

DEVELOPMENT OF TECHNOLOGY OF USING SUBSTANDARD EGGS IN FARM POULTRY FEEDING (p. 4-14)

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Theoretically and experimentally, there was substantiated the expediency of enriching grain raw material in the composition of feed with the protein of animal origin due to a substantial reduction of nutritional and energy value of the grain components that are produced in Ukraine, often with violation of agrotechnology. The possibility to use valuable substandard egg mass for feeding agricultural poultry was proved. This will allow solving the problem of utilizing defective eggs.

A technological way of producing the extruded feed additive was developed, which implies obtaining the preceding mixture of crushed corn and egg mass without shell of substandard chicken eggs in the 1:1 ratio in a frame mixer for 180 s, mixing the preceding mixture with corn grit, which remained in the blade batcher for 120...180 s, and the extrusion of the resulting highly homogeneous mixture. The rational parameters of technological process of the extrusion of the feed additive were established: pressure in the working zone of the extruder is 2...3 MPa, power consumption of the electromotor is 4.0...4.5 kW, product temperature at the outlet of the extruder is 110...120 °C, duration of the process is 60...120 s, diameter of the hole of the matrix is 10 mm. The optimum amount of the egg mass in the mixture is 10 %. The influence of the extrusion process on the quality and nutritional value of the extruded feed additive was defined. During the extrusion process, the 3,1 % loss of crude protein content was observed, the starch content decreased by 26.8 %, in this case, the content of water-soluble carbohydrates increased by 6 times. During the storage of the extruded feed additive for 3 months, bacterial semination decreased by 7 times.

Biological assessment of efficiency of the improved technology of the production of extruded feed additive was defined on laboratory animals, and it was found that the extruded feed additive is characterized by high biological value, so in the tested group the daily average gain of live weight of rats was 25,4 % higher, and the conversion of feed was 20.3 % lower than in the control group.

Keywords: extruded feed additive, production technology, enrichment of grain raw materials, substandard eggs.

References

- Shevcov, A. A., Ostrikov, A. N., Lytkina, L. I., Suharev, A. I. (2005). *Povyshenie yeffektivnosti proizvodstva kombikormov*. Moscow: DeLi Print, 243.
- Iegorov, B. V. (2011). *Tehnologiya virobnictva kombikormiv*. Odesa: Drukars'kij dim, 448.
- Svezhencov, A. I. (2008). *Kombikorma, premiksy, BVMD dlya zhyvotnyh i pticy*. Dnepropetrovsk: ART-PRESS, 412.
- Luk'yanova, V. D., Dugonov, Ye. A., Kosenko, N. F. (1989). *Promyshlennoe pticevodstvo*. Moscow, 278.
- Svezhencov, A. I., Urdzik, R. M., Egorov, I. A. (2006). *Korma i kormlenie sel'skohozyajstvennoj pticy*. Dnepropetrovsk: ART-PRESS, 232–361.
- Podobed, L. I. (1994). *Kombikormi dlya molodnyaka sil's'kogospodars'kih tvarin*. Kyiv: Urozhaj, 144.
- Pelevin, A. D., Pelevina, G. A., Vencova, I. Yu. (2008). *Kombikorma i ih komponenty*. Moscow: DeLi print, 519.
- Direktiva Evropejs'kogo parlamentu ta Radi ES 07.052002. N 2002/32/ES pro nebazhani rehovini u kormah dlya tvarin.
- Reglament Evropejs'kogo parlamentu ta Radi ES 22.09.2003. N 1831/2003 pro domishki dlya vikoristannya u harchuvanni tvarin.
- Mel'nik, V. V. (2007). *Kormi dlya pticy*. Suchasne ptahivnictvo, 5-6 (54-55), 14–19.
- Taranu, I. (2006). *Nutrition, feeding and egg quality*. Poultry international, 8, 38–42.
- Egorov, I. A., Toporkov, N. V. *Novye podhody v ispol'zovanii netradicionnyh kormov v pticevodstve*. VNITIP. Available at: <http://www.webpticeprom.ru/ru/articles-birdseed.html?pageID=1209369752>
- Yackson, M. (2009) *Improving soya utilization in monogastrics: maize-soya diets with β -mannanase*. Feed international, 12, 22–26.
- Gill, C. (2007). *Poultry nutrition update*. Feed international, 4, 16–17.
- Gill, C. (2008). *Enzymes for broilers: reducing maize energy variability*. Feed international, 4, 12–14.
- Semykin, V. A., Pigorev, I. Ya., Oksenenko, I. A. (2008). *Vozdelyvanie kukuruzy na zerno bez gerbicidov*. *Sovremennye naukoemkie tehnologii*, 4, 58–60.
- Bol'shinstvo yaic v mire proizvodyat 15 stran (2012). *Dajdzhest mirovogo pticevodstva*. Prilozhenie k zhurnalu "Ptica i pticeprodukty", 2 (16), 76.
- Velyamov, M. T., Knyazheva, Zh. K., Kashaganova, Zh. A. (2015). *Ispol'zovanie pitatel'noj sredy iz fermentativnogo gidroliza nekondicionnyh kurinyh yaic dlya kul'tivirovaniya proizvodstvennyh shtammov na predpriyatii*. *Mezhdunarodnyj zhurnal yeksperimental'nogo obrazovaniya*, 3, 86–89.
- Angelovičová, M., Ševčíková, L., Angelovič, M. (2015). *The table eggs and their quality in small-scale breeding*. *Potravnarstvo*, 9 (1), 442–450. doi: 10.5219/515
- Chukwuka, O. K., Okoli, I. C., Okeudo, N. J., Udedibe, A. B. I., Ogbuewu, I. P., Aladi, N. O. et. al. (2011). *Egg Quality Defects in Poultry Management and Food Safety*. *Asian Journal of Agricultural Research*, 5 (1), 1–16. doi: 10.3923/ayar.2011.1.16
- Iegorov, B. V., Vorona, N. V. (2010). *Ispol'zovanie nekondicionnyh kurinyh yaic pri proizvodstve kormovyh dobavok i kombikormov*. *Zernovi produkti i kombikormi*, 3, 43–45.
- Ryabokon', Yu. A. (2006). *Sostoyanie i nauchnoe obespechenie otrasli pticevodstva*. *Ptahivnictvo*, 58, 10.
- Taranov, P. M., Gadaeva, V. Yu. (2013). *Povyshenie yekonomicheskoy yeffektivnosti rossijskogo pticeproduktovogo podkompleksa cherez glubokuyu pererabotku yajca*. *Yekonomicheskie nauki*. Available at: <http://cyberleninka.ru/article/n/povyshenie-ekonomicheskoy-effektivnosti-rossijskogo-ptitseproduktovogo-podkompleksa-cherez-glubokuyu-pererabotku-yaytsa>
- Narabari, D. (2008). *Nutritionally enriched eggs*. *Poultry international*, 10, 22–30.
- Skurihin, I. M., Tutel'yan, V. A. (2007). *Tablicy himicheskogo sostava i kalorijnosti rossijskih produktov pitaniya*. Moscow: DeLi print, 276.

