OPTIMIZATION OF COMPOSITION OF BLEND OF NATURAL VEGETABLE OILS FOR THE PRODUCTION OF MILK-CONTAINING PRODUCTS (p. 4-9)

Tatiana Belemets, Natalia Yushchenko, Olexei Lobok, Irina Radziyevska, Tatiana Polonskaya

The natural vegetable oils (corn, rapeseed and walnut oils) were selected to create the blend, optimized by the fat and acid composition on their basis. This choice of oils is substantiated according to their physical and chemical characteristics, the fat and acid composition, and compatibility with the milk base, availability, and organoleptic parameters. The developed blend of natural vegetable oils should be combined with dairy products of mass consumption for the optimization of their fat and acid composition. In order to solve the stated problem, the calculations in the environment of the MATLAB mathematical package were carried out. We chose the following criteria for optimization: the ratio of 3 main groups of fatty acids (saturated fatty acids to monounsaturated fatty acids and to polyunsaturated fatty acids), as well as the ratio of fatty acids of the ω–6 and ω–3 groups. The obtained data were proved experimentally using the method of gas–liquid chromatography for the determination of the exact number of all components of the optimization in the examined samples. Partial substitution (50 %) of milk fat in sour milk products with the developed blend of vegetable oils will allow creating dairy products of mass consumption with somewhat optimized fat and acid composition. This design is relevant and appropriate because consumption of such optimized milk containing products will significantly increase the amount of intake of fatty acids from food and will somewhat correct the problem of shortage of the ω–6 and ω–3 fatty acids in a daily ration.

Keywords: optimized fat and acid composition, sour cream product, blends of natural vegetable oils, mathematical blending, chromatographic analysis, substitution of milk fat.

References
1. Zelenkova, H. O. (2013). Analiz suchasnykh tendentsiy zastosuvannya biolohichno aktyvnьh dobavok u vyrobnytstvi kyslomolochnykh syrkovьh vyrobiv. Naukovyy poshuk molodykh doshlynykiv, 2, 16–21.
2. Makarchuk, T. L., Podrushnyak, A. E., Koval’, A. V. (2003). Problemy kachestva i bezopasnosti novьh maslozhirovyh produktov: Problemi harchuvannya, 1, 44–46.
3. Stepycheva, N. V., Fu’d’ko, A. A. (2011). Kupazhirovannye rastitel’nye masla s optimizirovannym zhirnokoislotnym sostavom. Himiya rastitel’noy syrya, 2, 27–33.
4. Levickij, A. P. (2002). Ideall’noy formy zhiryhovogo pitanья. Odessa: NPA “Odesskaya biotehnologiya”, 61.
5. Tihomirova, N. A. (2002). Tekhnologiya produktov funkcionnal’noy pitanья. Moscow, 213.
6. Konopleva, G. S. (2014). Zameniteli molochnogo zhira: razvevayem mify. Molochnaya sfera, 4 (51), 62–64.
7. Ivankin, A. N. (2007). Zhiry v sostave sovremennyh m’yasnyh produktov. Myasnaya industriya, 6, 8–13.
8. Stepycheva, N. V., Fu’d’ko, A. A. (2011). Kupazhirovannye rastitel’nye masla s optimizirovannym zhirnokoislotnym sostavom. Himiya rastitel’noy syrya, 2, 27–33.
9. Smolyar, V. I. (2006). Kontseptsiya ideall’noy zhiryhovogo kharchuvannya. Problemy kharchuvannya, 4, 14–24.
10. Tutel’yan, V. A., Suhano, B. P., Ehller, K. I. (2004). Biologicheskii aktivnye dobavki k pisheche i lekarstvennye sredstva rastitel’nogo proishkhodzheniya. Ocenka bezopasnosti i standartizatsiya. Voprosy pitanья, 3, 32–37.
11. Par’ko, O. V. (2009). Molokosoderzhashchie produkty s rastitel’nym syryem. Molochnaya promyshlennost’, 7, 40–41.
12. Konopleva, G. S. (2014). Zameniteli molochnogo zhira: razvevayem mify. Molochnaya sfera, 4 (51), 62–64.

8. Stepycheva, N. V., Fu’d’ko, A. A. (2011). Kupazhirovannye rastitel’nye masla s optimizirovannym zhirnokoislotnym sostavom. Himiya rastitel’noy syrya, 2, 27–33.
9. Smolyar, V. I. (2006). Kontseptsiya ideal’noho zhirovoho kharchuvannya. Problemy kharchuvannya, 4, 14–24.
10. Tutel’yan, V. A., Suhano, B. P., Ehller, K. I. (2004). Biologicheski aktivnye dobavki k pisheche i lekarstvennye sredstva rastitel’nogo proishkhodzheniya. Ocenka bezopasnosti i standartizatsiya. Voprosy pitanья, 3, 32–37.
11. Par’ko, O. V. (2009). Molokosoderzhashchie produkty s rastitel’nym syryem. Molochnaya promyshlennost’, 7, 40–41.
12. Par’ko, O. V. (2009). Molokosoderzhashchie produkty s rastitel’nym syryem. Molochnaya promyshlennost’, 7, 40–41.
To determine optimal method of the formation of layer, we conducted experimental studies of the change in hydraulic resistance from the speed of gas flow motion under conditions of forming a layer of candied fruits by different methods. Based on generalizations of experimental and theoretical studies, we obtained estimated dependencies for the calculation of coefficient of hydraulic resistance and losses of pressure in the layer of candied fruits formed by different methods. They represent equations, which include such hydrodynamic parameters, obtained through experimental research and generalization of research data, as: actual speed of gas flow, equivalent diameter and equivalent height of channels between the particles, coefficient of hydraulic resistance. Obtained theoretical dependencies agree well with experimental data and are important for the prediction of kinetics of the filtration drying with regard to energy costs for the process. The dependencies are also important both for numerical simulation of the course of thermal mass exchanging processes during drying and for practical calculations.

Based on the generalizing equations and values of specific surface, received by Authors, the expediency of forming a layer by the method of arranging the particles of candied fruits vertically “with blocking the channels” was substantiated. It is proved that this method allows providing for the maximum speed of thermal agent in the layer and, as a consequence, intensifying the process of filtration drying.

Keywords: candied fruit from pumpkin, filtration drying, hydrodynamics, hydraulic resistance, specific surface, layer formation, the Darcy-Weisbach equation, equivalent diameter.

