supposed to progressive dephosphorilation under influence of enzyme – phytaza, which is present in wheaten flour. Optimal phytazic activity develops at pH ~ 5,0 and t ~ 50ºC. On the contrary insoluble phytates of calcium are not disposable for enzymatic hydrolysis. That's why ionic calcium incorporation should be done only after a part of natural phytates were dephosphorilated, because some products of hydrolysis (inozitol tri-, di- and monophosphate) do not form insoluble helates with cationes of metals, which are able to penetrate gastrointestinal barrier. [8].

Studies of the grade of calcium disposability in wheaten flour have demonstrated that almost all the calcium is insoluble. One mmol of phytic acid is able to fix about 6 mmol of calcium [8] that's why, it is obvious, that in wheaten flour, where molar correlation calcium / phytic acid varies between 1,1 and 1,5 (tab.1) all the calcium is not disposable. This fact contradicts to widespread opinion that mineral bioavailability is higher in products made from highest quality flour: with the growth of the degree of flour extraction molar correlation calcium / phytic acid varies insignificantly. Growth of disposability of calcium during the baking process doesn't take place because calcium phytates are not supposed to enzymatic hydrolysis.

Table 1. Contain of Minerals and phytic acid in wheaten flour

Flour quality	Flour constituents, mg %				υ (Ca) / υ (phytic acid)
	Ca	Mg	P total	Phytic acid	
Highest	21,6	40,5	91,3	324	1,1
I	27,6	51,3	98,8	348	1,3
II	53,6	82,6	111,3	395	1,5

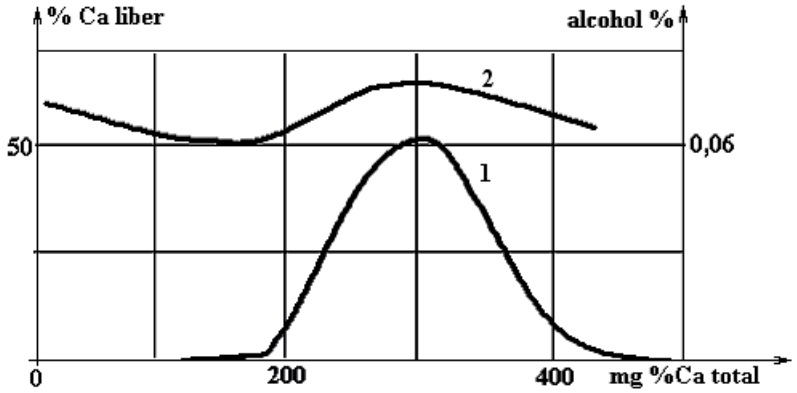
Taking into consideration that fortification of food products with calcium aims growth of its bioavailability evolution of containing of soluble calcium during the process of baking was studied by monophasic method, which consists in simultaneous intermix of all the ingredients and by biphasic method (leaven phase and dough phase). In the second case supplement is incorporated not in leaven but in dough.

It was established that in case of incorporation of the supplement at the first phase (monophasic method) contain of soluble calcium decreases quickly. So 75% of calcium introduced into dough becomes insoluble during the first 1,5 hours (tab.2). Then the amount of soluble calcium remains constant.

Table 2. Evolution of amount of soluble calcium during the dough fermentation

Baking phase	Soluble calcium, mg %						
	Contact duration, hours						
	0	0,5	1,0	1,5	2,0	2,5	3,0
I. Monophasic method	200	120	104	45	44	44	45
II. Biphasic method	–	–	200	80	100	105	110

Supplement - $CaCl_2$, 200mg%.



Evolutions of contain of soluble calcium (% in correlation with total calcium) (1) and of total contain of accumulated alcohol during dough fermentation in dependence on supplement concentration (2).

Introduction of the supplement at the beginning of the second phase, after the leaven fermentation also shows a significant decrease of contain of soluble calcium during the first hour but then a positive balance of soluble calcium is observed (tab.2). This fact is connected with development of an important phytazic activity during the first phase under the combined influence of phytaze, which is present in flour and in yeast used in baking.

Phytazic activity correlates directly with intensification of fermentation process, which can be evaluated by total contain of ethyl alcohol accumulated during the dough fermentation [6].

It was established that maximum of alcohol accumulation, what shows an important phytazic activity, is the main factor for calcium disposability (figure.).

The amount of supplement is also essential. At high concentrations (400 mg % of $CaCl_2$) suppression of fermentation process, which is associated with decrease of contain of accumulated alcohol and percent of calcium disposable for gastrointestinal digestion, takes place.

Conclusions:

– Performed studies have demonstrated that all the calcium available in wheaten flour with different degree of extraction is not disposable for gastrointestinal absorption, due to their existence in the insoluble phytates form.

– Supplementation of bread products in case of dough processing by monophasic method is not efficient, because in this case about 75% of introduced calcium are in transaction into helate form by phytates presented in flour, which lately are not supposed to enzymatic hydrolysis.

– Fortification of bread, prepared by biphasic method, at the beginning of the second phase allows developing an important phytazic activity during the first phase, what involves partial dephosphorisation of natural phytates and growth of amount of soluble calcium in the final product.

– Amount of introduced supplement influences essential at the fermentation process evolution (biphasic method) so at high concentrations of supplement suppression of fermentation process takes place, what influences the quality of final product.

– A correlation between the intensity of dough fermentation process, degree of calcium disposability and amount of introduced supplement exists.

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Summary

The process of fortification of wheaten bread with calcium salts was studied. The effect of interaction between phytic acid, containing in flour and calcium salts, introduced into the samples for fortification, on the amount of bioavailability calcium in the final product was analyzed. Calcium salts form insoluble complexes with phytic acid, which are not disposable for gastrointestinal digestion. During the fermentation process phytic acid is being dephosphorilazed under the action of phytaza and lowers its ability to form insoluble complexes with calcium. So, calcium introduced into the dough during the second phase of fermentation process becomes bioavaliable. Phytazic activity correlates directly with intensification of fermentation process and the main factor showing calcium bioavailability is the total contains of ethyl alcohol. The amount of supplied calcium influences significantly on the evolution of dough fermentation. At high concentrations of supplement suppression of fermentation process takes place, what affects the quality of final product. There is a strict correlation between intensity of dough fermentation process, degree of calcium bioavailability, the amount of introduced supplement and the moment of its introduction.