



## RESEARCH ON MICROSTRUCTURE AND REDISTRIBUTION OF THE MOISTURE CONNECTION FORMS IN THE MODEL SYSTEMS OF CONFECTIONERY SEMI-FINISHED PRODUCT WITH BANANA POWDER

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**Abstract:** *The article is devoted to research of model systems of a new finishing confectionery semi-finished product which contains sugar fondant, plant powder, butter and surfactant - citric acid ester. A derivatographic analysis of the model systems of a confectionery semi-finished product was carried out and the distribution of moisture connection forms was investigated. Types of moisture connections were determined in terms of the classification system of Reh binder P.A. which is based on a magnitude of connection energy of water with material.*

*The results of microstructure researches of model systems are presented in the article. It has been found that particles of banana powder do not act as crystallization centers and therefore do not exert impact on the process of grain formation of sucrose in fondant mass.*

*The expediency of surfactant use in the production of a new confectionery semi-finished product with banana powder is proved.*

**Keywords:** *finishing semi-finished products, plant powder, fondant mass, surfactant, grain formations.*

### 1. Introduction

In the 21<sup>st</sup> century, a topical issue of the world level is considerable prevalence of chronic non-communicable diseases (NCD), which causes global social and economic losses of the population in many countries of the world, including Ukraine.

Risk factors that cause by NCD are known and widespread among the population. Simultaneous reduction of the frequency and levels of several common risk factors contributes to the reduction of the prevalence of the main NCD.

In this regard, World Health Organization (WHO) has proposed an integrated prevention program for non-communicable diseases across the country. One of the main directions of disease prevention is healthy eating, which suggests that diets should consist of a variety of products of predominantly plant origin.

Today, the nutrients lack of the plant origin in nutrition of the population has become a serious problem, being connected with a sharp decrease in energy consumption and a change in diet, which does not provide the formed physiological needs in a number of irreplaceable nutrients.

Consumption of confectionery products plays a significant role in full nutrition of various age groups of the population, especially children. They are in steady demand, first of all, thanks to refined taste properties. Value of confectionery products in food is caused by the high energy value which is provided by the considerable content of sugars, and in some products by content of fats, but their nutrition value is limited [1]. Therefore, the use of plant raw materials for enrichment this category of products is relevant today.

High moisture content in plant raw materials is the reason of their instability during storage, because of bacterial, enzymatic

and chemical damage. Drying at low temperatures is the most rational way of preservation, as in dried products microbiological processes are slowed down, and the composition of nutritious and biologically valuable substances remains close to natural [2, 3]. Therefore, in order to reduce the energy value and increase the nutritional value of confectionery products, it is expedient to use plant powders which are concentrates of biologically active substances [4].

In this regard, after having taken into consideration some modern studies in the field of finishing semi-finished products, we came to the conclusion of making some universal confectionery semi-finished products which will considerably reduce time of technological process with production, enlarge the range of products, have increased nutrition value and improve organoleptic properties. For enrichment, sugar fondant was chosen.

Banana powder was chosen as material for enrichment of fondant, provided by the company "Naturex AG", Switzerland (Conclusion of the State Sanitary and Epidemiological Service No. 05.03.02-03 / 125796 dated 27.12.2011), which has a moisture mass fraction of 5% and a dispersion of 10-20 microns. This powder has high organoleptic properties, namely, intense taste and aroma. Banana powder is a source of dietary fiber, organic acids, potassium and magnesium [5,6].

Addition of butter will make the basis of a semi-finished product more plastic: mechanical influence, on its further use, will carry out much easier as it receives the necessary form when being decorated. Research results of confectionery semi-finished products showed that for the best structural and mechanical properties it is important to add the surfactant when adding the powder-butter mix, since it allows holding the corresponding consistency un-

der the influence of temperature. Citric acid ester and mono - diglycerides (E 472 c) – are the surfactants added in an obligatory amount of 0.5% from the weight of a semi-finished product that help keep uniform structure with multiple thermal and mechanical influence [7, 8].

The addition of plant powder, butter and surfactant influences significantly the structural and mechanical properties of a ready-made product and changes its rheological properties. The considerable influence on formation of structural characteristics and storage terms has to comply with the condition of water phase [9]. Due to addition in its composition of plant powder and butter, the amount of moisture in a semi-finished product increases, thus making possible the premature development of microorganisms and reduction its storage shelf life. Therefore, the purpose of research was to study redistribution of the moisture connection forms in model systems of a confectionery semi-finished product with banana powder by the method of thermogravimetric analysis.