26. Iegorov, B. V., Vorona, N. V. (2011). Tehnologiya virobniictva ekstrudovanoi kormovoi dobavki dlya sil's'kogospodars'koi ptici. *Zernovi produkti i kombikormi*, 4, 31–36.
27. Iegorov, B., Vorona, N., Makarynska, A., Voietska, O., Bordun, T. (2016). The study of production regimes and quality parameters of extruded feed additive based of corn seed and substandard egg mass. *Eureka: Life Sciences*, 3 (3), 26–35. doi: 10.21303/2504-5695.2016.00144
28. Braterskij, F. D. (1983). *Ocenka kachestva syr'ya i kombikormov*. Moscow: Kolos, 320.
29. Iegorov, B. V. (Ed.) (2010). *Tehnologiya kombikormovogo virobniictva*. Odesa: ONAHT, 60.
30. Iegorov, B. V. (Ed.) (2011). *Organizaciya tehnomichnogo i tehnologichnogo kontrolyu na pidpriemstvah galuzi*. Odesa: ONAHT, 82.
31. Iegorov, B. V., Vorona, N. V. (2011). Issledovanie biologicheskoy yeffektivnosti i sanitarnogo kachestva yekstrudirovannoy kormovoy dobavki dlya molodnyaka sel'skohozyajstvennoj pticy v processe hraneniya. *Zernovi produkti i kombikormi*, 2, 29–33.
32. Afanas'ev, V. A. (2002). *Teoriya i praktika special'noj obrabotki zernovykh komponentov v tehnologii kombikormov*. Voronezh: Voronezhskij gosudarstvennyj universitet, 296.
33. Iegorov, B. V., Vorona, N. V. (2011). Pat. 64221 Ukraina, MPK A23K 1/10. Dobavka do kombikormu dlya sil's'kogospodars'koi ptici. № u201108847. Declared: 14.07.2011, published: 25.10.2011, Byul. № 2.
34. Ostrikov, A. N., Abramov, O. V., Rudometkin, A. S. (2004). *Ekstruziya v pishhevoj tehnologii*. SPb.: GIORD, 288.
35. Iegorov, B. V., Levic'kij, A. P., Vorona, N. V. (2014). *Vivchennya kormovoi cinnosti ekstrudovanoi dobavki dlya sil's'kogospodars'koi ptici*. *Hranenie i pererabotka zerna*, 9 (186), 43–45.
36. Fairfield, D., Gill, C. (2010). Back to basics: mixing system efficiency. *Feed international*, 8, 24–26.
37. Behnke, K. C. (2006). From ingredient uniformity to animal performance. *Roche Technical Seminar*, Lafferson GA, 43–51.

EXPLORING THE COLOR OF PLANT POWDERS USING COMPUTER COLORIMETRY (p. 15-20)

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The question of using a new method of color measurement with the use of contemporary digital computer technology was considered, which implies obtaining, under certain conditions, digital image of the tested sample. The plant powders, explored in the work, contain a number of pigments, which determine both the color of the powder and the color of culinary products, in composition of which they are included.

When measuring color coordinates of the powders, their restoration with water was conducted, in this case, the restored samples have lower lightness in comparison with the native powder. The difference of change in the value of color coordinate L on average decreases by 20 %.

The measurement of color of prepared meals, which was made with the use of plant powders, showed that they have lower saturation in comparison with the powders, since the pigment concentration decreases. In this case, other ingredients of meals shift the magnitudes of color coordinates of lower magnitudes of saturation and lightness towards the lightness of native powder. The exception is the powder from

sea buckthorn, the pigments of which are manifested poorly in the restored state.

The accessibility of the method makes it possible to use it for evaluating quality, controlling technological process of preparing meals and culinary products using traditional and innovative ingredients, including vegetable and fruit-and-berry powders.

Keywords: color coordinates, computer colorimetry, index of yellowness, plant powders, digital image, color.

References

1. Atanazevych, V. Y. (2000). *Sushka pyshchevykh produktov*. Moscow: DeLy, 365.
2. Duthie, G., Campbell, F., Bestwick, C., Stephen, S., Russell, W. (2013). Antioxidant Effectiveness of Vegetable Powders on the Lipid and Protein Oxidative Stability of Cooked Turkey Meat Patties: Implications for Health. *Nutrients*, 5 (4), 1241–1252. doi: 10.3390/nu5041241
3. *Drying Fruits and Vegetables*. 3rd Edition (2009). Idaho – Oregon – Washington, A Pacific Northwest Extension Publication, 32.
4. Petrushevskyy, V. V., Kazakov, A. L., Bandyukova, V. A. (1985). *Byolohychesky aktyvnye veshchestva pyshchevykh produktov*. Kyiv: Tekhnika, 127.
5. Van Lent, K., Le, C. T., Vanlerberghe, B., Van der Meeren, P. (2008). Effect of formulation on the emulsion and whipping properties of recombined dairy cream. *International Dairy Journal*, 18 (10-11), 1003–1010. doi: 10.1016/j.idairyj.2008.04.002
6. Kim, N.-C., Kinghorn, A. D. (2002). Sweet-tasting and sweetness-modifying constituents of plants. *Studies in Natural Products Chemistry*, 27 (H), 3–57. doi: 10.1016/s1572-5995(02)80033-3
7. Neacsu, M., Vaughan, N., Raikos, V., Multari, S., Duncan, G. J., Duthie, G. G., Russell, W. R. (2015). Phytochemical profile of commercially available food plant powders: their potential role in healthier food reformulations. *Food Chemistry*, 179, 159–169. doi: 10.1016/j.foodchem.2015.01.128
8. Harbaum, B., Hubbermann, E. M., Zhu, Z., Schwarz, K. (2008). Free and bound phenolic compounds in leaves of pak choi (*Brassica campestris* L. ssp. *chinensis* var. *communis*) and Chinese leaf mustard (*Brassica juncea* Coss). *Food Chemistry*, 110 (4), 838–846. doi: 10.1016/j.foodchem.2008.02.069
9. Olabi, A., Jinjara, S., Jiménez-Flores, R., Walker, J. H., Daroub, H. (2015). Compositional and sensory differences of products of sweet-cream and whey buttermilk produced by microfiltration, diafiltration, and supercritical CO₂. *Journal of Dairy Science*, 98 (6), 3590–3598. doi: 10.3168/jds.2014-9141
10. Lim, J. (2011). Hedonic scaling: A review of methods and theory. *Food Quality and Preference*, 22 (8), 733–747. doi: 10.1016/j.foodqual.2011.05.008
11. Chebotarev, A. N., Snygur, D. V., Bevzyuk, E. V., Efymova, Y. S. (2014). *Analyz tendencyy razvytyya metodov xymycheskoj czvetometryy. Metody y ob'ekty xymycheskogo analyza*, 9 (1), 4–11.
12. Afshari-Jouybari, H., Farahnaky, A. (2011). Evaluation of Photoshop software potential for food colorimetry. *Journal of Food Engineering*, 106 (2), 170–175. doi: 10.1016/j.jfoodeng.2011.02.034
13. Louka, N., Juhel, F., Fazilleau, V., Loonis, P. (2004). A novel colorimetry analysis used to compare different drying fish

- processes. *Food Control*, 15 (5), 327–334. doi: 10.1016/s0956-7135(02)00119-6
14. Odarchenko, A. M., Didienko, O. V., Ishtvan, Ye. O., Spodar, K. V. (2012). Kolorymetrychnyj analiz yakosti tomatnyx ovochiv i produktiv yix pererobky. *Tovaroznavstvo ta innovaciyi*, 4, 173–179.
 15. Valous, N. A., Mendoza, F., Sun, D.-W., Allen, P. (2009). Colour calibration of a laboratory computer vision system for quality evaluation of pre-sliced hams. *Meat Science*, 81 (1), 132–141. doi: 10.1016/j.meatsci.2008.07.009
 16. Shapyrov, L., Stokman, Dzh. (2006). *Kompyuternoe zrenye*. Moscow: BYNOM, 752.
 17. Vinnov, O. S., Mayevska, T. M., Zasyekin, D. A. (2013). Sposib vymiryuvannya koloru xarchovyx produktivno. pat. 82347, MPK G01N 33/02, G01N 33/12. zayavnyk i patentovlasnyk Nacionalnyj universytet bioresursiv i pryrodokorystuvannya Ukrainy, № u 2013 02612; declared: 01.03.2013; published: 25.07.2013, Byul. 14, 2.
 18. Ishtvan, Ye. O. (2013). Kolorymetriya, matematychni osoblyvosti procesu obchyslennya kolirnyx xarakterystyk zrazka dlya realizaciyi ekspres metodu. Aktualni problemy rozvytku xarchovyx vyrobnyctv, restorannogo ta gotel'nogo gospodarstv i torgivli, 112–114.
 19. Petrusha, O., Niemirich, A. (2016). Assessment of color of meat using the method of computer colorimetry. *Eureka: Life Science*, 3 (3), 3–7. doi: 10.21303/2504-5695.2016.00141

THE EFFECT OF CRYOMECHANODESTRUCTION ON ACTIVATION OF HETEROPOLYSACCHARIDE-PROTEIN NANOCOMPLEXES WHEN DEVELOPING NANOTECHNOLOGIES OF PLANT SUPPLEMENTS (p. 20-28)

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The regularities and mechanisms of the effect of deep processing of plant raw materials were established, such as finely dispersed grinding in developing nanotechnology of obtaining frozen nanopuree and nanopowders on the transformation of bound amino acids of protein to free soluble form by mechanolysis of molecules of protein (by 45...55% to separate α -amino acids). We discovered the mechanism of mechanodestruction of protein molecules and its nanocomplexes with other biopolymers and BAS, which is linked to mechanocracking.