References

1. Roongruangsri, W., Bronlund, J. E. (2015). A Review of Drying Processes in the Production of Pumpkin Powder. International Journal of Food Engineering, 11 (6). doi: 10.1515/ijfe-2015-0168
2. De Souza Silva, K., Caetano, L. C., Garcia, C. C., Romero, J. T., Santos, A. B., Mauro, M. A. (2011). Osmotic dehydration process for low temperature blanched pumpkin. Journal of Food Engineering, 105 (1), 56–64. doi: 10.1016/j.jfoodeng.2011.01.025
3. Dini, I., Tenore, G. C., Dini, A. (2013). Effect of industrial and domestic processing on antioxidant properties of pumpkin pulp. LWT – Food Science and Technology, 53 (1), 382–385. doi: 10.1016/j.lwt.2013.01.005
4. Dirim, S., Caliskan G. (2012). Determination of the effect of freeze drying process on the production of pumpkin (Cucurbita moschata) puree powder and the powder properties. GIDA J Food; 37(20) Р. 3–10.
5. Ciezarzynska, A., Lenart, A., Greda, K. J. (2014). Effect of pre-treatment conditions on content and activity of water and colour of freeze-dried pumpkin. LWT – Food Science and Technology, 59 (2), 1075–1081. doi: 10.1016/j.lwt.2014.06.035
6. Ahmed, J., Al-Foudari, M., Al-Salman, F., Almusallam, A. S. (2014). Effect of particle size and temperature on rheological, thermal, and structural properties of pumpkin flour dispersion. Journal of Food Engineering, 124, 43–53. doi: 10.1016/j.jfoodeng.2013.09.030
7. Dubkovetskyy, I., Malezhik, I. E., Strelchenko, L. V., Yevchuk, Ya. V. (2015). Investigation of the kinetics of convection – drying termodiatsiynoho Hawthorn. Proceedings ONAFT, 47 (2), 18–22.
8. Alibas, I. (2006). Characteristics of Chard Leaves during Microwave, Convective, and Combined Microwave-Convective Drying. Drying Technology, 24 (11), 1425–1435. doi: 10.1080/07373930600952776
9. Abrańko, A. S., Lemos, A. M., Vilela, A., Sousa, J. M., Nunes, F. M. (2013). Influence of osmotic dehydration process parameters on the quality of candied pumpkins. Food and Bioprocess Technology, 91 (4), 481–494. doi: 10.1016/j.fbipt.2013.04.006
10. Hashim, N., Daniel, O., Rahaman, E. (2014). A Preliminary Study: Kinetic Model of Drying Process of Pumpkins (Cucurbita moschata) in a Convective Hot Air Dryer. Agriculture and Agricultural Science Procedia, 2, 345–352. doi: 10.1016/j.aaspro.2014.11.048
11. Nepochatykh, T. (2016). Some theoretical and practical approaches to the production of candied fruits from plant material. Science trajectory, 2 (6), 2.1–2.8.
12. Clifford, I. O., Kingsley, E., Chika, C. O., Chinyere, I. I. (2014). Effects of Osmotic Dewatering and Oven Drying on β-Carotene Content of Sliced Light Yellow-Fleshed Sweet Potato (Ipomea batatas L.). Nigerian Food Journal, 32 (2), 25–32. doi: 10.1016/s0189-7241(15)30114-4
13. Radjabov, M. F. (2015). Planning the Experiment of Treated Melon Slices during the Drying. MOJ Food Processing & Technology, 1 (4). doi: 10.15406/mojfpt.2015.01.00019
14. Yarovyj, I. L., Katasonov, O. V. (2015). Some problems of experimental modeling process drying plant material in a microwave electromagnetic field. Proceedings ONAFT, 47 (2), 227–231.
15. Atamanyuk, V. N., Huzova, I. A., Patrij, N. I. (2016). Hydrodynamics sludge drying coffee. Chemical Industry of Ukraine, 2, 12–16.
16. Han, Y.-C., Easa, S. M. (2016). Superior cubic channel section and analytical solution of best hydraulic properties. Flow Measurement and Instrumentation, 50, 169–177. doi: 10.1016/j.flowmeasinst.2016.06.019
17. Roumbas, G., Kastrinakis, E. G., Nychas, S. G. (2016). Scalar transport in the near field between two coaxial square air jets. Experimental Thermal and Fluid Science, 78, 229–241. doi: 10.1016/j.expthermflusci.2016.06.004
18. Atamanyuk, V., Huzova, I., Gnativ, Z., Mykyychak, B. (2016). The study of hydrodynamic processes at the gas flow filtration through the candied fruits layer. EU-REKA: Life Sciences, 4 (4), 9–13. doi: 10.21303/2504-5695.2016.00170
19. Atamanyuk, V. (2013). Scientific basis filtration drying dispersed materials. Lviv, 340.

THE EFFECT OF MONO- AND DISACCHARIDES ON STRUCTURAL-MECHANICAL PROPERTIES OF PECTIN GELS (p. 16-24)

Antonella Dorohovich, Viktoriya Dorohovich, Julya Kambolova

For creating the assortment of confectionery products for children, dietetic or functional designation, we examined the influence of mono- and disaccharides – glucose, fructose, saccharose and lactulose, on the structural and mechanical properties of pectin gel, formed on apple puree. It was determined that effective viscosity of pectin gels on glucose or fructose is larger than the viscosity of pectin
gel on saccharose. This is explained by the formation of the larger amount of hydrogen bonds between monosaccharides and molecules of pectin.

It was found that in the process of storing gels at temperature of 293 K, their strength grows. In this case, in gels on glucose we observed the formation of crystals, connected to the low solubility of glucose. To prevent the growth of crystals and reach necessary structural and mechanical, organoleptic indicators, it is recommended to reduce the amount of glucose in gels by 30%.

It was determined that lactulose increases the amount of free moisture in the pectin gels on saccharose or glucose, which decreases effective viscosity of their structure. In the pectin gels on fructose, on the contrary, the addition of lactulose reduces the total amount of free moisture, which increases effective viscosity of the structure. This is explained by the larger solubility of lactulose compared to saccharose or glucose, and lower than fructose.

The thixotropic properties of gel systems with mono- and disaccharides were studied and it was established that under production conditions, mechanical method of conducting thixotropy makes it possible to restore the structure of gel by 85–90% and conduct the process of molding.

We determined the losses of lactulose when storing pectin gels for 7 days, which amount to: 11% – for gel with saccharose and lactulose, 14.4% – with fructose and lactulose and 11.8% – with glucose and lactulose. These data must be included in the formulations of gels with functional properties to provide for the daily need of human organism in prebiotic.

Keywords: pectin gels, glucose, fructose, prebiotic lactulose, thixotropy, thixotropic properties, functional products, apple puree.