## **2. Materials and methods**

To do the research aimed at, the following samples were used: a control sample consisting of sugar fondant with moisture content of 11.2% (sample A); sugar fondant with addition of banana powder in amount of 18% to prescription weight with the general moisture content of 12.6% (sample B); sugar fondant with mixture addition of powder and butter (moisture content of 16.6%) to prepare preliminary mixing of butter (20%) with banana powder (18%) to homogeneous mass (sample C); sugar fondant with mixture of powder and butter and addition of surfactant in number of 0,8% to prescription weight with moisture content of 11.2% (sample D) [11]. The re-

search of redistribution of the moisture connection forms was conducted by method of the thermogravimetric analysis, which at the same time allows taking measurements of temperature in samples, change in weight and speed. Curves were taken on a derivatograph of Paulie-Erden system Q-1500 D on air with the growth rate of temperature of 5 °C/min. The weight of samples was of 197-205 mg. Derivatographic curves were reviewed: the differential-thermal analysis (DTA), thermogravimetric (TG), differential thermogravimetric (DTG) and temperature curve (T).

On receipt of derivatograms with the subsequent processing by means of the mathematical program PeakFit 4.12, the curve DTA on Gauss's curves was displayed and temperature peaks and intervals of its removal with various types of connections were determined. The TG curve determined the amount of moisture removed in percentages.

The microstructure was investigated by means of Analytical Scanning Electron Microscope Jeol JSM-6060LA with a 600-time increase.

### **3. Results and discussion**

The method of the thermogravimetric analysis provides derivatograms of the experimental samples of semi-finished products. In order to identify moisture with different connection forms and establish their role in formation of consistency and structure of finished products, according to the method proposed by Rashevskaya T.O. [10], the received curves of DTA were decomposed in simpler components, based on regularities of normal curves distribution of Gauss. Figure 1 shows the mathematically processed derivative curves of experimental types of fondant

masses. Quantitative distribution of different moisture connection forms with material, and also temperature intervals and peaks of its removal are shown in Table 1.

The derivatogram of the control sample (Fig. 1A) shows that the removal of weakly bound osmotic moisture takes place in two stages: in a wide temperature interval with a clear peak at 69 °C and diffuse peak at 78 °C, which is well manifested during the mathematical processing of the curve. The total amount of weakly bound moisture in the structure of the product is 10.7%. The temperature peaks of 97 °C and 143 °C in the range 92-147 °C indicate the removal of the strongly bound moisture of the poly- and monomolecular layers respectively.

The analysis of the derivatogram of the semi-finished product enriched with banana powder (Fig. 1B), indicates the redistribution of the moisture connection forms with the components of the product and a significant increase in the weakly bound osmotic moisture. In comparison with control sample, its relative quantity grows in structure by 2.2 times, and removal happens at higher temperatures than in the control sample and in three stages with peaks of 69 °C, 80 °C and 88 °C. Removal of strongly bound moisture takes place discretely at temperatures over 100 °C, which indicates high energy of connexions between components of a product and its water phase. The relative amount of strongly bound moisture in comparison with control sample decreases by 1.2 times.

The obtained research results indicate that in the structure of the enriched fondant mass, as a result of swelling processes and interaction between water phase and components of banana powder, the quantity of a disperse phase grows substantially and the surface of interphase interaction in-

creases. Such processes promote formation of additional coagulative connection and structure plasticization of the enriched fondant mass respectively.

The following figures show derivatograms of enriched fondant mass with plant powder and butter without surfactant (Fig. 1C) and with surfactant (Fig. 1D). The nature of the DTA curves of the experimental samples, the similarity of the peaks and the temperature intervals of the moisture removal and its quantitative distribution between various forms of bonding indicates the similarity of the interaction processes of the water phase with the components of the enriched fondant masses described above.