In the deep processing of plant raw materials, in particular, Jerusalem artichoke, which is based on the comprehensive action of cryogenic «shock» freezing, freeze drying and finely dispersed grinding processes when obtaining nanopowders, the processes of cryodestruction, mechanodestruction and mechanochemistry occur that lead to the fuller extraction of BAS from the raw material (by 1.8...2.3 times more than is in the original raw material) and destruction of biopolymers (inulin, proteins) to their monomers.

It was found that the freezing and cryomechanodestruction lead to the transformation of chemical substances of Jerusalem artichoke (cryomechanochemistry) and transformation, in particular, conformational changes of protein molecules: reduction of radius of the volume of a protein molecule, radius of its nucleus, and also to a decrease in the indicator of filling the nucleus with hydrophobic remains of amino acids. In addition, the shape of protein molecules changes.

We proposed and designed cryogenic nanotechnology of finely dispersed frozen nanopuree and nanopowders from

Jerusalem artichoke with prebiotic properties. It was shown that nanosupplements exceed the known world analogues in the content of BAS and dispersed composition. In addition, a large part of the substances (both BAS and biopolymers) is in the nanodimensional form.

Keywords: deep processing of raw materials, cryomechanodestruction, finely dispersed grinding, Jerusalem artichoke, nanocomplexes, nanopowders, nanopuree.

References

1. FAO/WHO/UNU (2013). Dietary protein quality evaluation in human nutrition. Report of an FAO Expert Consultation. Food and agriculture organization of the united nations Rome, 92, 57.
2. Kaprelyants, L. (2015). *Prebiotics: chemistry, technology, application*. Kyiv: EnterPrint, 252.
3. Gibson, G. (2008). *Handbook of Prebiotics*. Vol. 4. London: CRS Press, 22–42. doi: 10.1201/9780849381829
4. Sousa, V. M. C. de, Santos, E. F. dos, Sgarbieri, V. C. (2011). The Importance of Prebiotics in Functional Foods and Clinical Practice. *Food and Nutrition Sciences*, 2 (2), 133–144. doi: 10.4236/fns.2011.22019
5. Roberfroid, M. B. (2000). Fructo-oligosaccharide malabsorption: benefit for gastrointestinal functions. *Current Opinion in Gastroenterology*, 16 (2), 173–177. doi: 10.1097/00001574-200003000-00013
6. Pavlyuk, R., Pogarskaya, V., Pavlyuk, V., Radchenko, L., Yur'eva, O., Maksimova, N. (2015). Cryo- and Mechanochemistry in the food technology. Kharkov State University of Food Technology and Trade; Kharkov trade and economic Institute of Kyiv national University of trade and economy, 255.
7. Gaukel, V. (2016). Cooling and Freezing of Foods. Reference Module in Food Science, 1–3. doi: 10.1016/b978-0-08-100596-5.03415-6
8. Afoakwah, N. A., Dong, Y., Zhao, Y., Xiong, Z., Owusu, J., Wang, Y., Zhang, J. (2015). Characterization of Jerusalem artichoke (*Helianthus tuberosus* L.) powder and its application in emulsion-type sausage. *LWT - Food Science and Technology*, 64 (1), 74–81. doi: 10.1016/j.lwt.2015.05.030
9. Kolida, S., Tuohy, K., Gibson, G. R. (2002). Prebiotic effects of inulin and oligofructose. *British Journal of Nutrition*, 87 (2), 193–197. doi: 10.1079/bjn/2002537
10. Galland, L. (2013). Functional Foods: Health Effects and Clinical Applications. *Encyclopedia of Human Nutrition*, 366–371. doi: 10.1016/b978-0-12-375083-9.00130-6
11. Radovanovic, A., Stojceska, V., Plunkett, A., Jankovic, S., Milovanovic, D., Cupara, S. (2015). The use of dry Jerusalem artichoke as a functional nutrient in developing extruded food with low glycaemic index. *Food Chemistry*, 177, 81–88. doi: 10.1016/j.foodchem.2014.12.096
12. Tu, J., Zhang, M., Xu, B., Liu, H. (2015). Effects of different freezing methods on the quality and microstructure of lotus (*Nelumbo nucifera*) root. *International Journal of Refrigeration*, 52, 59–65. doi: 10.1016/j.ijrefrig.2014.12.015
13. James, S. J., James, C. (2014). Chilling and Freezing. *Food Safety Management*, 481–510. doi: 10.1016/b978-0-12-381504-0.00020-2
14. Baláž, P., Baláž, M., Bujňáková, Z. (2014). Mechanochemistry in Technology: From Minerals to Nanomaterials and Drugs. *Chemical Engineering & Technology*, 37 (5), 747–756. doi: 10.1002/ceat.201300669
15. Zhao, X., Zhu, H., Zhang, G., Tang, W. (2015). Effect of superfine grinding on the physicochemical properties and anti-

oxidant activity of red grape pomace powders. *Powder Technology*, 286, 838–844. doi: 10.1016/j.powtec.2015.09.025

16. Pavlyuk, R., Pogarska, V., Pavlyuk, V., Balabai, 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

THE STUDY OF BIOLOGICALLY ACTIVE SUBSTANCES OF CHAENOMELES AND THE PRODUCTS OF ITS PROCESSING (p. 29-35)

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The importance of developing food products of improved biological value to ensure the healthy nourishment of the population was analyzed. The prospects of using plant raw materials as a source of biologically active components were shown. The chemical composition of chaenomeles fruit and of the products of its processing was determined. The biological value of the components of the fruit was explored, and it was found that maximum amount of L-ascorbic acid is contained in the pulp of the fruit and that maximum amount of phenolic substances is contained in the peels of the fruit. With the help of chromatographic studies, it was established that the products of chaenomeles processing have significant content of organic acids, among which malic, quinic, citric and succinic acids were identified, malic acid is dominant among them. The sugars, found in the fruit of chaenomeles, are represented by fructose, glucose and saccharose, among them fructose and glucose prevail. The raw material contains procyanidins, hydroxycinnamic acids, flavones and flavan-3-ols, among them procyanidin trimmer, chlorogenic acid, rutin and epicatechine dominate, which have high antioxidant properties. In the products of chaenomeles processing, 48 types of aromatic compounds were identified, among which prevail alcohols, acids, ethers and unsaturated carbohydrates that give products of chaenomeles processing unique aroma and predetermine their antibacterial properties.

The products of chaenomeles processing (juice, puree) are a valuable source of organic acids; they were used as a natural regulator of acidity and as an antioxidant in manufacturing products from flour yeast dough. Puree from chaenomeles contains a significant amount of pectic substances and was used in the production of fruit sauces as a structuring agent. An increase in the organoleptic and physical and chemical indicators in fruit sauces and flour products with the use of products of chaenomeles processing was established.

Keywords: chaenomeles, chemical composition, chromatograms, procyanidin, aromatic substances, sauce, flour products.

