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WATER PHASE CONDITION IN THE BUTTER PASTE WITH RED BEET POWDER

***Oksana PODKOVKO[1], Tamara RASHEVSKAYA[1]**

[1]The National University of Food Technologies, Kyiv, Ukraine
oa_podkovko@mail.ru
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Abstract. *The technology of butter paste with red beet powder based on butter with addition of dry skimmed milk, flaxseeds and inulin is developed. The quantity of the plant food additives in the ready product is the following: red beet powder – 0.80 %, inulin – 1.50 %, flaxseeds – 2.90 %.The condition of water phase in the fresh product was investigated for the indicators: dispersion of plasma and forms of moisture connection. Dispersion was determined by computing the drops of moisture under the MICROmed XS-2610 microscope. The article concludes that the addition of red beet crio-powder, flaxseeds, inulin with simultaneously mechanical processing generates dispersion of moisture in the butter paste with the increasing of droplets with the diameter of 1...5 microns. The main forms of moisture connection research were conducted by the thermogravimetry method using a Pauli-Erdene Q-1500 D derivatograph system. These results suggest that the selected complex of plant food additives leads to the increasing of the amount of monomolecular and polymolecular firmly bound moisture.*

Key words: *butter paste, plant food additives, dispersion of plasma, forms of moisture connection.*

1. Introduction.

Nutrition plays an important role in everyday life. The components of food provide the body with vitamins, minerals, dietary fibers, polyunsaturated fatty acids, which in their turn determine the state of health, support the immunity, physical and mental efficiency. Considering this, it is important and appropriate to develop and improve food technologies that will correspond to the status of health, prophylactic and functional purpose. An assortment of butter with functional properties containing pectin and inulin polysaccharides, red beet, black currant and carrot plant criopowders, artichoke and flaxseeds was developed in the National University of Food Technologies (NUFT) led by prof. Rashevskaya T. Tests on butter with pectin, inulin, red beet powder and black currant buds were conducted in the clinics within the Institute of Ecological Hygiene and Toxicology M.I. Medvedya and in the Institute of Microbiology and Virology National Academy of Sciences biomedical and accordingly, the Ukraine Health Ministry drew some conclusions on the use of this assortment for health, prophylactic and dietary nutrition [1].

It is important nowadays to develop and produce moderate calorie foods with simultaneously increase of the biological value and dietary properties. The reducing of energy value of butter can be achieved by correcting its composition and correlating its components. The continuation of the work in this direction with these requirements has limitations, since the content of milk fat in butter should be at least 51.00 %; it is not recommended to use non-dairy ingredients,

since the traditional color of the product is preferred. Therefore, it is appropriate to create a new group of moderate calorie products with typical consumer characteristics for the traditional composition of butter. In such groups butter paste could be included – dairy product with fat emulsion base of fat mass fraction of 39...49 % that is produced from cow's milk, dairy products and (or) milk processing byproducts using stabilizers, but not substitutes of milk component parts by nondairy components or without them. The composition and technologies of butter paste with honey, cocoa, chicory, fruit and berry, vegetable and fungal additives, spices, herbs were science-based in the All-Russian Research Institute of dairy and cheese manufacturing by Vishemirskii F. [2,3]. Chocolate butter paste "For tea" is produced in Belarus with fat mass fraction of 40.00 % and consists of butter, drinking water, sugar, dry skimmed milk, cocoa powder, stabilizers, iodized salt, potassium sorbate and citric acid. The disadvantage of the above assortment is that these additives do not have functional properties. Preference is given to the use of food additives made from plant raw materials, which are a source of biologically active substances. Butter paste assortment with the complex of biologically active substances, containing honey, carrot powder, micronutrients, viburnum syrup, on antidiabetic purpose, was developed by the young scientists in NUFT led by prof. Rashevsky T.[4]. The use of inulin and flaxseed into the composition was the common basis for these types of products, which are technological and have functional properties [5-7]. Recently, red beet has attracted the attention of medical and food industries. It is rich in anthocyanin coloring agents (betaine and betanin), catechins, flavonoid glycosides, vitamins and minerals that help strengthen capillaries and blood vessels, increase the hemoglobin content and the amount of red blood cells, reduce blood pressure, prevent cancer, reduce cholesterol blood, enhance detoxification, toxins, salts of heavy metals and radionuclides from the body[8]. In this direction, we have developed the technology of red beet powder butter paste with fat mass fraction of 42.00 % based on butter with addition of dry skimmed milk. Into the milk-based plant product, red beet crio-powder, flaxseeds and inulin were added. Plant additives were used as suspension in buttermilk. The method of producing red beet powder butter paste was awarded the Ukraine patent for invention [9].