References
1. Willats, W. G. T., Knox, J. P., Mikkelsen, J. D. (2006). Pectin: new insights into an old polymer are starting to gel. Trends in Food Science & Technology, 17 (3), 97–104. doi: 10.1016/j.tifs.2005.10.008
2. Thakur, B. R., Singh, R. K., Handa, A. K., Rao, M. A. (1997). Chemistry and uses of pectin – A review. Critical Reviews in Food Science and Nutrition, 37 (1), 47–73. doi: 10.1080/10408399709527767
3. Phillips, G. O., Adams, P. A.; Kochetkova, A. V., Sarafanova, L. A. (Eds.) (2006). Handbook of hydrocolloids. Saint Petersburg: GIORD, 536.
4. Krupyvnytska, I. A., Pertsevoy, F. V., Omelchuk, E. O. (2015). Scientific and practical aspects of pectin and producty with pectin. Sumy National Agrarian University, 314.
5. Zubchenko, A. V. (2001). Physico-Chemical Bases confectionary technology of products. Voronezh State-owned technological academy, 389.
6. Yoo, B., Yoo, D., Kim, Y.-R., Lim, S.-T. (2003). Effects of sugar type on rheological properties of high methoxyl pectin gel. Food Science and Biotechnology, 12 (3), 316–319.
7. Donchenko, L. V., Firsov, G. G. (2007). Pectin: basic properties, production and application. Moscow: Delhi Print, 276.
8. Gorban, N. (2012). Choose marmalade: most children’s treat. Bakery and confectionery industry, 1, 28–29.
9. Kozhanov, Y. (2007). Market confectionery. Products & ingredients, 5, 28–31.
10. Ilicholob, S. (2007). The situation on the market of sugary confectionery products of Ukraine. Industrial overview. Food & Drinks, 4-5, 26–31.
11. Stacinewich, S. A., Walewski, S. M. (2013). Confectionery Market of Ukraine: supply and demand. Products & ingredients, 1, 14–17.
12. Express market analysis “Marmalade”. Available at: http://www.informsistema.com/result.asp
13. Grosso, C. R. F., Bobbio, P. A., Airoldi, C. (2000). Effect of sugar and sorbitol on the formation of low methoxyl pectin gels. Carbohydrate Polymers, 41 (4), 421–424. doi: 10.1016/s0144-8617(99)00099-5
14. Lobosova, L. A. (2007). Development of technology for Zephyr functional purpose on the basis of fructose. Voronezh state technological Academy, 19.
15. Avetisyan, K. V. (2015). Improvement of technology, double-layered jelly marmalade with the use of starch syrups. Odessa national Academy of food technologies, 23.
16. Krats, R., Kolesnikov, A. Y. (1997). New jelly marmalade on pectin. Food industry, 2, 20–21.
17. Magomedov, G. A., Magomedov, A. K., Miroshnikova, T. N., Lobosova L. A. (2007). The effect of fructose on studiohuline in the production of marshmallows. Confectionery production, 2, 31–33.
18. Solovyova, O. L. (2011). Improvement of the technology of jelly marmalade special consumption. Kyiv: National University of food technologies, 20.
19. Nakane, K. P. (2013). Effect of sorbitol substitution on physical, chemical and sensory properties of low-sugar mango jam. Proceeding – Science and Engineering, 12–18.
20. Evageliou, V. (2000). Effect of pH, sugar type and thermal annealing on high-methoxy pectin gels. Carbohydrate Polymers, 42 (3), 245–259. doi: 10.1016/s0144-8617(99)00191-5
21. Fu, J.-T., Rao, M. A. (2001). Rheology and structure development during gelation of low-methoxyl pectin gels: the effect of sucrose. Food Hydrocolloids, 15 (1), 93–100. doi: 10.1016/s0268-005x(00)00056-4
22. Hirahara, T. (2004). Key factors for the success of functional foods. BioFactors, 22 (1-4), 289–293. doi: 10.1002/biof.5520220156
23. Bagchi, D. (2008). Nutraceutical and functional food regulation. Academic press, 462.
24. Siró, I., Kápolna, E., Kápolna, B., Lugasi, A. (2008). Functional food. Product development, marketing and consumer acceptance – A review. Appetite, 51 (3), 456–467. doi: 10.1016/j.appet.2008.05.060
25. Ambrozewicz, E. G. (2005). Features of European and Eastern approaches to ingredients for health food products. Food ingredients. Raw materials and additives, 1, 30–31.
26. Dorohovich, A., Dorohovich, V., Kambulova, J. (2014). The study of the rheological properties of pectin gels with mono- and disaccharides. EUREKA: Life Sciences, 4 (4), 14–19. doi: 10.21303/2504-5695.2016.00167
27. Grabovsky, O. V., Kowalewska, Ye. I. (2009). Rheology of food products. Kyiv, National University of food technologies, 22.
28. Goralezyk, A. B., Pivovarov, P. P., Grinenko, O. A. et. al. (2006). Rheological methods of research of raw materials and food products and automation of calculations of rheological characteristics: a train. Kharkiv state University of food technology and trade, 63.
Determining technological parameters for treating pectin-containing raw materials in the technology of milk-vegetable minces (p. 25-31)

Grygoriy Dejnychenko, Victoriya Gnitsevych, Tatiana Yudina, Iryna Nazarenko, Olena Vasylieva

We substantiated scientifically and verified experimentally the choice of technological parameters for the treatment of vegetable raw materials to ensure the realization of their target properties as a structure-forming agent in the technology of milk-vegetable minces. A technological scheme of obtaining puree from carrot or pumpkin or zucchini was developed.

The procedure of obtaining puree from vegetables is as follows. Carrot of the Chantenay variety, pumpkin of the Gilea variety or zucchini of the Zolotinka variety are inspected, washed and peeled, shredded in cubes with rib size l=(0,8…1)×10⁻² m and are exposed to thermal treatment (TT) with steam at temperature τ=108…112 ºC for τ=(20…25) 60 s – for carrot and pumpkin and (15…20) 60 s – for zucchini. The vegetables are shredded at temperature τ=75…85 ºC to the size d=(5…7)×10⁻⁴ m. TT of puree is carried out at temperature τ=70…80 ºC for τ=(6…7) 60 s at pH of the medium – 3.0±3.4.

Puree from vegetables, received by the proposed techniques, has buttering consistency that does not stratify during storage and consequent usage. The accumulation of soluble pectin, which displays the properties of a structure-forming agent, milk-protein concentrate, milk-vegetable minces.

Keywords: pectin substances, soluble pectin, structure-forming agent, milk-protein concentrate, milk-vegetable minces.