References

- Gul'ich, M. P. (2011). Ratsionalne harchuvannya ta zdoroviy sposib zhittya-osnovni chinniki zberzhennya zdorov'ya naselennya. *Problemy stareniya i dolgoletiya*, 20 (2), 128–132.
- Lebedenko, T. E., Donskoy, D. M., Novichkova, T. P., Tkachenko, T. Z., Sokolova, N. Yu. (2010). Ispolzovanie ekstraktov pryano-aromaticheskikh i lekarstvennykh rasteniy v tehnologii hlebopecheniya. *Naukovi pratsi Odeskoyi natsionalnoyi akademiyi harchovih tehnologiy*, 38 (1), 248–253.
- Tarko, T., Duda-Chodak, A., Semik, D., Nycz, M. (2015). The use of fruit extracts for production of beverages with high antioxidative activity. *Potravinarstvo*, 9 (1), 280–283. doi: 10.5219/480
- Ros, J., Laencina, J., Hellin, P., Jordan, M., Vila, R., Rumpunen, K. (2004). Characterization of juice in fruits of different Chaenomeles species. *Lebensmittel-Wissenschaft Und Technologie*, 37 (3), 301–307. doi: 10.1016/j.lwt.2003.09.005
- Chen, J.-C., Chang, Y.-S., Wu, S.-L., Chao, D.-C., Chang, C.-S., Li, C.-C. et. al. (2007). Inhibition of Escherichia coli heat-labile enterotoxin-induced diarrhea by Chaenomeles speciosa. *Journal of Ethnopharmacology*, 113 (2), 233–239. doi: 10.1016/j.jep.2007.05.031
- Chen, Q., Wei, W. (2003). Effects and mechanisms of glucosides of chaenomeles speciosa on collagen-induced arthritis in rats. *International Immunopharmacology*, 3 (4), 593–608. doi: 10.1016/s1567-5769(03)00051-1
- Li, X., Yang, Y.-B., Yang, Q., Sun, L.-N., Chen, W.-S. (2009). Anti-Inflammatory and Analgesic Activities of Chaenomeles speciosa Fractions in Laboratory Animals. *Journal of Medicinal Food*, 12 (5), 1016–1022. doi: 10.1089/jmf.2008.1217
- Sawai, R., Kuroda, K., Shibata, T., Gomyou, R., Osawa, K., Shimizu, K. (2008). Anti-influenza virus activity of Chaenomeles sinensis. *Journal of Ethnopharmacology*, 118 (1), 108–112. doi: 10.1016/j.jep.2008.03.013
- Golubev, V. N., Kolechik, A. A., Rigavs, U. A. (1991). Carbohydrate complex of the fruit of Chaenomeles maulei. *Chem Nat Compd*, 26 (4), 387–390. doi: 10.1007/bf00598988
- Sancheti, S., Sancheti, S., Seo, S.-Y. (2009). Chaenomeles Sinensis: A Potent α - and β -Glucosidase Inhibitor. *American Journal of Pharmacology and Toxicology*, 4 (1), 8–11. doi: /10.3844/ajtp.2009.8.11
- Klimenko, S. V., Mezhenkiy, V. M. (2013). Pohodzhennya sortiv henomelesa (Chaenomeles Lindl.) ukrayinskoyi selektsiyi. *Introduktsiya roslin*, 4, 25–30.
- Zhang, L., Cheng, Y.-X., Liu, A.-L., Wang, H.-D., Wang, Y.-L., Du, G.-H. (2010). Antioxidant, Anti-Inflammatory and Anti-Influenza Properties of Components from Chaenomeles speciosa. *Molecules*, 15 (11), 8507–8517. doi: 10.3390/molecules15118507
- Dzhan, T. V., Konovalova, O. Yu., Klimenko, S. V., Buhtlarova, T. A., Yadlovskiy, O. E. (2011). Doslidzhennya vplivu na krov plodiv henomelesu (Chaenomeles lindl.) rIznih vidiv. *Farmatsevtichnyi zhurnal*, 6, 83–86.
- AACC International. *Methods 10-50D and 10-52. Approved Methods of the American Association of Cereal Chemists*, 10th ed. (2000). AACC International, St. Paul, MN, U.S.A.
- Khomych, G., Horobetc, A., Levchenko, Y., Boroday, A., Ishchenko, N. (2016). The study of main physical-chemical parameters of chaenomeles and products of its processing. *Eureka: Life Sciences*, 3 (3), 50–56. doi: 10.21303/2504-5695.2016.00147
- Khomych, G. P., Vasyuta, V. M., Levchenko, Yu. V. (2015). Kompleksna pererobka plodiv henomelesu. *Naukovi pratsi Odeskoyi natsionalnoyi akademiyi harchovih tehnologiy*, 46 (2), 75–79.
- Khomych, G. P., Kaprelyants, L. V., Tkach, N. I. (2010). Viktorystannya fermentnih preparativ dlya pererobki plodovo-yagidnoyi dikorosloyi sirovini. *Obladnannya ta tehnologiyi harchovih virobnitstv*, 25, 123–128.
- Khomych, G. P., Levchenko, Yu. V. (2015). Viktorystannya henomelesu v tehnologiyi virobnitsta solodkih sousiv. *Naukoviy visnik Lvivskogo Natsionalnogo universitetu veterinarneyi meditsini ta biotekhnologiy im. S. Z. Gzhitskogo*, 17.4 (64), 166–174.

19. Thomas, M., Guillemin, F., Guillon, F., Thibault, J.-F. (2003). Pectins in the fruits of Japanese quince (*Chaenomeles japonica*). *Carbohydrate Polymers*, 53 (4), 361–372. doi: 10.1016/S0144-8617(03)00118-8
20. Dodatok 1 do Nakazu Ministerstva ohoroni zdorov'ya Ukraini (1999). Pro zatverdzhennya norm fiziologichnih potreb naselennya Ukraini v osnovnih harchovih rečovinah ta energiyi, 272.
21. Gorbov, A. I., Rubtsov, P. P. (1890–1907). Kisloty organicheskie. *Entsiklopedicheskiy slovar Brokgauza i Efrona*. In 86 volumes. Vol. 82. SPb.
22. Yang, J., Xiao, Y.-Y. (2013). Grape Phytochemicals and Associated Health Benefits. *Critical Reviews in Food Science and Nutrition*, 53 (11), 1202–1225. doi: 10.1080/10408398.2012.692408
23. Cos, P., Bruyne, T., Hermans, N., Apers, S., Berghe, D., Vlietinck, A. (2004). Proanthocyanidins in Health Care: Current and New Trends. *Current Medicinal Chemistry*, 11 (10), 1345–1359. doi: 10.2174/0929867043365288
24. Cukan, A. (2014). Ingredient in dark chocolate may be the linked to helping to keep weight down and to prevent type 2 diabetes. *Heals news*.
25. Du, H., Wu, J., Li, H., Zhong, P.-X., Xu, Y.-J., Li, C.-H. et al. (2013). Polyphenols and triterpenes from *Chaenomeles* fruits: Chemical analysis and antioxidant activities assessment. *Food Chemistry*, 141 (4), 4260–4268. doi: 10.1016/j.foodchem.2013.06.109
26. Scalia, S., Marchetti, N., Bianchi, A. (2013). Comparative Evaluation of Different Co-Antioxidants on the Photochemical- and Functional-Stability of Epigallocatechin-3-gallate in Topical Creams Exposed to Simulated Sunlight. *Molecules*, 18 (1), 574–587. doi: 10.3390/molecules18010574
27. Khomych, G. P., Gorobets, A. M. (2015). Viktoristannya henomelesu ta produktiv yogo pererobki v tehnologiyi boroshnyanih virobiv. *Naukoviy visnik Lvivskogo Natsionalnogo universitetu veterinarnoyi meditsini ta biotekhnologiy im. S. Z. Gzhitskogo*, 17:4 (64), 174–179.

DEEP PROCESSING OF CAROTENE-CONTAINING VEGETABLES AND OBTAINING NANOFOOD WITH THE USE OF EQUIPMENT OF NEW GENERATION (p. 36-43)

Raisa Pavlyuk, Viktoriya Pogarskaya, Ludmila Radchenko, Roman Tauber, Nadiya Timofeeva

We proposed and designed a new method of deep processing of carotene-containing vegetables – alternative to cryogenic treatment, based on the comprehensive action of steam thermal treatment and finely dispersed grinding on raw materials using a new generation of equipment that is applied in restaurant business, which makes it possible to more fully utilize biological potential (2...3 times higher than in the original raw materials).

It was found that during deep (steam convection) processing of carotene-containing vegetables (carrot and pumpkin) with the use of modern steam convection equipment, the fermentative processes proceed with less intensity than during traditional method of thermal treatment – blanching by immersion in boiling water. The quantitative indicator of the maximum fermentative activity during treatment of the carotene-containing vegetables in a combi steamer, compared to blanching, is 2–4,5 times less for polyphenol oxidase, by 3 times for peroxidase. It was demonstrated that the complete inactivation of oxidative enzymes during thermal treatment of carotene-containing vegetables in a

combi steamer occurs earlier than during blanching and takes place in 20 minutes, which is 10–15 minutes faster than at blanching. The complete inactivation of oxidative enzymes during blanching of carotene-containing vegetables occurs in 30–35 minutes.

It was demonstrated that, compared with fresh raw materials, during thermal treatment of carotene-containing vegetables (carrot, pumpkin) in a combi steamer (under the above-mentioned modes), not only the preservation of β -carotene is achieved in 10 minutes, but also the increase in its mass by 2...2,3 times that occurs due to the release from the hidden state (forms, associated with biopolymers) to free form that is registered by the chemical methods of research. It was found that the loss of vitamin C during thermal treatment of carotene-containing vegetables in a combi steamer is much lower than at blanching. Thus, after 20 minutes of thermal treatment in the combi steamer, the mass fraction of L-ascorbic acid remained by 65...80 %, while after blanching by 40...50 %.