In previous studies it was found out that red beet crio-powder, flaxseeds and inulin influenced the quality indicators of butter paste. The selected complex of plant additives improves heat resistance of the ready product, the structure ability to keep the liquid phase of fat, promotes its plasticizing and forms the structure with optimal ratio of coagulation and crystallization connections [10,11]. The butter paste is characterized by high moisture content (47.00 %), which is why the water phase state, dispersion of plasma, forms of moisture connection with the components plays an important role in providing the quality of the ready product. It is acknowledged that the addition of crio-powders and polysaccharides changes the ratio of forms of moisture connection, the amount of strongly bound absorption moisture and dispersion of moisture on the micro- and nanoscale increases, the number of drops with the diameter higher than 5 microns is reduced, coalescence of droplets during storage is broken [6, 12, 13]. According to the above information, the aim of this work is to analyze the impact of red beet crio-powder, flaxseeds

and inulin on the state of water phase in butter paste.

2. Materials and methods.

The objects of the study were samples of fresh butter paste with red beet powder and butter with fat mass fraction of 63.00 % as a control. The determination of dispersion of plasma product was performed by counting the drops of water under a microscope. By applying a piece of the sample with help of a metal needle with size less than 1 mm microscopic pattern were prepared, carefully covered by cover slip, set a 100 g weight and left for 5 min at 20 ^{0}C. The prepared patterns were studied under a microscope MICROmed XS-2610 with lighting "on the passage". At least five most typical fields and the scale line of the object-micrometer were photographed to calculate dispersion. According to the obtained images size of droplets of plasma, fractions were determined and shared: (1...2) mm, (3...4) mm, (5...6) mm, (7...8) mm, (9…10) mm. The content of each droplets fraction and the average diameter in the samples were determined as well. The analysis of bond moisture forms was made by the method of thermogravimetry, which allows the determining of temperature of the sample, its mass change, rate of mass change and enthalpy change simultaneously. Curves were reflected on the derivatograph Pauli-Erdene Q-1500 D system with speed increasing temperature 5^{0}C/min. The weight of the samples was of (150...200) mg. Tape speed was 2mm/min. Simultaneous getting of derivatograph curves – differential thermal analysis (DTA), thermogravimetric (TG), differential-thermogravimetric (DTG) and temperature (T) of moisture removal allows the determination of the chemical and physical transformations in the studied samples and conduct of qualitative and quantitative assessment of these changes. According to the obtained derivatogram curves, the temperature peaks and intervals of the removal with different types of connection were determined. According to (TG) curve the number of removed moisture in percent was determined. Classification of bond forms was moisture held by Rehbinder P., who identified three groups: chemical, physico-chemical and physico-mechanical [14].

3. Results and discussion.

The dispersion of plasma product affects the stability of the ready product by microbial and oxidative deterioration. The research results are presented in Fig. 1.