References

1. Prokopenko, O. M. (2016). Balansy ta spozhynnia osnovnykh produktiv kharchuvannya naselenniam Ukrainy. Derzhava služha statystyky Ukrainy, 54.
2. Lipatov, N. N., Sazhynov, S. Yu., Bashikirov, O. I. (2001). Sovkupnoe kachestvo technolohicheskih proksetssov moloch-

noi promyshlennosti i kolichestvennye kriterii eho otsenki. Khranenie i pererabotka selkhozyria, 4, 33–34.
3. Asafov, V. A., Folomeeva, O. G. (2001). Perspektivy ispol- zovaniia rastitelnogo syria v proizvodstve molochnykh produktov. Syrodelie i maslodeliie, 1, 37–38.
4. Nursetoiva, Z. T. (2010). Razrabotka tekhnologii kombi-

niruyemykh syrov iz korovego i kozogo moloka s fermentirovannymi ovoshhami. Respublika Kazakhstana, Semei, 23.
5. Gnitsevych, V. A., Chehova, N. S. (2011). Doslidzhennia pokaznykiv yakosti napivfabrikatu na osnovi pecheryt ta nasinnya garbuza. Obladannia ta tekhnologii kharchovych byrobyntstv, 28, 207–212.
6. Romanova, V. V. (2005). Proektirovanie geleobraznykh produktov s ispolzovaniem molochnoi syvorotki i rastitel-

nogo syria. Kemerovo, 18.
7. Amennkova, N. B. (2006). Quality change of combined extru-

sion products during storage. Global safety of commodity and environment. Quality of life. The 15th Symposium of IGWT, 806–811.
8. Young, G. (1995). Future opportunities for functional foods. Food Manufacture, 70 (10), 63–72.
9. Erdem, Y. K., Ulusoy, A. (2004). Manufacturing of white pickled cheese from the full concentrated whole milk’s reten-

tate. IFD Symposium on cheese: Ripening, Characterization and Technology, 130.
10. Martynov, A. V. (2000). Mirovye tendencii postroeniia as-

sortimentnoi politiki. Molochnaia promyshlennost, 2, 26.
11. Gorbatova, K. K. (2003). Khimiia i fizika moloka. SPb.: GIORD, 288.
12. Yudina, T. I. (2000). Oderzhannia molochno-bilkovogo kropetsyiptatit si skolytyn i doslidzhennia yogo yakisnykh pokaznykiv: Visnyk DonDUET. Tekhnichni nauky, 6, 60–64.
13. Geisow, M. (1977). Serum albumin structure and function. Nature, 270 (5637), 476–477. doi: 10.1038/270476a0
14. FAO/WHO. Energy and Pritein Requirements. Report of a Joint FAO/WHO ad Hoc Expert Committee, WHO (1973). Techn. Rep. Ser., 64–65.
15. Kühnau, J. (1949). Biochemie des Nahrungseiweisses. Angewandte Chemie, 61 (9), 357–365. doi: 10.1002/ange.19490610904
16. Odarchenko, D. M., Dubinina, A. A., Zinenko, O. V. (2002). Doslidzhennia karotyniv u protsesi zberezhennia zamorozhnykh past na osnovi morkvy ta garbuza. Vestnik Khersonskogo gosudarstvennogo tehnicheskogo universitet-a, 3, 415–418.
17. Telezhenko, L. N., Bezusov, A. T. (2004). Biologicheski ak-

tivnye veshchestva fruktov i ovoshhei i ikh sokhraneniie pri pererabotke. Odessa: «Optimum», 268.
18. Yudina, T. I., Nazarenko, I. A. (2012). Obgruntuvannia vy-

provnyt s ispolzovaniem molochnoї syvorotki i rastitel-

nogo syria v proizvodstve molochnykh produktov. Syrodeliie i maslodeliie, 1, 37–38.
19. Belaev, M. I., Maliuk, L. P. (2005). Printsyp soosazhde-

stv, 29 (2), 322–328.
20. Pokrovskii, A. A., Leviant, P. P. (1970). Printsyp soosazhde-

niaiia vzaimodopolniaiushchikh belkov i belkovyi obogatitel, poluchaemyi na ego osnove. Voprosy pitaniia, 5, 3–12.
21. Vasilenko, Z. V., Masanskii, S. L., Bolotko, A. Yu. (2004). Izuchenie vliianiia osnovnykh tekhnologicheskikh fakt-

torov na svoistva mnogofunktionalnogo polufabrikata iz mezgi morkvy Khranenie i pererabotka selkhozyria, 11, 50–52.
22. Kuliev, N. Sh., Amonova, Z. M. (2005). Struktura miakogo morozhennogo s fruktovo-ovoshchennymi stabilizatorami. Pishchevyie ingredienty. Syrie i dobavki, 2, 92.

23. Pogarskaia, V. V., Cherevko, A. I., Paviuk, R. Yu. et. al. (2007). Novye tehnologii funktsionalnykh ozdorovitelnykh produktov. Kharkovskiy gosudarstvenny universitet pitania i torgovli, 262.

24. Krapyvnyts’ka, I. O. (2012). Pat. 73050 Ukraina: MPK A 23 L 1/06. Sposib vyrobnyctva pektynovismishnoho ovochevoho pyure. Zayavnyk i patentovlasnyk Natsional’nyi universitet kharkovskiyh tehnologiy. u 201202160; declrated: 24.02.12; published: 10.09.12, Bul. 17, 5.

25. Deynychenko, G., Gnitsevych, V., Yudina, T., Nazarenko, I., Vasylieva, O. (2016). The study of technological parameters of pectin containing raw material processing in the vegetable-milk forcemeats technology. EUREKA: Life Sciences, 4 (4), 29–36. doi: 10.21303/2504-5695.2016.001895

**STUDY OF INFLUENCE OF TECHNOLOGICAL FACTORS ON THE SORPTION OF IONIZED CALCIUM FROM SKIMMED MILK BY SODIUM ALGINATE (p. 32-39)**

Raisa Plotnikova, Nataliya Grychenko, Pavlo Pyvovarov

The possibility of regulating the composition of the salt system of skimmed cow milk for the purpose of regulating the functional and technological properties was investigated. Parameters for the regulation of the composition of the salt system of skimmed cow milk were established. We defined the prospects of using sodium alginate as a natural ion exchanger, the implementation of whose properties for the binding of calcium ions allows using it under conditions of regulating the composition of the salt system of skimmed cow milk or the systems based on it, stable over time and during thermal treatment. The research revealed the influence of technological factors on the process of sorption of ionized calcium by the solution of complexing agent sodium alginate. It was determined that the important factors that affect the process are active acidity and the conditions of conducting the process, namely, a phased introduction of the sorbent, which contributes to the same speed of the process and, as a result, obtaining the same sorption speed throughout the whole process. In addition, the study of influence of the sorption area and temperature indicate that these factors are not determining in this process. Rationalization of parameters of the sorption of ionized calcium leads to the increased thermal stability of skimmed cow milk and the systems based on it. Materials, presented in this paper, are the basis for the development and implementation of technologies of new food products, the composition of which provides colloidal stability under condition of the joint use of dairy and fruit and berries raw materials, which might be used in food industry.