It was also demonstrated that after steam thermal treatment and finely dispersed grinding of carotene-containing vegetables when making puree, a significant increase in the extraction of L-ascorbic acid and β -carotene occurs in comparison to the original raw materials, which is 2 and 3 times larger for pumpkin, respectively, and for carrot – 1,7 and 2,5 times, respectively.

It was found that the comprehensive application of steam thermal treatment of vegetable raw materials in a combi steamer with finely dispersed grinding makes it possible to obtain puree, the quality of which is close to the quality of the puree, obtained using the cryogenic product treatment (in particular, the content of β -carotene is 2,5...3 times during steam thermal treatment and is 2,8...3,5 times during cryogenic treatment).

Keywords: deep processing, carotene-containing vegetables, steam thermal treatment, finely dispersed grinding, steam convection furnace, products in the nanofarm.

References

1. FAO/WHO/UNU. Global Strategy on Diet, Physical Activity and Health (2013). Resolution WHA.55.23 accepted session of World Health Assembly (WHA), World Health Organization, Geneva.
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. Pavljuk, R. Ju., Pogarskaja, V. V., Pavljuk, V. A., Radchenko, L. A., Jur'eva, O. A., Maksimova, N. F. (2014). Krio- i mehanohimija v pishhevyyh tehnologijah. Kharkiv: Finart, 260.
4. Reznikov, O. H., Polumbryk, O. M., Balion, Y. H., Polumbryk, M. O. (2014). Pro- and antioxidant systems and pathological processes in humans. *Visnik NAM of Ukraine*, 10, 17–27.
5. Pogarskaya, V., Pavlyuk, R. (2013). Activation of the hydrophilic properties of herbal raw materials carotenoids. Kharkiv: Finart, 345.
6. Goñi, I., Serrano, J., Saura-Calixto, F. (2006). Bioaccessibility of β -Carotene, Lutein, and Lycopene from Fruits and Vegetables. *Journal of Agricultural and Food Chemistry*, 54 (15), 5382–5387. doi: 10.1021/jf0609835
7. Bernstein, P. S., Khachik, F., Carvalho, L. S., Muir, G. J., Zhao, D.-Y., Katz, N. B. (2001). Identification and Quantitation of Carotenoids and their Metabolites in the Tissues of the Human Eye. *Experimental Eye Research*, 72 (3), 215–223. doi: 10.1006/exer.2000.0954

8. Dherani, M., Murthy, G. V. S., Gupta, S. K., Young, I. S., Maraini, G., Camparini, M. et. al. (2008). Blood Levels of Vitamin C, Carotenoids and Retinol Are Inversely Associated with Cataract in a North Indian Population. *Investigative Ophthalmology & Visual Science*, 49 (8), 3328–3335. doi: 10.1167/iovs.07-1202
9. Stahl, W., Sies, H. (1996). Lycopene: A Biologically Important Carotenoid for Humans? *Archives of Biochemistry and Biophysics*, 336 (1), 1–9. doi: 10.1006/abbi.1996.0525
10. Frese, R. N., Palacios, M. A., Azzizi, A., van Stokkum, I. H. M., Kruip, J., Rögner, M. et. al. (2002). Electric field effects on red chlorophylls, β -carotenes and P700 in cyanobacterial Photosystem I complexes. *Biochimica et Biophysica Acta (BBA) – Bioenergetics*, 1554 (3), 180–191. doi: 10.1016/s0005-2728(02)00242-6
11. Rakhimberdieva, M. G., Stadnichuk, I. N., Elanskaya, I. V., Karapetyan, N. V. (2004). Carotenoid-induced quenching of the phycobilisome fluorescence in photosystem II-deficient mutant of *Synechocystis* sp. *FEBS Letters*, 574 (1-3), 85–88. doi: 10.1016/j.febslet.2004.07.087
12. Oberbayl, K. (1998). *Vitamins healer*. Minsk: Paradoks, 424.
13. Lisichenok, O. V. et. al. (2014). Effect of heat treatment methods on the nutritional value of fish culinary products. *Bulletin of Novosibirsk State Agrarian University*, 4 (33), 100–104.
14. Ivanov, A., Kirik, I., Kirik, A. V. (2011). The results of experimental studies of heat transfer in the machine Steam convection. *Innovative technologies in the production and processing of agricultural products, Part 2*, 47–49.
15. Kirik, A. (2010). Investigation of heat exchange processes in machine Steam convection. *Engineering and technology of food production, Part 1*, 8–9.
16. Kirik, M. et. al. (2009). Steam convection apparatus for catering. *Innovative technologies in the food industry*, 394–401.
17. Kutkina, M., Fedinishina, E. (2007). Combi-Steamer: Know and be able to: recommendations for heat treatment of different types of culinary products. *Power and society*, 10, 10–12.
18. Kotova, V., Ryabov, V., Dolmatova, I. (2013). Study of the heat treatment of fish using combined heat. *Innovative technologies in agricultural production, food processing industry*, 63–65.
19. Kutkina, M., Eliseev, S. (2014). Development of individual vegetable semis technology high availability. *Proceedings of the universities. Food technology*, 2/3, 66–69.
20. Pavlyuk, R., Pogarskaya, V., Pavlyuk, V., Radchenko, L. et. al. (2015). *Cryo- and Mechanochemistry in food technology*. Kharkiv: Fact, 255.
21. Pavlyuk, R., Pogarska, V., Radchenko, L., Tauber, R. D., Timofeyeva, N., Kotuyk, T. (2016). The new method of processing of carotene-containing vegetables for the production of nanoproducts using combi-steamers and fine-dispersed comminution. *Eureka: Life Sciences*, 3 (4), 44–49. doi: 10.21303/2504-5695.2016.00146
22. GOST 13496.17-95. *Mezhgosudarstvennyy standard. Stern. Method of determination of carotin* (2011). Moscow: Standartinform, 5.
23. DSTU 4305:2004. *Fruit, vegetables and products of their processing. Method of determination of carotin* (2005). Kyiv: Derzhspozhivstandart, 18.
24. GOST 24556-89. *Mezhgosudarstvennyy standard. Products of processing of fruit and vegetables. Method of determination of vitamin C* (2003). Moscow: IPK publishing house of standards, 12.
25. DSTU 4373:2005. *National standard of Ukraine. Fruit, vegetables and products of their processing. Methods of determination of polifenoliv* (2006). Kyiv: Derzhspozhivstandart, 10.
26. Makaseeva, O. N., Tkachenko, L. M. (2001). *Enzymes. Ch. 2. Vitamins and enzymes. Methodical pointing to laboratory practical work. (Determination of activity of o-difenoloksidazy (polifenoloksidazy) and peroksidazy on Mikhlinu and Bronevickoy)*. Mogilevskiy state technological institute, 25–27.

DETERMINATION OF TOTAL ANTIOXIDANT CAPACITY IN MARMALADE AND MARSHMALLOW (p. 43-50)

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Creation of functional foods with various plant additives as a preventive means of population antioxidant protection programs is an important task, the solution of which is impossible without a preliminary assessment of antioxidant properties of food components – plant material. For this purpose, the antioxidant capacity of plant additives of apples, quince, grapes, pumpkins, carrots, rose hips, sea buckthorn, Sudanese rose, black chokeberry, obtained by cryogenic technologies and products with them – fruit jelly and marshmallow was investigated by galvanostatic coulometry. It was found that the TAC of cryopastes increases in the row: pumpkins < carrots < quince < apples < grapes from 25 to 550 C/100 g. The TAC of cryopowders increases in the row: grapes < black chokeberry < Sudanese rose < sea buckthorn < rose hips from 663 to 4400 C/100 g. The values correlate with the content of the main classes of antioxidants in these cryoadditives. It was determined that marmalade with the addition of carrot and pumpkin cryopastes has the lowest bromine TAC. Additional introduction of cryopowders in marmalade samples with cryopastes in an amount 1.5 % increases the TAC of marmalade by 3.5–10 times. It is shown that the use of water-alcohol extracts as additives with the addition of 1 % citric acid provides the samples of marshmallow with more pronounced antioxidant properties.

The calculations, based on the additive scheme show that the functional properties of the products are due to the antioxidant properties of the additives.