In sample C, the amount of weakly bound moisture is increased by 1.5 times as com-

pared with the sample B and by 3.3 times as compared with the sample A (control). It is caused by the addition of butter to the model system, which contains a significant amount of weakly bound moisture, part of which is absorbed by banana powder. In sample D, this moisture content is reduced by 1.3 times as compared with the previous sample, which allows us to conclude that the surfactant is able not only to hold the fat phase of the semi-finished product, but it also contributes partly to the redistribution of moisture to the side of the strongly bound. At the next stage, the microstructure of experimental species of confectionery semi-finished products with an increase of 200 and 500 times was studied. The received pictures of a microstructure are given in the Figure 2.

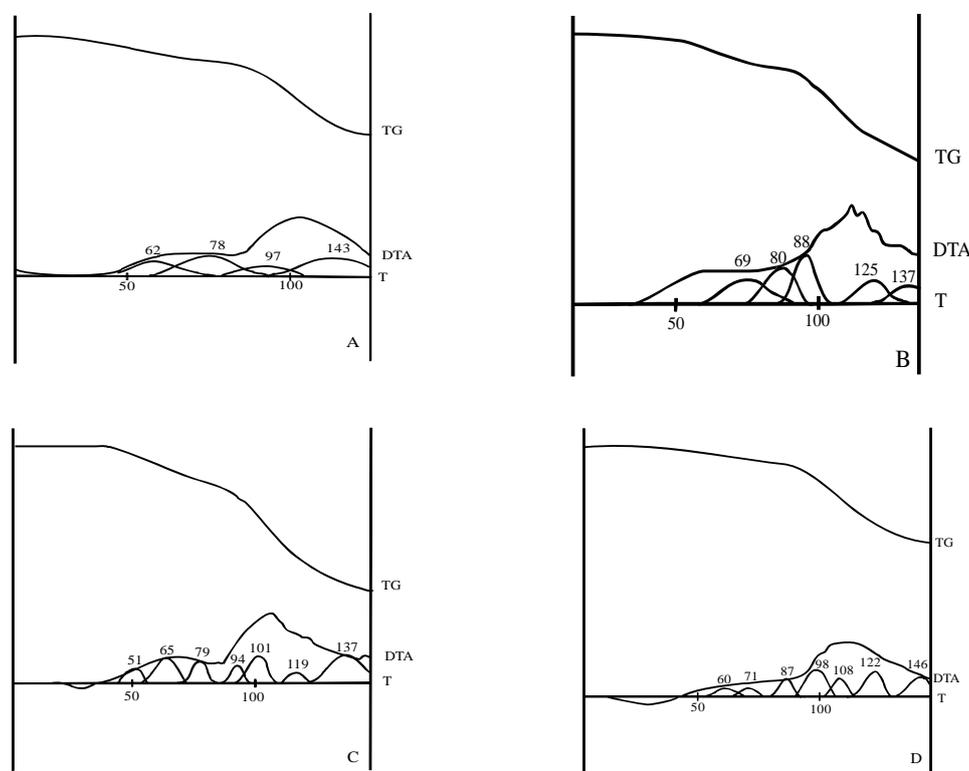


Fig. 1. Derivatograms of confectionery semi-finished products model systems

Table 1.

The moisture connection forms of confectionery semi-finished products model systems

Forms connection of moisture	Sample A			Sample B			Sample C			Sample D		
	Relative moisture content, %	Removal temperature, °C		Relative moisture content, %	Removal temperature, °C		Relative moisture content, %	Removal temperature, °C		Relative moisture content, %	Removal temperature, °C	
		peak	interval		peak	interval		peak	interval		peak	interval
Weakly bound moisture	10.7			23.7			34.8			25.9		
Mechanical												
Osmotic	6.3 4.4	62 78	47-70 71-91	11.1 8.7 7.9	69 80 88	55-71 72-83 84-99	15.0 9.0 10.8	65 79 94	56-72 73-86 87-92	9.8 4.5 11.6	60 71 87	50-69 70-75 76-96
Strongly bound moisture	89.3			72.3			65.2			74.1		
Poly molecular	34.8	97	92-120	43.7	125	100-126	25.9 22.9	101 119	93-115 116-123	23.2 4.5	98 108	97-104 105-110
Mono molecular	54.5	143	121-147	28.6	137	127-146	16.4	137	124-146	38.4 8.0	122 146	111-138 139-149