**Keywords:** skimmed cow milk, complexing agent, sodium alginate, ionized calcium, sorption.

**References**

1. Singh, H. (2004). Heat stability of milk. International Journal of Dairy Technology, 57 (2-3), 111–119. doi: 10.1111/j.1471-0307.2004.00143.x

2. Faka, M., Lewis, M. J., Grandison, A. S., Deeth, H. (2009). The effect of free Ca2+ on the heat stability and other characteristics of low-heat skim milk powder. International Dairy Journal, 19 (6-7), 386–392. doi: 10.1016/j.idairyj.2008.12.006

3. Tepel, A. (2012). Chemistry and physics of milk. Saint Petersburg: Profession, 824.

4. Philippe, M., Legraet, Y., Gaucheran, F. (2005). The effects of different cations on the physicochemical characteristics of casein micelles. Food Chemistry, 90 (4), 673–683. doi: 10.1016/j.foodchem.2004.06.001

5. Auty, M. A. E., O’Kennedy, B. T., Allan-Wojtas, P., Mulvihill, D. M. (2005). The application of microscopy and rheology to study the effect of milk salt concentration on the structure of acidified micellar casein systems. Food Hydrocolloids, 19 (1), 101–109. doi: 10.1016/j.foodhyd.2004.04.019

6. Xu, Y., Liu, D., Yang, H., Zhang, J., Liu, X., Regenstein, J. M. et. al. (2016). Effect of calcium sequestration by ion-exchange treatment on the dissociation of casein micelles in model milk protein concentrates. Food Hydrocolloids, 60, 59–66. doi: 10.1016/j.foodhyd.2016.03.026

7. Post, A. E., Arnold, B., Weiss, J., Hinrichs, J. (2012). Effect of temperature and pH on the solubility of caseins: Environmental influences on the dissociation of αs- and β-casein. Journal of Dairy Science, 95 (4), 1603–1616. doi: 10.3168/jds.2011-4641

8. Tanashuk, S., Savchenko, O., Nkolaych, А. (2006). Zastosuvaniya ioneobmennych smol. Harchova i pererobna promislovist, 2, 23–25.

9. Sokolova, L. I. (1975). Application of ion exchange processes for the thermal stability of milk. Moscow, USSR: Moscow Technological Institute of Meat and Dairy Industry, 21.

10. Fedushnov, P. A. (2007). Izpolzovanie sistema Budal 935. Produktu i ingredientu, 63–67.

11. Pyvovarova, O., Grinchenko, O., Pyvovarov, Y. (2009). Analytic study of the system «AlgNa – CaSO4 – water» and scientific prognostication of its structure-forming regularity. Formular de evaluare. 33 Congres Ara : a lucrarilor din cadrul Celui, 101–113.

12. Pyvovarov, P. P., Neklesa, O. P., Nagorniy, A. Yu. (2013). Innovatsionnyie tehnologii proizvodstva kapsulirovannyih produktov. Produktyi & ingredientyi, 3, 24.

13. Moroz, O. V., Protsik, V. O., Pyvovarov, Y. P. (2012). Doslidzhennya vplivu kaltsiu na strukturno-mehanichni vlastivosti alghnovих draghiv z metoyo vikoristannya v tehnologii produktsiyi z zhelechynou strukturoyu. Visnik Kharkivskogo natsionalnoho tehnicnogo universytetu sil skogo gospodarstva Im. P. Vasilenka. Suchasni napryamy tehnologi ta mehanizatsiyi protsesiv pererobnih i harchevih virobnist, 131, 271–278.

14. Donskaya, G. V., Drozhzhin, V. M., Grivkova, A. I. (1998). Izbiratelnoe sorbent rastitel’nogo prishodgeniya dlya ochistki moloka ot stronziya. Molochnaya promushlennost, 1, 31–32.

15. Plotnikova, R., Grychenko, N., Pyvovarov, P. (2016). The study of sorption of the milk ionized calcium by sodium alginate. EUREKA: Life Sciences, 4 (4), 45–48. doi: 10.21303/2504-5695.2016.00191

16. Pyvovarov, O. P. (2009). Tehnologiya polufabrikatov re-strukturirovannuy na osnovno shampionov Kharkiv State University of Food and Trade, 19.
EXPLORING THE EFFECT OF DRY PROTEIN-CARBOHYDRATE SEMI-FINISHED PRODUCT ON THE STRUCTURAL-MECHANICAL PROPERTIES OF YEAST DOUGH OBTAINED BY THE ACCELERATED TECHNIQUE (p. 39-45)

Svitlana Popova, Alina Slashcheva, Radion Nykyforov, Yuri Korenets

The purpose of the conducted research was the substantiation of rational concentration of dry protein-carbohydrate semi-finished product (DPCS) from the point of view of structural-mechanical and rheological properties of yeast dough.

The research was conducted on the model systems of yeast dough, obtained by the accelerated technique through preliminary activation of yeast in a nutrient medium of the dry additive, obtained from the secondary products of potato processing.

The obtained results demonstrated that the examined additive contributes to the strengthening of gluten properties of flour, which contributes to an increase in the energy of dough in the process of fermentation. The samples of dough with the addition of DPCS have a stable structure, which ultimately ensures the absence of adhesion of dough with the working bodies of technological equipment.

It is proven that the use of DPCS in the concentration of 15% by weight of flour contributes to an improvement in the structural-mechanical and rheological properties of yeast dough.

The obtained formulation will make it possible to produce a broad range of products at the enterprises with low capacities such as mini-bakeries, flour shops in supermarkets, and restaurants.

Keywords: dry protein-carbohydrate mixture, dry potato additive, yeast dough, structural-mechanical properties, rheological properties.