Keywords: antioxidant, coulometry, plant additive, cryogenic technology, cryopaste, cryopowder, marmalade, marshmallow.

References

1. Valko, M., Leibfritz, D., Moncol, J., Cronin, M. T. D., Mazur, M., Telser, J. (2007). Free radicals and antioxidants in normal physiological functions and human disease. *The International Journal of Biochemistry & Cell Biology*, 39 (1), 44–84. doi: 10.1016/j.biocel.2006.07.001
2. Frankel, E. N. (2012) *Antioxidants in food and biology Facts and fiction*. Philadelphia: Woodhead Publishing Limited, 254.
3. Pokorny, J., Yanishlieva, N., Gordon, M. (2001) *Antioxidants in food. Practical applications*. Cambridge: Woodhead Publishing Limited, 380.
4. Pisoschi, A. M., Pop, A. (2015). The role of antioxidants in the chemistry of oxidative stress: A review. *European Journal of Medicinal Chemistry*, 97, 55–74. doi: 10.1016/j.ejmech.2015.04.040 10.1016/j.ejmech.2015.04.040
5. Yao, L. H., Jiang, Y. M., Shi, J., Tomás-Barberán, F., Datta, N., Singanusong, R., Chen, S. S. (2004). Flavonoids in Food and Their Health Benefits. *Plant Foods for Human Nutrition*, 59 (3), 113–122. doi: 10.1007/s11130-004-0049-7

6. Elżbieta, S., Cieślík, E., Topolska, K. (2008). The sources of natural antioxidants. *Elżbieta Sikora, Ewa Cieślík, Kinga Topolska. Acta Sci. Pol., Technol. Ailment*, 7 (1), 5–17.
7. Kovalenko, I. O., Bondar, N. P., Sharan, L. O. (2014). Udoskonalennia tekhnolohii marshmelou na fruktozi z vykorystanniam plodovo-iahidnoi syrovyny u zakladakh restorannoho hospodarstva. *Ukrainian Food Journal. Food Technologies*, 2, 62–67.
8. Dorohovich, A. N., Badruk, V. V. (2013). Marshmelou funktsionalnogo naznacheniya. *Hlebopek*, 2, 37–39.
9. Pavlyuk, R. Yu., Pogarskaya, V. V., Yureva, O. O. (2015). Krio- i mehanohimiya v tekhnologiyah pischevyykh proizvodstv. *Kharkiv: Domino*, 255.
10. Shulyak, V. A., Berezuk, D. I. (2008). Nizkotemperaturnaya tekhnologiya proizvodstva naturalnykh pischevyykh krasiteley. *Holodilnaya tehnika*, 9, 28–29.
11. Lomachinskiy, V. V., Kasyanov, G. I. (2009). Tekhnologiya polucheniya plodoovoschnyykh krioporoshkov. *Krasnodar: Ekoinvest*, 102.
12. Kasyanov, G. I., Lomachinskiy, V. V. (2010). Proizvodstvo i ispolzovanie krioporoshkov iz ovoschey i fruktov. *Izvestiya VUZov. Pischevaya tekhnologiya*, 3, 113–114.
13. Chuiko, A. M., Vereshko, N. V., Lysiuk, H. M. (2002). Vykorystannia krias-poroshkiv z vynohradnykh vychavkiv yak kompleksnykh polipshuvachiv dlia boroshniannykh vyrobiv. *Prohresyvni resursozberihaiuchi tekhnolohii ta yikh ekonomichne obgruntuvannia u pidpriemstvakh kharchuvannia. Ekonomichni problemy torhivli*, 90–97.
14. Achkasova, O. V., Zhukov, Ie. V. (2009). Tekhnolohiia vypechenoho napivfabrykatu «Smetannyi» z dodavanniam buriakovoho krioporoshku. *KhTEI KNTEU*, 51–52.
15. Tuz, N. E., Artamonova, M. V., Lysiuk, H. M. (2012). Doslidzhennia pokaznykiv yakosti zheleinoho marmeladu z krias-poroshkami roslynnoho pokhodzhennia pid chas zberihannia. *Naukovi pratsi Odeskoi natsionalnoi akademii kharchovykh tekhnolohii*, 210–214.
16. Artamonova, M. V., Shmatchenko, N. V. (2014). Vykorystannia roslynnykh kriopast u tekhnolohii zheleinykh vyrobiv. *Naukovi pratsi Odeskoi natsionalnoi akademii kharchovykh tekhnolohii*, 46 (2), 177–180.
17. Artamonova, M. V., Piliuhina, I. S., Shmatchenko, N. V. (2015). Udoskonalennia tekhnolohii marmeladno-pastylnykh vyrobiv z vykorystanniam roslynnykh dobavok otrymanykh za kriotekhnolohiiamy. *Povnotsinne kharchuvannia: innovatsiini aspekty tekhnolohii, enerhoefektyvnoi pererobky, zberihannia ta marketynhu*, 144–171.
18. Pavljuk, R. Ju., Pogars'ka, V. V., Berestova, A. A. (2013). Innovative technologies of vitamin fruitberry ice-cream production using frozen fine-dispersed additives made of plant raw materials. *Eastern-European Journal of Enterprise Technologies*, 4 (10 (64)), 57–62. Available at: <http://journals.uran.ua/eejet/article/view/16316/13839>
19. Apak, R., Gorinstein, S., Böhm, V., Schaich, K. M., Özyürek, M., Güçlü, K. (2013). Methods of measurement and evaluation of natural antioxidant capacity/activity (IUPAC Technical Report). *Pure and Applied Chemistry*, 85 (5), 957–998. doi: 10.1351/pac-rep-12-07-15
20. Misin, V. M., Hrapova, N. G., Zavyalov, A. Yu., Burlakova, E. B. (2012). Standartizatsiya terminov i opredeleniy v oblasti «Antioksidanty». *Vestnik Kazanskogo tekhnologicheskogo universiteta*, 15 (17), 236–241.
21. Badarinath, A. V., Rao, K. M., Chetty, C. M. S. (2010). A review on in-vitro antioxidant methods: comparisons, correlations and considerations. *International Journal of PharmTech Research*, 2 (2), 1276–1285.
22. Ahmad, S., Arshad, M. A., Ijaz, S. et. al. (2014). Review on methods used to determine antioxidant activity. *International Journal of Multidisciplinary Research and Development*, 1 (1), 35–40.
23. Pisoschi, A. M., Negulescu, G. P. (2012). Methods for Total Antioxidant Activity Determination: A Review. *Biochemistry & Analytical Biochemistry*, 01 (01), 1–10. doi: 10.4172/2161-1009.1000106
24. Shahidi, F., Zhong, Y. (2015). Measurement of antioxidant activity. *Journal of Functional Foods*, 18, 757–781. doi: 10.1016/j.jff.2015.01.047
25. Antolovich, M., Prenzler, P. D., Patsalides, E., McDonald, S., Roberts, K. (2002). Methods for testing antioxidant activity. *The Analyst*, 127 (1), 183–198. <http://doi.org/10.1039/b009171p>.
26. Yin, H., Xu, L., Porter, N. A. (2011). Free Radical Lipid Peroxidation: Mechanisms and Analysis. *Chemical Reviews*, 111 (10), 5944–5972. doi: 10.1021/cr200084z
27. Prior, R. L., Wu, X., Schaich, K. (2005). Standardized Methods for the Determination of Antioxidant Capacity and Phenolics in Foods and Dietary Supplements. *Journal of Agricultural and Food Chemistry*, 53 (10), 4290–4302. doi: 10.1021/jf0502698
28. Ivanova, A. V., Gerasimova, E. L., Brainina, K. Z. (2015). Potentiometric Study of Antioxidant Activity: Development and Prospects. *Critical Reviews in Analytical Chemistry*, 45 (4), 311–322. doi: 10.1080/10408347.2014.910443
29. Pisoschi, A. M., Cimpeanu, C., Predoi, G. (2015). Electrochemical Methods for Total Antioxidant Capacity and its Main Contributors Determination: A review. *Open Chemistry*, 13 (1), 824–856. doi: 10.1515/chem-2015-0099
30. Sochor, J., Dobes, J., Krystofova, O., Ruttikay-Nedecky B. (2013). Electrochemistry as a Tool for Studying Antioxidant Properties. *Int. J. Electrochem. Sci*, 8, 8464–8489.
31. Abdullin, I. F., Turova, E. N., Budnikov, G. K. (2001). Kulonometricheskaya otsenka antioksidantnoy sposobnosti ekstraktov chaya elektrogenerirovannyim bromom. *Analiticheskaya himiya*, 56 (60), 627–629.
32. Ziyatdinova, G. K., Nizamova, A. M., Budnikov, G. K. (2010). Galvanostatic coulometry in the analysis of natural polyphenols and its use in pharmacy. *Journal of Analytical Chemistry*, 65 (11), 1176–1180. doi: 10.1134/s1061934810110146
33. Ziyatdinova, G., Kozlova, E., Budnikov, H. (2016). Chronocoulometry of wine on multi-walled carbon nanotube modified electrode: Antioxidant capacity assay. *Food Chemistry*, 196, 405–410. doi: 10.1016/j.foodchem.2015.09.075.
34. Artamonova, M. V., Pilyugina, I. S., Shmatchenko, N. V. (2015). Ispolzovanie karotinoidnykh i antotsianovykh dobavok v tekhnologiyah marmelada i marshmellou. *Innovatsionnye tekhnologii proizvodstva produktov pitaniya funktsionalnogo naznacheniya*, 15–18.
35. Gubskiy, S., Nikitin, S., Evlash, V., Nemirich, O. (2015). Iodine content determination in dried talli of laminaria by galvanostatic coulometry. *Ukrainian Food Journal*, 4 (2), 320–327.
36. Drozd, A. V., Tishakova, T. S. (2011). Spectrophotometric determination of trace amounts of iodide-ions in form of ionic associate with brilliant green using electrochemical oxidation. *Cent.eur.j.chem.*, 9 (3), 432–436. doi: 10.2478/s11532-011-0020-z
37. Pavliuk, R. Iu., Artamonova, M. V., Shmatchenko, N. V. (2014). Pat. 92844 Ukraina, MPK A 23 L 1/06. Sklad marmeladu z roslynnykh dobavkami. Zaiavnyk i patentovlasnyk Kharkivskiy derzhavnyi universytet kharchuvannia ta torhivli. № u 2014 02562; declared: 14.03.2014; published: 10.09.2014, *Biul.* 17, 3.