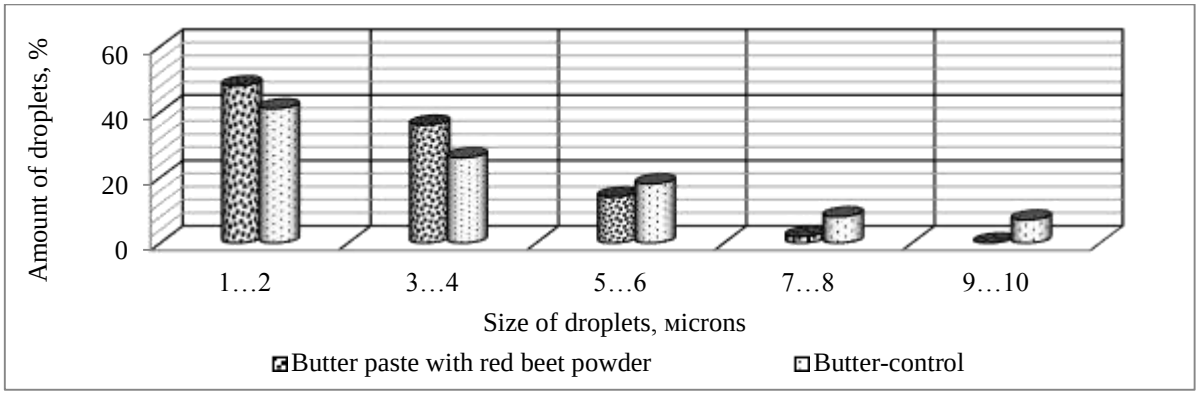

Fig. 1. Dispersion of butter paste with red beet powder plasma and butter-control

According to the obtained results the amount of drops of plasma with diameter (1...2) microns is of 48 % in fresh butter paste and of 41 % in butter-control, respectively. Moisture droplets with diameter (9...10) microns in the paste are not available, however in the control there are 7 %. In our opinion, the dispersion of plasma droplets in the butter paste occurs due to the addition of red beet criopowder, flaxseeds and inulin together with simultaneous homogenization process during the addition of supplements into the product composition. In previous studies it has been established that red beet criopowder, flaxseeds and inulin are characterized by the ability to connect free moisture and to swell [6,15,16]. Due to such properties of plant additives and simultaneous use of mechanical processing of mixing, the presence of a higher number of plasma droplets with diameter (1...5) microns was caused, increasing the stability of the ready product to oxidation and microbial deterioration.

Food products are systems in which moisture has different forms of connection with the hard skeleton. We can identify them, using the method of thermogravimetry. The deryvatohramies of the butter paste with red beet powder and butter-control are shown in Fig.2.