References

1. Cauvain, S. P. (2016). Bread: BakingProcesses. Encyclopedia of Food and Health, 478–483. doi: 10.1016/B978-0-12-384947-2.00087-8
2. Huang, S., Miskelly, D. (2016). Optional Ingredients for Dough. Steamed Breads, 47–63. doi: 10.1016/B978-0-08-100715-0.00004-5
3. Rosell, C. M. (2012). Nutritionally enhanced wheat flours and breads. Baking America, 687–710. doi: 10.1533/9780857095693.4.687
4. Rodríguez Furlán, L. T., Pérez Padilla, A., Campderros, M. E. (2015). Improvement of gluten-free bread properties by the incorporation of bovine plasma proteins and different saccharides into the matrix. Food Chemistry, 170, 257–264. doi: 10.1016/j.foodchem.2014.08.033
5. Lebedenko, T. E., Kozhevnikova, V. O., Sokolova, N. Yu. (2015). Improving the activation process of the yeast through the use of herbal supplements [Udokonalennya protseu aktivatsiyi drizhzhiv shlyachom vikoristannya fitodobavok]. Food science and technology, 2 (31), 25–33. doi: 10.15673/2073-8684.31/2015.44264
6. Slashcheva, A., Nykyforov, R., Popova, S., Korenets, Y. (2016). Study of the protein-carbohydrate mix effect on the technological properties of short yeast-leavened dough. Eastern-European Journal of Enterprise Technologies, 2 (11 (80)), 24–31. doi: 10.15587/1729-4061.2016.64294
7. Hager, A.-S., Zannini, E., Arendt, E. K. (2012). Formulating breads for specific dietary requirements. Baking America, 711–735. doi: 10.1533/9780857095693.4.711
8. Lebedenko, T. E., Kozhevnikova, V. O., Sokolova, N. Yu. (2015). Modern ideas about the nutritional value of bakery products. The main directions of their correction [Sovremennye predstavleniya o pishchevoy tsennosti khrubushnoy izdeliy. Osnovnye napravleniya diya ih korrektsii]. Grain products and mixed fodders, 2 (58), 19–25. doi: 10.15673/2313-478x.38/2015.46011
9. O’Regan, J., Ennis, M. P., Mulvihill, D. M. (2009). Milk proteins. Handbook of Hydrocolloids, 298–338. doi: 10.1053/9781845695873.238
10. Singh, H. (2016). Functional Properties of Milk Proteins. Reference Module in Food Science, 358–402. doi: 10.1016/B978-0-08-100596-5.00034-3
11. Van Riemsdijk, L. E., Pelgrom, P. J. M., van der Goot, A. J., Boom, R. M., Hamer, R. J. (2011). A novel method to prepare gluten-free dough using a meso-structured whey protein particle system. Journal of Cereal Science, 53 (1), 133–138. doi: 10.1016/j.jcs.2010.11.003
12. Popova, S. Ju., Nykyforov, R. P., Slashcheva, A. V. (2015). Pre-activation optimization of the yeast. Technology Audit and Production Reserves, 5 (4 (25)), 29–35. doi: 10.15587/2312-8372.2015.51760
13. Korshunova, G. F., Nykyforov, R. P., Gnitsevich, V. A. (2007). Pat. 27201 Ukraine, MPK CA23C 23/00, A23C 9/152. A method of producing a dry mixture [Spособ otrimannya suhoyi sumish]. № u200705242; declarated: 14.07.2007, published: 23.10.2007, Bul. 17, 3.
14. Hadiyanto, Asselman, A., Straten, G. van, Boom, R. M., Eveld, D. C., Boxtel, A. J. B. van (2007). Quality prediction of bakery products in the initial phase of process design. Innovative Food Science & Emerging Technologies, 8 (2), 285–298. doi: 10.1016/j.ifset.2007.01.006
15. Ronda, F., Pérez-Quirce, S., Villanueva, M. (2017). Rheological Properties of Gluten-Free Bread Doughts: Relationship With Bread Quality. Advances in Food Rheology and Its Applications, 297–334. doi: 10.1016/B978-0-08-100431-9.00012-7
16. Sanz, T., Salvador, A., Hernández, M. J. (2017). Creep–Recovery and Oscillatory Rheology of Flour-Based Systems. Advances in Food Rheology and Its Applications, 277–295. doi: 10.1016/hj978-0-08-100431-9.00011-5
17. Heertje, I. (2014). Structure and function of food products: A review. Food Structure, 1 (1), 3–23. doi: 10.1016/j.foodstr.2013.06.001
18. Kinsella, J. E. (1987). Physical Properties of Food and Milk Components: Research Needs to Expand Uses. Journal of Dairy Science, 70 (11), 2419–2428. doi: 10.3168/jds.s0022-0302(87)80304-1
19. Kneifel, W., Paquin, P., Abert, T., Richard, J.-P. (1991). Water-Holding Capacity of Proteins with Special Regard to Milk Proteins and Methodological Aspects – A Review. Journal of Dairy Science, 74 (7), 2027–2041. doi: 10.3168/jds.s0022-0302(91)78373-2
20. Dotsenko, V. F., Ischenko, T. I., Shidlovskaya, O. B., Ivahno, O. O. (2013). Pat. 104091 Ukraine, MPK A21D 8/02 (2006.01). Method of production of dietary wheat bread [Method of production of dietary wheat bread]. № a 2012 12522; declarated: 02.11.2012; published 25.12.2013, Bul. 24, 8.
21. Popova, S., Slashcheva, A., Nykyforov, R., Korenets, Yu. (2016). Study of rheology of yeast dough with protein-carbohydrate additives. Technology and equipment of food production, 42 (6), 15–25.
EFFECT OF SAUTEING OF ONION ON ITS STORAGE AT LOW TEMPERATURES  (p. 46-50)

Oleksander Cherveyko, Andrey Odarchenko, Nycolay Pogozhikh, Dmytro Odarchenko, Evgenia Sokolova

We studied dynamics of freezing and defrosting of sautéed onion, determined its acidic and peroxide number, which was stored during 30 days at temperature of –18 °C. The change in anatomical structure of frozen onion depending on thermal pre-treatment was examined.

The technology of production of frozen vegetable mixes implies the use of thermal treatment; therefore, selecting the method of canning, which will make it possible to maximally preserve useful substances of chemical composition of a product, is relevant.

As the object of experiment we used fresh and frozen sautéed onion.

It was found as a result that at temperature of freezing –20 °C, the value of maximum speed of freezing practically does not change; this indicates that the rate of cooling is not limited by thermal and physical properties of the sample.

We also experimentally determined the increase in acid number in the process of refrigeration storage during 30 days and the decrease in peroxide number in the examined samples of sautéed and frozen onion.

It was revealed that the cells of onion after sautéing changed their form and structure: they do not have a clear form and orderliness; the breaks are visible at the contours of the walls of cells. The luminescent formations after sautéing of onion change their form as a result of deformation of cellular membranes.

The obtained data may be used for providing high quality of the frozen vegetable mixes for soups and for determining rational regimes of freezing and defrosting of sautéed onion in their composition. Adding sautéed onion to the frozen vegetable mixes is expedient and will not change organoleptic properties of a product; it will not accelerate the oxidation processes of fats, but will only help to preserve the integrity of shape and delicate consistency of onion in a soup prepared from such a mix.

Keywords: freezing, luminescent substances, sautéing, anatomical structure, acid number, refrigeration storage.

References

1. Melo, C. O., Moretti, C. L., Machado, C. M. M., Mattos, L. M., Muniz, L. B. (2012). Chemical and physical alterations in stored onion genotypes under refrigeration. Ciência Rural, 42 (11), 2078–2084. doi: 10.1590/S0103-84782012001100027

2. Abrameto, M. A. (2010). Analysis of methodologies for the study of composition and biochemical carbohydrate changes in harvest and postharvest onion bulbs. International Journal of Experimental Botany, 79, 123-132.

