Optimization of foaming parameters of the whipped mass with "magnetofood" food additiveusing

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Abstract
The article presents the influence results of "Magnetofood" food additive on the foaming indicators of the whipping confectionery masses in the marsh-mallow technology (foaming capacity, froth resistance, density, plastic strength, effective viscosity, degree of whip and volume kinetics in the storage process). It is proved the surface activity of the nanoparticles of "Magnetofood additive. The mathematical modeling has established the optimal parameters of the whipped masses. The prospects for "Magnetofood" additive using for the creaming confectionery masses as a stabilizer and the structural forming of foamy structures are determined.

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DOI: 10.24263/RES-2018-4

Introduction

The whiiping confectionery (marsh-mallow, pastille, sweets with whipped body) are in the high demand among the population [1–3]. Their value is determined by a significant proportion of the air phase, a high degree of dispersion and the structural properties. The low temperature zones, moderate mechanical stress, the presence of pectin substances which can prevent the oxidation of biologically active substances in the whipped confectionery products production allow you to preserve the beneficial properties of itemized nutrients [4].

However in the modern conditions the production and sale of whiiped confectionery products in the domestic market are the subject to fierce and constantly growing competition. In the current situation (shortage of domestic raw materials, a significant part of imported ingredients with high cost, etc.), Marsh-mallow production is looking for the ways to improve the competitiveness of finished products by improving and stabilizing quality, reducing costs and extending the shelf life of pastry confectionery [2, 3].

The production of whipping confectionery products is complex and difficult to manage the process. Expansion and improvement of this production requires the search for a simplified technology with the help of reducing the duration of the technological stages, including the preparatory operations and the structure formation of whiipped confectionery products, reducing production space and energy resources, improving the system stability and improving the quality of marsh-mallow production products [4].

The nanopowder food additives using of the mineral origin as a foaming and structure former in the production of whipped confectionery products was not considered.

"Magnetofood" -is a food additive [Patent UA № 126502, МПК A 23L 13/40, A23L 33/10. "Magnetofood"food additive] can influence the processes of structure former of jelly –like sweet pastes and the whipped masses foaming in the production of the whipped confectionery products as well as on the quality indices of finished products. However, these data are missing and the additional studies are needed.

"Magnetofood" additive has a certain functional and technological potential and can both independently form the structural and mechanical properties of jelly masses and foam structures and also affect the gel and foaming agent entering into the chemical and electrostatic interactions. Therefore, "Magnetofood" food additive can perform the several technological functions in the system at once: act as a stabilizer and structure former (foam and jelly formations).

Materials and methods

The study object –is the technology of white pink marshmallows on agar and the apple pectin. The research subject – is the model samples of white pink marshmallows on agar and pectin which are based on the basic formulations № 95 and № 126 and are given in Table 1; and the experimental samples of egg albumen.

The experimental samples of egg white are:

- the experimental sample 9 – control – 30% aqueous solution of dried egg white, [AUSS 30363-2013];
- the experimental sample 10–30% aqueous solution of dried egg white with the introduction of "Magnetofood food additive in the amount of 0,10 % by weight of dried egg white;
- the experimental sample 11–30% aqueous solution of dried egg white with the introduction of "Magnetofood" food additive in the amount of 0,15% to the mass of dried egg white;
- the experimental sample 12–30% aqueous solution of dried egg white with the introduction of "Magnetofood" food additive in the amount of 0,20% by weight of dried egg white.

Table 1

Formulations of white-pink marshmallow on agar and pectin (control) and with different mass fraction of "Magnetofood" food additive (experimenal)

Name of the raw materials	Inputs of the raw material per 1 ton of finished product, kg							
	marshmallow samples on agar				marshmallow samples on pectin			
	№ 1 control	№ 2	№ 3	№ 4	№ 5 control	№ 6	№ 7	№ 8
Granulated sugar	673,0	672,0	671,5	671,0	671,0	670,0	670,5	669,0
Powdered sugar	29,9	29,9	29,9	29,9	29,9	29,9	29,9	29,9
Molasses	139,4	139,4	139,4	139,4	142,9	142,9	142,9	142,9
Apple sauce	390,0	390,0	390,0	390,0	298,0	298,0	298,0	298,0
Egg white	65,0	65,0	65,0	65,0	65,0	65,0	65,0	65,0
Agar	8,6	8,6	8,6	8,6	–	–	–	–
Apple pectin	–	–	–	–	13,4	13,4	13,4	13,4
lactic acid	11,8	11,8	11,8	11,8	8,4	8,4	8,4	8,4
Sodium lactate	–	–	–	–	6,8	6,8	6,8	6,8
Different kinds of essence	2,0	2,0	2,0	2,0	2,0	2,0	2,0	2,0
Dye red	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6
"Magnetofood" food additive	–	1,0	1,5	2,0	–	1,0	1,5	2,0