THE STUDY OF NANOPARTICLES OF MAGNETITE OF THE LIPID-MAGNETITE SUSPENSIONS BY METHODS OF PHOTOMETRY AND ELECTRONIC MICROSCOPY (p. 51-61)

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With the aid of the methods of photometry and electronic microscopy, we studied the sedimentation and aggregative stability of the lipid-magnetite suspensions (LMS). Different LMS were obtained. All suspensions are sufficiently stable over time. The best results in stability were displayed by suspensions, in which the ratio $\text{Fe}_3\text{O}_4:\text{SAS}=0,02:0,35$ g or 0,04 mass %:0,70 mass % and 0,025:0,35 g or 0,05 mass %:0,70 mass %. We determined size of the particles of magnetite with SAS. The order of mean particle size is defined – it amounts to $\langle d \rangle \sim 76$ nm.

It was found that in the course of time (0–48,0 h) and with an increase in the wavelength (210–1000 nm), a gradual increase in the coefficient of transmission is observed from 25 % (210 nm) to 71,9 % (1000 nm) at 0 hours of exposure of the suspension: from 27,5 % (210 nm) to 81,2 % (1000 nm) at the maximum period of exposure of the suspension (48 hours).

The indices of LMS are determined: concentration of the particles – $N=1,43 \cdot 10^{12} \text{ cm}^{-3}$, in 48 hours the concentration decreased by 20 % ($N=1,19 \cdot 10^{12} \text{ cm}^{-3}$); $r=38$ nm, $n=1,48$, $\kappa=0,01$. The distribution function of the particles by size is rather narrow and symmetrical, which indicates that the system of the synthesized nanoparticles is homogenous with a low degree of polydispersity.

The UV spectra of LMS and their components were taken and analyzed. The comparison of the spectra of transmission of suspensions with different degree of dilution testifies to chemical identity of the samples.

The kinetic dependences of the coefficient of transmission for the suspensions with different concentration of magnetite (Fe(ov).), were examined, based on which we calculated the effective mean radius of the particles of the stabilized magnetite: 76–168 nm. The mean radius of the particles in the lipid suspension of magnetite without stabilizer ($r_{\text{eff}}=400$ nm. Visually, LMS manifested high aggregation stability at the total time of sedimentation reaching several tens of hours.

It was established that LMS can be used as the biologically-active and food supplements, which possess the comprehensive action: beneficial biological effect on the human organism; due to the presence of bivalent iron in magnetite and capacity to form transition complexes with oxygen and peroxide radicals (and hydroperoxides), they manifest antioxidant activity, which leads to improvement in the quality and lengthening of the period of storage of the products that contain fat. Furthermore, LMS due to Fe^{2+} of magnetite can be recommended as the source of easily assimilated iron and as the anti-anemic means. Therefore, the introduction of LMS to the food products increases its quality, nutritional and biological value.

Keywords: magnetite, photometry, electron microscopy, dispersibility, size and effective mean radius of particles, stabilization, magnetite suspension, surface active substance (SAS), sedimentation and aggregative stability.

References

- Skurihin, I. M. (1991). *VsYo o pische s tochki zreniya himika*. Moscow: Vyssh. shk., 33–40.
- Tyutyunnikov, B. N. (1992). *Himiya zhirov*; 3rd edition. Moscow: Kolos, 448.
- Roginskiy, V. A. (1990). Kinetika okisleniya efirov poline-nasyischennyih zhirnyih kislot, ingibirovannogo zameschen-nyimi fenolami. *Kinetika i kataliz*, 31 (3), 546–552.
- Demydov, I. M., Hryhorova, A. V. (2012). Vplyv stupenya nenasychenosti oliy na sklad vtorynnykh produktiv yikh okysnenya. *Tekhnichni nauky: stan, dosyahnennya i per-spektyvy rozvytku m"yasnoyi, oliye-zhyrovoyi ta molochnoyi haluzey*, 42–43.
- Demidov, I. N., Nevmivaka, D. V. (2014). Opredelenie srokov hraneniya zhirov i zhirovyykh produktov uskorennym meto-dom. *Maslozhirovaya otrasl: tehnologii i ryinok*, 27–28.
- Denysova, A. Yu., Tsykhanovskaya, Y. V., Skorodumova, O. B., Honcharenko, Ya. M., Pryymak, H. O., Shevchenko, I. V. (2013). Doslidzhennya vplyvu zhyro-mahnetyto-voyi suspenziyi na termin zberihannya tvarynnykh zhyriv. Prohresyvna tekhnika ta tekhnolohiyi kharchovykh vyrob-nystv, restorannoho ta hotel'noho hospodarstv i torhivli. *Ekonomichna stratehiya i perspektyvy rozvytku sfery to-rhivli ta posluh, Part 1*, 71–72.
- Ilyuha, N. G., Barsova, Z. V., Kovalenko, V. A., Tsihanovs-kaya, I. V. (2010). Tehnologiya proizvodstva i pokazateli kachestva pischevoy dobavki na osnove magnetita. *Eastern-European Journal of Enterprise Technologies*, 6 (10 (48)), 32–35. Available at: <http://journals.uran.ua/eejet/article/view/5847/5271>
- Tsihanovskaya, I. V., Denisova, A. Yu., Skorodumova, O. B., Levitin, E. Ya., Kovalenko, V. A., Aleksandrov, A. V., Bar-sova, Z. V. (2012). Izuchenie rastvorimosti magnetita v uslovi-yah, imitiruyuschih pischevaritelnyie protsessy zheludochno-kishechnogo trakta. *Eastern-European Journal of Enterprise Technologies*, 6 (6 (60)), 29–31. Available at: <http://journals.uran.ua/eejet/article/view/5547/4988>
- Tsykhanovs'ka, I. V., Barsova, Z. V., Demydov, I. M., Pavlo-ts'ka, L. F. (2015). Doslidzhennya protsesiv okysnyuval'nykh ta termichnykh peretvorenn' v systemi: oliya – lipido-mahne-tytova suspenziya. Prohresyvna tekhnika ta tekhnolohiyi khar-chovykh vyrobnystv restorannoho hospodarstva i torhivli, 1 (21), 353–362.
- Krushenko, G. G., Reshetnikova, S. N. (2011). Problemyi opredeleniya razmerov nanochastits. *Vestnik Sibirskogo gosudarstvennogo aerokosmicheskogo universiteta imeni akademika M. F. Reshetneva*, 2, 167–170.
- Suzdalev, I. P. (2006). *Nanotehnologiya: fiziko-himiya nanoklastero, nanostruktur i nanomaterialov*. Moscow: Kom-Kniga, 365.
- Keckes, L. J., Woodman, R. H., Trevino, S. F., Klotz, B. R., Hirsch, S. G., Gersten, B. L. (2003). Characterization of a Nanosized Iron Powder by Comparative Methods. *KONA*, 21, 143–150. doi: 10.14356/kona.2003017
- NaBond Technologies Co. Available at: http://www.nabond.com/TiN_nanopowder.html
- Egorova, E. M. et. al. (2002). Stabilnyie nanochastitsyi se-rebra v vodnih dispersiyah, poluchennyih iz mitsellyarnyyh rastvorov. *Zhurnal prikladnoy himii*, 75 (10), 1620–1625.
- Pimenova, N. V. (2011). Poroshki volframa, poluchennyie razlichnyimi sposobami. *Tehnologiya metallov*, 2, 25–27.
- Xu, R. (2001). *Particle Characterization: Light Scattering Methods*. N.Y.: Kluwer Academic Publishers, 410.
- Mamani, J. B., Sibov, T. T., Caous, C. A., Amaro, Jr. E., Gamarra, L. F. (2012). Particokinetics: computational analy-sis of the superparamagnetic iron oxide nanoparticles deposi-