3. Kniecik, W., Lisiewska, Z., Sluski, J., Gębryczynski, P. (2008). The effect of pre-treatment, temperature and length of frozen storage on the retention of chlorophylls in frozen brassicas. J. Acta Sci. Pol., Technol. Aliment, 7 (2), 21–34.

4. Komolka, P., Gorecka, D., Dzedzic, K. (2012). The effect of thermal processing of cruciferous vegetables on their content of dietary fiber and its fractions. J. Acta Sci. Pol., Technol. Aliment, 11 (4), 347–354.

5. Park, S. H., Balasubramaniam, V. M., Sastry, S. K. (2014). Quality of shelf-stable low-acid vegetables processed using pressure-ohmic-thermal sterilization. LWT – Food Science and Technology, 57 (1), 243–252. doi: 10.1016/j.lwt.2013.12.036

6. Roldán, E., Sánchez-Moreno, C., de Ancos, B., Cano, M. P. (2008). Characterisation of onion (Allium cepa L.) by-products as food ingredients with antioxidant and anti-browning properties. Food Chemistry, 108 (3), 907–916. doi: 10.1016/j.foodchem.2007.11.058

7. Pinho, C., Soares, M. T., Almeida, I. F., Aguiar, A. A. R. M., Mansilha, C., Ferreira, I. M. P. L. V. O. (2016). Impact of freezing on flavonoids/radical-scavenging activity of two onion varieties. Czech Journal of Food Sciences, 33 (4), 340–345. doi: 10.17221/704/2014-cfs

8. Gennaro, L., Leonardi, C., Esposito, F., Salucci, M., Maiani, G., Quaglia, G., Fogliano, V. (2002). Flavonoid and Carbohydrate Contents in Tropea Red Onions: Effects of Homelike Peeling and Storage. Journal of Agricultural and Food Chemistry, 50 (7), 1904–1910. doi: 10.1021/jf011102r

9. Colantonio, A., Longo, L., Biondi, P., Baciotti, B., Monarca, D., Salvati, L. et. al. (2014). Thermal stress of fruit and vegetables pickers: temporal analysis of the main indexes by “predict heat strain” model. Contemporary Engineering Sciences, 7, 1881–1891. doi:10.12988/ces.2014.410201

10. Roy, M. K., Takenaka, M., Isobe, S. (2007). Thermal processing enhances anti-radical activity and reduces pro-oxidant activity in water-soluble fraction of selected Allium vegetables. Journal of the Science of Food and Agriculture, 87 (12), 2259–2265. doi: 10.1002/jsfa.2981

11. Rickman, J. C., Barrett, D. M., Bruhn, C. M. (2007). Nutritional comparison of fresh, frozen and canned fruits and vegetables. Part 1. Vitamins C and B and phenolic compounds. Journal of the Science of Food and Agriculture, 87 (6), 930–944. doi: 10.1002/jsfa.2825

12. Cordella, C., Moussa, L., Martel, A.-C., Sbirrazzuoli, N., Lizzani-Cuvelier, L. (2002). Recent Developments in Food Characterization and Adulteration Detection: Technique-Oriented Perspectives. Journal of Agricultural and Food Chemistry, 50 (7), 1751–1764. doi: 10.1021/jf010996z

13. Ahmed, J. (2006). High pressure processing of fruits and vegetables. Stewart Postharvest Review, 2 (1), 1–10. doi:10.2212/spr.2006.5.9

14. Odarchenko, A. M., Odarchenko, D. M., Pohozhykh, M. I. (2006). Pat. 13953 Ukraina, MPK A23L 1/00. Prystryb dlya vyvzachennya kil’kosti vi’tnoyi ta zv’yazanyoi volobry pri temperaturakh, bly’kykh do temperatury ridkoho azotu. Zayavnyk ta patentovlasnyk Kharkivsky universytet kharchovykh ta torhivli. u200511091; declarated: 23.11.05; published: 17.04.06, Bul. 4, 4.

15. Cherkevko, O., Odarchenko, A., Pogozhikh, N., Odarchenko, D., Sokolova, E. (2016). The study of thermal reversibility of the freezing-defrost process of browned onion. EUREKA: Life Sciences, 4 (4), 20–28. doi: 10.21303/2504-5695.2016.00169
16. Chope, G. A., Terry, L. A., White, P. J. (2006). Effect of controlled atmosphere storage on ascorbic acid concentration and other biochemical attributes of onion bulbs. Postharvest Biology and Technology, 39 (3), 233–242. doi: 10.1016/j.postharvbio.2005.10.010

17. Lisiewska, Z., Gebczynski, P., Kmiecik, W., Skoczen-Slupska, R. (2007). Effect of vegetable freezing and preparation of frozen foods for consumption on the content of lead and cadmium. J. Environ. Stud. 16, 579–585.

18. Bahceci, K. S., Serpen, A., Gökmen, V., Acar, J. (2005). Study of lipooxygenase and peroxidase as indicator enzymes in green beans: change of enzyme activity, ascorbic acid and chlorophylls during frozen storage. Journal of Food Engineering, 66 (2), 187–192. doi: 10.1016/j.jfoodeng.2004.03.004

19. Avramiuc, M. (2015). The comparison of acid ascorbic content during processing of some vegetables and fruits. Analele Stiintifice Ale Universitatii Alexandru Ioan Cuza din Iasi, Seziunea II A: Genetica si Biologice Moleculare, 2 (16), 327–349.

20. Odarchenko, A. M. (2012). Changes in the anatomical structure of frozen berries based on pre-treatment [«Zminy anatomichni budovy zamorozhenykh yahid zalezhno vid poperedomi obrobky»]. Tovary i rynky, 1, 117–122.