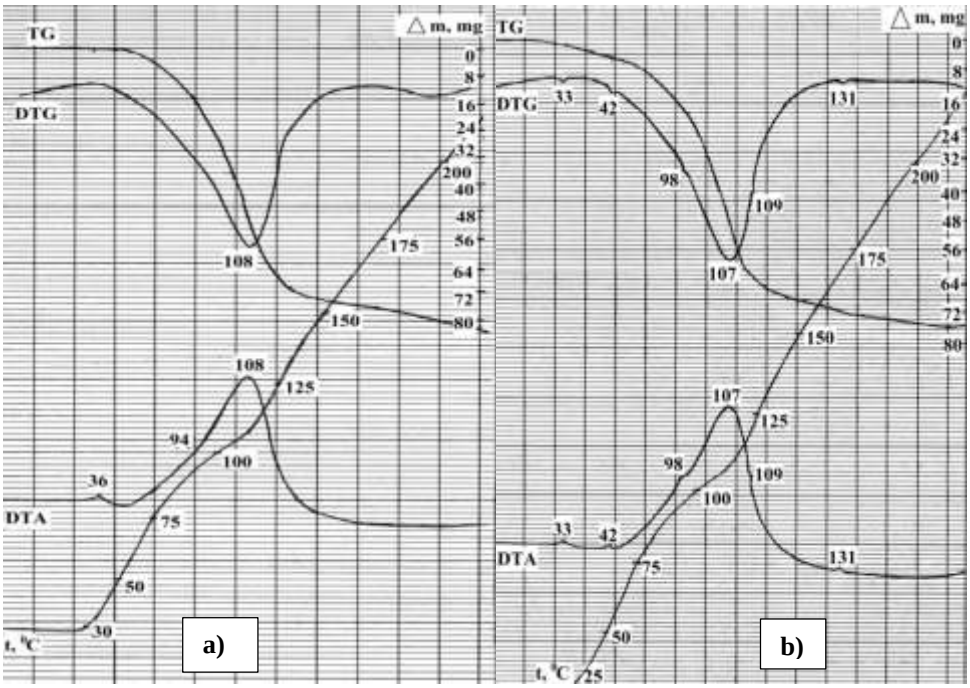

Fig. 2.Deryvatohramms of the fresh butter paste with red beet powder and (a) and butter-control (b)

Analyzing DTA curves of the butter paste with red beet criopowder and butter-control, four main forms of connection of moisture were highlighted by temperature peaks. By TG curves their number in percent was defined (Table 1).

Butter-control is characterized by a weakly bound in an amount of 11.91 % and 35.09 % strongly bound moisture. Removal of free moisture is held in several stages: first, mechanically connected one at temperatures of 33 ^{0}C and 42 ^{0}C in an amount of 3.76 % is removed, then – 8.15

% osmotic at 98 ^{0}C. Firmly connected moisture is presented by polymolecular form that is removed at temperatures of 107 ^{0}C and 109 ^{0}C in an amount of 33.21 % and by monomolecular with the fixed peak at 131 ^{0}C in an amount of 1.88 %.

Table 1

Forms of connection of moisture in the butter paste with red beet powder and butter-control

Forms of connection of moisture	Name of fresh sample					
	butter paste with red beet powder			Butter-cjntrol		
	moisture, %		Temperature, ^{0}C	moisture, %		Temperature, ^{0}C
	absolute	relative		absolute	relative	
Weakly bound:	8.02	17.05	-	11.91	25.33	-
mechanical	0	0	36	0.63 3.13	1.33 6.67	33 42
osmotic	8.02	17.05	94	8.15	17.33	98
Firmly bound:	38.98	82.95	-	35.09	74.67	-
polymolecular	32.10	68.30	108	27.57 5.64	58.67 12.00	107 109
monomolecular	6.88	14.65	127	1.88	4.00	131

Unlike butter-control, in the butter paste with red beet powder mechanically bound moisture was not found. Weakly bound moisture is presented by only osmotic connections in an amount of 8.02 %. The temperature peak of removal is 94 ^{0}C. The number of firmly bound monomolecular moisture increases by 5.00 % in comparison with the butter-control. In our opinion, such redistribution of moisture connection forms is due to the microstructure of plant supplements. In previous studies it has been established that red beet criopowder has indestructible mechanical and leading texture which connects free moisture [15]. So, when adding criopowder, the joining of adsorption of moisture of the butter paste by additive particles is done. It has been proved that inulin has the ability to form strong hydrogen bonds in the structure of butter, increasing the content of tightly bound monomolecular moisture [13]. It is known that the addition of flaxseeds into the composition of butter helps thin dispersion of water phase droplets due to the formation of additional intermolecular bonds [16]. We assume that inulin and flaxseed have similar properties in the structure of the butter paste as well. Due the complex effects of plant food supplements, the mechanical weakly bound moisture in the ready product is not available, thus increasing the number of monomolecular tightly connected ones.

4. Conclusion.

The addition of the complex of plant food additives promotes the dispersion of plasma in the ready product, increasing the amount of droplets with diameter of (1...5) microns.

Red beet criopowder, flaxseeds and inulin lead to the increase in the amount of firmly bound, especially monomolecular and absence of mechanical weakly bound moisture in the butter paste.

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