Foaming ability of egg white and whipped masses was determined by the Lurie method [7]. The change in thefoam stability was recorded on theresiduum of the foam column over time. The active properties were evaluated superficially by the magnitude of the surface tension and determined by "Du Noüy ring" method on the Kruss tensiometers [8]. The expansion foam and the volume concentration of air in the mass were determined by the calculation taking into account the volume of the foam. In our work it was used the optical method for microstructure analyzing of a whipped mass based on image processing obtained by a light in an electron microscope with the use of the personal computer. Marshmallow mass has been obtained and the foaming process was studied on a developed experimental whipping equipment. The structural-mechanical characteristics of whipped marshmallow masses were investigated by the using of the standard and generally accepted methods [8]. The strength of the whipping masses was investigated with the ultimate shear stress – on penetrometers AR-4/1; the rheological properties were determined on Reotest-2 device. The whipping process was optimized by the experimental modeling in order to obtain a criterial equation which describing the whipping process.

Results and discussion

The foaming capacity of protein (PO) which depends both on its concentration, the fractional composition and structure and on the temperature, the presence of salts, sucrose, dietary fiber, etc., significantly affects on the structure formation of whipped masses [9, 10]. Therefore, we studied the effect of "Magnetofood" food additive on the foaming capacity (FC) and the foam stability (FS) of egg white (Fig. 1 and Fig. 2, respectively).

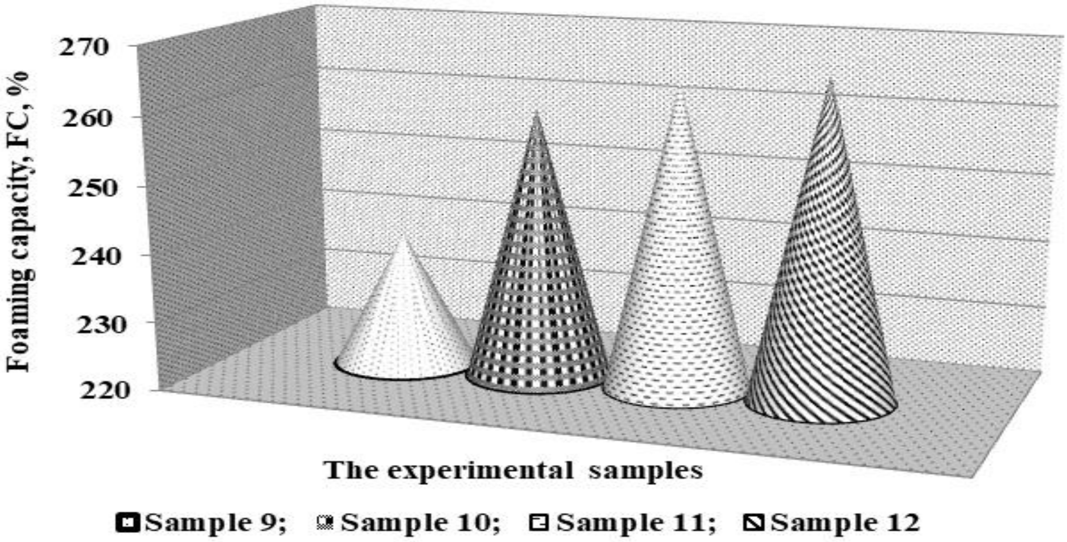

Fig. 1. Influence of "Magnetofood" food additive on the foaming capacity of the egg white (t=20±2 °C, pH=4,8)

From the data in Fig. 1 it follows that the introduction of "Magnetofood" food additive in egg white in the amount of (0,10–0,20)% by weight of dried egg white increases the software of the "protein-NP "Magnetofood" system by (8,3–11,3)%, which is associated with the capacity of the polarized nanoparticles (NP) of "Magnetofood" food additive to reduce the surface tension of the protein solution and accelerate the coagulation of protein molecules which leads to the increase in the protein solution of the volume concentration of the air phase and a decrease in the size of air bubbles. When using the "Magnetofood" additive due to the amphotericity and nanoparticles, the active acidity of the "protein-NP "Magnetofood"system [8, 11] changes in the direction close to the isoelectric point of the protein in which the maximum FC of protein solutions appears [11].