During the research of the model systems microstructure, it is shown that in sugar fondant prevails homogeneous crystal phase. Fondant mass is presented by separate crystals up to 10 microns in size, evenly distributed over the entire mass (Fig. 2A). At addition of banana powder, there is uneven, namely, conglomerate distribution in research system. It was found that particles of powder do not act as centers of crystallization during maturing and therefore do not exert an impact on the process

of sucrose crystal formation in fondant mass (Fig. 2B). The uniform distribution of powder in model system is reached by preliminary receiving powder and butter mix (Fig. 2C). By microstructural research it is shown that the crystals of fondant are surrounded by a fatty phase of butter, and the bulked-up particles of powder do not form groups. The surfactant introduction promotes the receiving of homogeneous poly-phase systems that is confirmed by uniform plastic structure (Fig. 2D).

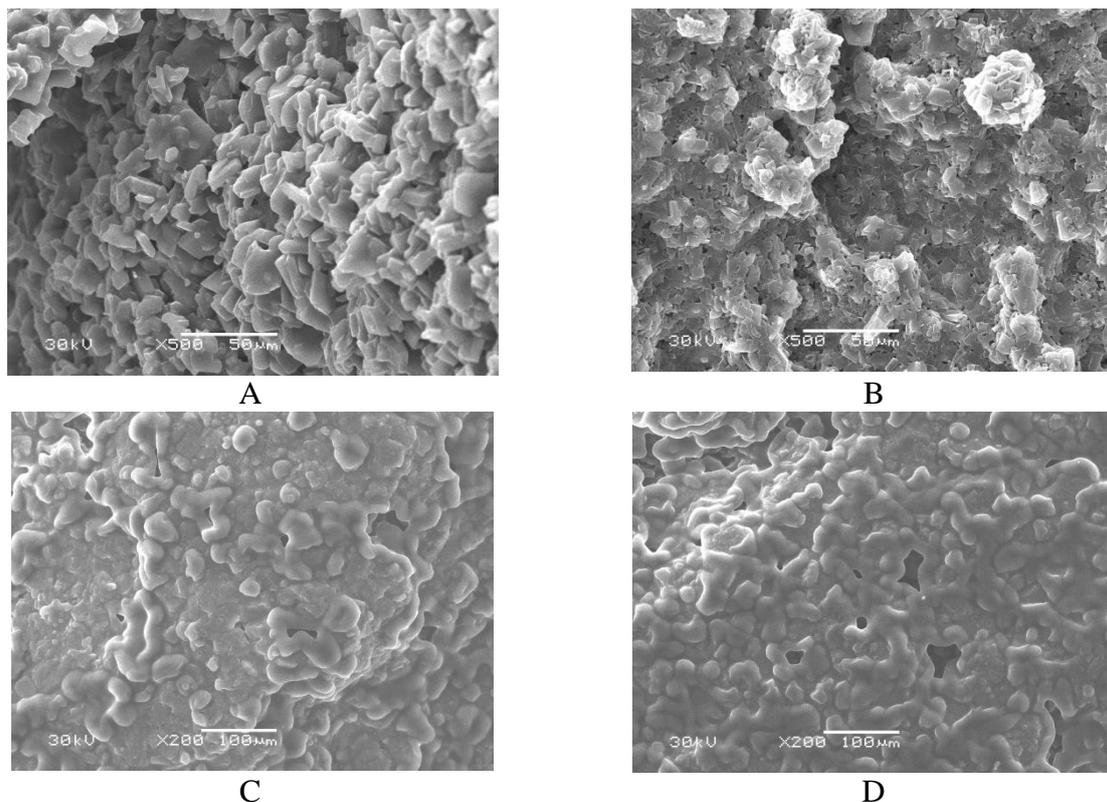


Fig. 2. Microstructure of confectionery semi-finished products model systems

#### 4. Conclusions

Consequently, according to the results of studies on the redistribution of the moisture connection forms, it has been established that the addition of banana powder and butter contributes to the increase of osmotic moisture, which influences negatively the process of storage of confectionery semi-finished products. The addition of surfactant acts in the opposite direction and contributes to the increase of strongly bound moisture, in particular monomolecular one. The study of microstructure has shown that banana powder does not affect the crystal formation of the fondant mass, but some uneven distribution of particles in the research system is observed. The addition of butter and surfactant helps to obtain a homogeneous polyphase system.

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