**TECHNOLOGY OF HEALTHY PROCESSED CHEESE PRODUCTS WITHOUT MELTING SALTS WITH THE USE OF FREEZING AND NON-FERMENTATIVE CATALYSIS (p. 51-61)**

**Raisa Pavlyuk, Viktoryia Pogarska, Olga Yurieva, Lidia Skripka Tatjana Abramova**

Authors studied comprehensive influence of the processes of non-fermentative catalysis – cryomechanalysis and freezing of solid rennet cheeses during their preparation for melting, which leads to the cryodestruction of low-soluble paracaseinatocalciumphosphate nanocomplexes into soluble gel form. It was established that there occurs their cryodestruction and transformation of their significant part to the nanoform (by 45...55 %). A nanotechnology of healthy processed cheese products was developed. Mechanisms of the processes were revealed. It was established that during freezing and finely dispersed grinding of solid rennet cheeses before melting, there occurs cryomechanodestruction and non-fermentative cryocatalysis (destruction) of protein molecules to separate monomers – α-amino acids by 55...60 %, that is a significant part of amino acid is transformed from the bound state to the free soluble form. A mechanism of the process was revealed; it was shown that in parallel with the destruction of nanocomplexes, nanoparticles of protein, whose conformational changes take place: erasing molecules, decreasing in volume, shape, the ratio of hydrophobic and hydrophilic groups in a molecule, and filling the nucleus of a molecule with hydrophobic residues. Authors proposed and developed the cryogenic nanotechnology of manufacturing processed cheese products based on solid rennet cheeses without melting salts, which includes an integrated influence of freezing and finely dispersed grinding, non-fermentative catalysis. It was established that cheese products, produced by the nanotechnology (fillings for confectionery products “PanCake”, dressing sauces, dipping sauces, ball shaped snacks) and enriched with herbal additives, exceed the known analogs in chemical composition. In addition, a large part of substances (as BAS and biopolymers) in cheese products is in the nanostructured form (55...60 % of protein) in the form of free amino acids.

New technologies of healthy processed cheese products have been tested under production conditions at a number of the Ukrainian enterprises (TOV VKG “Lisova kazka”, NVP “FIPAR”, NVP “KRIAS-1”). The regulatory documentation (TU, TI for “cheese and vegetable fillings for confectionery products “PanCake” and cheese dressing sauces”) was developed and approved.

**Keywords**: non-fermentative catalysis, mechanalysis, freezing, low temperature grinding, hard rennet cheese, nanocomplexes, processed cheese products.

**References**

1. FAO/WHO/UNU. Global’naya strategiya po pitaniyu, molokoproduktam i meditsinskim dietyam. Moskva: Nauka, 2003. 255 p.

2. FAO/WHO/UNU. Dietary protein quality evaluation in human nutrition. Report of an FAO Expert Consultation (2013). Food and agriculture organization of the united nations Rome, 92-57.

3. Pavlyuk, R. Yu., Pohars'ka, V. V., Yur'yeva, O. O., Pavlyuk, V. A. et al. (2014). Kriokataliz, distichnii i kriokhimiya v kharchovykh tekhnolohiyakh. Kharkiv: Finart, 260.

4. Gö, A., Kanawjia, S. K., Rajoria, A. (2014). Effect of phytochemicals on the texture and sensory properties of cheese spread. Food Chemistry, 145, 437–444. doi: 10.1016/j.foodchem.2014.08.049

5. Rudav's'ka, H. B., Holub, B. O. (1999). Osdorovochni produktu (TU, TI for “cheese and vegetable fillings for confectionery products”, “Crispy Jo”, “PanCake”). The regulatory documentation (TU, TI for “cheese and vegetable fillings for confectionery products “PanCake” and cheese dressing sauces”) was developed and approved.

6. McCarthy, C. M., Wilkinson, M. G., Kelly, P. M., Guinee, T. P. et al. (2011). New technologies of healthy processed cheese products. Technology and equipment of food production. 2011, 5(4), 297–302.

7. Rudav's'ka, H. B., Holub, B. O. (1999). Osdorovochni produktu (TU, TI for “cheese and vegetable fillings for confectionery products”, “Crispy Jo”, “PanCake”). The regulatory documentation (TU, TI for “cheese and vegetable fillings for confectionery products “PanCake” and cheese dressing sauces”) was developed and approved.

8. McCarthy, C. M., Wilkinson, M. G., Kelly, P. M., Guinee, T. P. et al. (2011). New technologies of healthy processed cheese products. Technology and equipment of food production. 2011, 5(4), 297–302.

9. McCarthy, C. M., Wilkinson, M. G., Kelly, P. M., Guinee, T. P. et al. (2011). New technologies of healthy processed cheese products. Technology and equipment of food production. 2011, 5(4), 297–302.

10. Katarzyna, K. (2008). Czynniki kształtujące teksturę serów topionych. ŻYWNOŚĆ. Nauka. Technologia. Jakość, 3 (58), 5–17.

11. Cichosz, G. (2000). Technologia serów topionych. Warszawa: Hoża, 255.

12. Szczesniak, A. S. (2002). Texture is a sensory property. Food Quality and Preference, 13 (4), 215–225. doi: 10.1016/s0950-3293(01)00039-8

13. Barambojm, N. K. (1978). Mekhanohimiya vysokomolekularnyh soedinenij. Moscow: Himiya, 384.
14. Allen Foegeding, E., Brown, J., Drake, M., Daubert, C. R. (2003). Sensory and mechanical aspects of cheese texture. International Dairy Journal, 13 (8), 585–591. doi: 10.1016/s0958-6946(03)00094-3
15. Tamime, A. Y. (2011). Processed Cheese and Analogues: An Overview. Processed Cheese and Analogues, 1–24. doi: 10.1002/9781444341850.ch1
16. Surówka, K. (2002). Tekstura żywności i metody jej badania. Przem. Spóż., 10, 12–17.
17. Pavlyuk, R. Yu., Cherevko, A. I., Gulyj, I. S. et. al. (1997). Novye tekhnologii vitaminnyh uglevodsoderzhashchih fito-dobavok i ih ispol'zovanie v produktah profilakticheskogo dejstviya. Kharkiv; Kyiv, 285.
18. Pogarskaya, V. V., Pavlyuk, R. Yu., Cherevko, A. I., Pavlyuk, V.A., Maksimova, N. F. (2013). Aktivaciya gidrofil'nyh svojstv karotinoidov rastitel'nogo syr'ya. Kharkiv: Fі-nart, 345.
19. Pavlyuk, R. Yu., Pohars'ka, V. V., Radchenko, L. O., Yuryeva, O. O., Hasanova, H. E., Abramova, T. S., Kolomiyets', T. M. (2015). The development of technology of nanoextracts and nanopowders from herbal spices for healthful products. Eastern-European Journal of Enterprise Technologies, 3(10(75)), 54–59. doi: 10.15587/1729-4061.2015.43323
20. Pavlyuk, R., Pogarska, V., Yurieva, O., Skripka, L., Abramova, T. (2016). Elaboration of the new method of the melt cheese products manufacturing without salts-smelters using cryomechanolysis. EUREKA: Life Sciences, 4 (4), 49–56. doi: 10.21303/2504-5695.2016.00193
21. Pavlyuk, R., Pogarska, V., Pavlyuk, V., Balahai, K., Loseva, S. (2016). The development of cryogenic method of deep treatment of inulin-containing vegetables (topinambour) and obtaining of prebiotics in the nanopowders form. EUREKA: Life Sciences, 3 (3), 36–43. doi: 10.21303/2504-5695.2016.00145