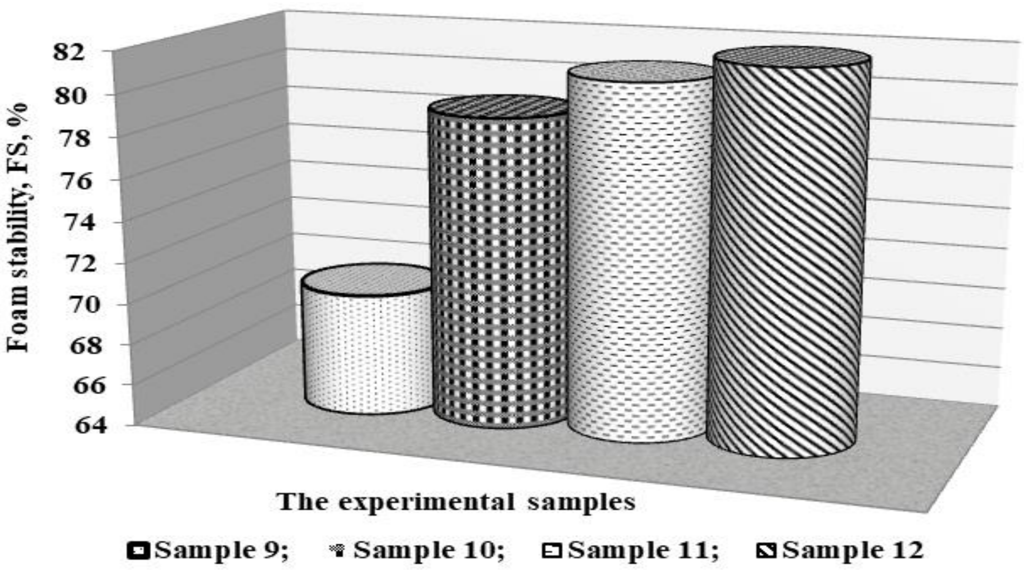

Fig. 2. Influence of "Magnetofood" food additive on the foam stability of the egg white (t=20±2 ºC, sample time τ=30x60 c)

Introduction of "Magnetofood" food additive to egg white in the amount of (0,10–0,20)% by weight of dried egg white increases the FS of the "protein-NP "Magnetofood "system by (12,6–17,1) % (Fig. 2). This is due to the presence of the active magnetic surface of "Magnetofood" additive on the interfacial surface in the adsorption layer of nanoparticles which increase the adhesion force between protein molecules – as a result, fluid mobility decreases and its flow in the film slows down, thereby preventing foam coalescence [12]; the viscosity of the liquid in foam films also increases, slows down their destruction and increases the stability (or stability) of the foam (see Fig. 2).

Correct for a factor in the resultthat the acidity of the medium significantly affects the electrostatic interaction and the properties of protein molecules the effect of the pH of the medium on the foaming capacity of the egg white in the experimental samples 9–12 is further investigated. The dependence picture of the foaming capacity (FC) and the foam stability (FS) of "Magnetofood" system "protein-NP" in the experimental samples 9-12 on pH values was established with the using elements of statistical data processing. As a result, the regression equations (1) and (2) were obtained which adequately describe the relationship between the foaming properties and the pH medium at the different mass fractions of "Magnetofood" food additive.

$$FC=166.7778+ 406.6667x+57.0556y-0,306xy -1200x^2-6.0556y^2 \quad (1)$$

$$FS=64.3523+145.5146x+1.6189y+2.4864xy-517.6136x^2-0.1963y^2 \quad (2)$$

where x – pH y – the mass fraction of "Magnetofood" food additive for unit

From the graphic images of software dependencies FC (Fig. 3, a) and FS (Fig. 3, b) from the pH values of the medium, it can be seen that for 100% egg white (sample 10-control) the values of FC and FS at pH values from 2 to 9 changed by 22,6 % and by 5,6%, respectively, whereas in the “egg white-NP “Magnetofood “system (samples 10–12), with an increase in the mass fraction of the “Magnetofood” additive, these indicators changed on average by 19,8 % and 3,1% respectively. That is, with the introduction of “Magnetofood”,additive the effect of pH on the foaming properties of egg white is less significant which is associated with the stabilizing effect of “Magnetofood” food additive.

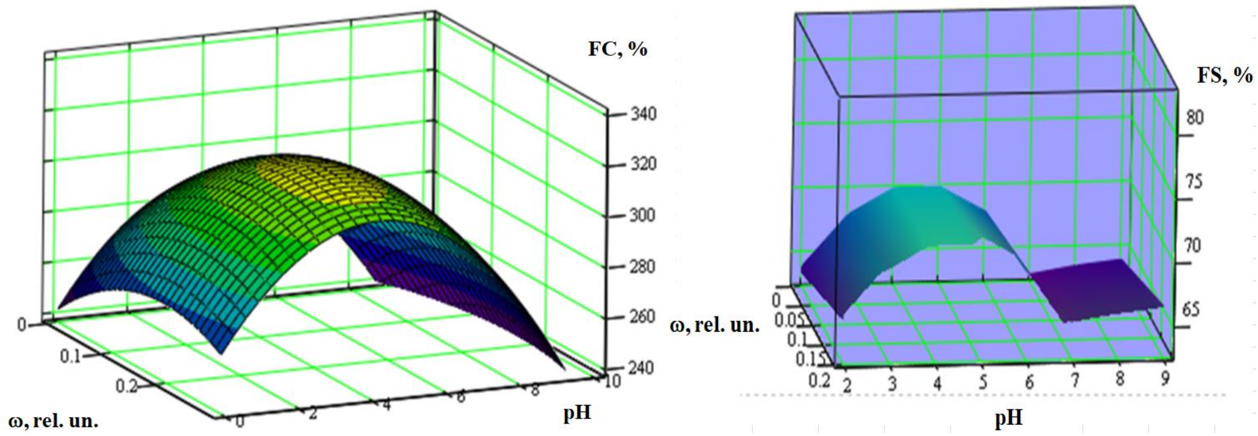

Fig. 3. Dependence of the foaming properties of the experimental samples of the composition “egg white-NP “Magnetofood” on the pH of the medium and the mass fraction of “Magnetofood” food additive, %:
a – foaming capacity (FC); b – foam stability (FS)

From Fig. 3 it follows that the foam stability (FS) and the foaming capacity (FC) of egg white in the experimental samples 9–12 were maximum at pH = 5,0; in the range of pH values of about 7 both of these indicators sharply decreased while at pH more than 7 they slightly increased. The foam stability of the composition “egg white-NPs “Magnetofood ”increased with an increase in the mass fraction of “Magnetofood” additive. The foam itself was formed at pH = 4,806 by mass fraction "Magnetofood" 0,155% by weight of dried egg white. Perhaps it was in the acidic medium when egg white molecules acquired a conformation that most contributed to the maximum manifestation of the surface-active properties necessary for the stable foam formation. Thus, the optimal values for the foaming capacity (FC): the content of “Magnetofood” food additive:**ω**=0,161; pH = 4,904; for the foam stability (FS):**ω**= 0,159; pH = 4,89.

Conclusion

The obtained results confirm the hypothesis of the foam structure stabilization of marshmallows using “Magnetofood” food additive:

- in all experimental samples of egg white with the introduction of “Magnetofood” food additive in the amount of (0,10–0,20)% by weight of the dried egg white, the foaming capacity (FC) increases by (8,3–11,3) %; the foam stability (FS) – by (12,6–17,1)% compared to control;

- at the introduction of the “Magnetofood” food additive in the amount (0,10-0,20)% of the mass of raw materials there is the effect of the structure stabilizing of the marshmallows samples: during the regulated storage period (90 days), the volume of the contracted structure decreases more slowly by 7,85% in the samples per pectin and 11% in agar compared with control.

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