- tion process. *International Journal of Nanomedicine*, 2012:7, 2699–2712. doi: 10.2147/ijn.s30074
18. Lou, W., Charalampopoulos, T. T. (1994). On the electromagnetic scattering and absorption of agglomerated small spherical particles. *Journal of Physics D: Applied Physics*, 27 (11), 2258–2270. doi: 10.1088/0022-3727/27/11/004
 19. Di Stasio, S. (2000). Feasibility of an optical experimental method for the sizing of primary spherules in sub-micron agglomerates by polarized light scattering. *Applied Physics B: Lasers and Optics*, 70 (4), 635–643. doi: 10.1007/s003400050872
 20. Mulholland, G. W., Donnelly, M. K., Hagwood, C. R., Kulkuck, S. R., Hackley, V. A., Pui, D. Y. H. (2006). Measurement of 100 nm and 60 nm Particle Standards by Differential Mobility Analysis. *Journal of Research of the National Institute of Standards and Technology*, 111 (4), 257. doi: 10.6028/jres.111.022
 21. Ivanov, L. A., Kizevetter, D. V., Kiselev, N. N. et. al. (2006). *Izmenenie svetovozvrasheniya ot steklyannykh mikrosharikov i progon kachestva sveto-vozvrashchayuschih pokrytiy*. *Opt. zhurn.*, 73 (1), 35–40.
 22. Van de Hulst, G. (1961). *Rasseyanie sveta malymi chastitsami*. Moscow: IL, 536.
 23. Kerker, M. (1969). *The scattering of light and other electromagnetic radiation*. N.Y., London, Academic Press, 666.
 24. Xu, R. (2001). *Particle Characterization: Light Scattering Methods*. N.Y.: Kluwer Academic Publishers, 410.
 25. Papok, I. M., Petrova, G. P., Anenkova, K. A., Papish, E. A. (2012). Using the dynamic light-scattering method for the analysis of a blood-serum model solution. *Moscow University Physics Bulletin*, 67 (5), 452–456. doi: 10.3103/s0027134912050104
 26. Sohrabi-Gilani, N., Makani, S. (2016). Extraction of ultratrace amounts of nelfinavir from biological samples and pharmaceutical formulations using surfactant-modified magnetite nanoparticles followed by spectrophotometric determination. *Microchemical Journal*, 129, 332–338. doi: 10.1016/j.microc.2016.06.003
 27. Sutorikhin, I., Bukaty, V., Zalaeva, U., Akulova, O. (2013). *Issledovaniya kontsentratsii i razmerov chastits vodnoy vzvesi s pomoshchyu opticheskogo metoda fluktuatsiy prozrachnosti*. *Izvestiya of Altai State University*, 1 (2), 189–193. doi 10.14258/izvasu(2013)1.2-39
 28. Ershov, A. E., Isaev, I. L., Semina, P. N., Markel, V. A., Karpov, S. V. (2012). Effects of size polydispersity on the extinction spectra of colloidal nanoparticle aggregates. *Physical Review B*, 85 (4). doi: 10.1103/physrevb.85.045421
 29. Ilyuha, M. G., Tsihanovska, I. V., Barsova, Z. V., TImofeeva, V. P., Vedernikova, I. O. (2010). Patent. na korisnu model № 54284, MPK S 01 G 49/00. Sposib otrimannya magnetitu. Published: 10.11.2010. *Byul. № 21*, 4.
 30. Van de Hulst, H. (1957). *Light Scattering by Small Particles*. N.Y.: J. Willey & Sons, 536.
 31. Voyutskiy, S. S. (1975). *Kurs kolloidnoy himii*; 2nd edition. Moscow: Himiya, 512.
 32. Ivanov, L. A., Kizevetter, D. V., Kiselev, N. N. et. al. (2006). *Izmenenie svetovozvrasheniya ot steklyannykh mikrosharikov i progon kachestva svetovozvrashchayuschih pokrytiy*. *Opt. zhurn.*, 73 (1), 35–40.
 33. Kizevetter, D. V., Malyugin, V. I. (2009). *Odnovremennoe izmerenie razmerov i skorosti dvizheniya chastits*. *Zhurn. tehn. fiziki*, 79 (2), 90–95.
 34. Chekhun, V., Horobets', S., Horobets', O., Dem'yanenko, I. (2011). *Mahnitni nanostruktury v pukhlynnnykh klitynakh*. *Visn. NAN Ukrayiny*, 11, 13–20.
 35. Alexandrov, A., Tsykhanovska, I., Gontar, T., Kokodiy, N., Dotsenko, N. (2016). Stability and morphological characteristics of lipid-magnetite suspensions. *Eureka: Life Sciences*, 3 (3), 14–25. doi: 10.21303/2504-5695.2016.00143

SUBSTANTIATION OF SELECTING THE METHOD OF PRE-COOLING OF FRUITS (p. 62-68)

Marina Serdyuk, Dmitrij Stepanenko, Svitlana Baiberova, Nonna Gaprindashvili, Alina Kulik

The research is devoted to the scientific substantiation of the feasibility of combination of pre-cooling the fruits and their treatment by antioxidant compositions before prolonged storage, as well as determining the optimal modes and methods of carrying out the given technological operation. The objects of research were the fruits of apple varieties Aydared, Golden Delicious, Simirenko Renet, Florin, the fruits of pear varieties Izyuminka Crimea and Conference, the fruits of plum varieties Voloshka and Stenley. Pre-cooling was conducted in three ways: by cold air in conventional storing chambers, by cold air in the chambers of intensive cooling and hydro-cooling in the solutions of antioxidant compositions. As a result of the studies, it was found that the most intensive method of pre-cooling is cooling by air at temperature minus 2...minus 4 °C and airflow velocity 3 m/s. Under such circumstances, general period of cooling to a temperature 0 °C of the apple fruits and pear fruits is about 2 hours and the plum fruits – slightly longer than 1 hour. The velocity constant of reduction in the intensity of breathing and heat release of fruits during intensive cooling exceeded the velocity constant of the analyzed indices during slow cooling by 4.3...6.6 times and during hydro-cooling by 1.2...1.6 depending on the type of fruit. Along with this, high speed of air motion increased the natural weight loss of fruits during cooling. The quantitative value of this indicator during intensive method was maximum and varied in the range of 0.56 % for the pear fruits to 0.44 % for the plum fruits. Combined method, which implies initial pre-cooling in the working solutions of antioxidant compositions and further cooling by the intensive method, was characterized by high velocity constant of reduction in the intensity of breathing and heat release of the fruits and low level of the natural loss weight. In this case, the quantitative value of the weight loss varied in the range from 0.005 % for plum fruits to 0.014 % for the apple and pear fruits.

Keywords: pre-cooling, antioxidants, hydro-cooling, intensity of breathing, heat release of fruits, weight loss.

References

1. DeLong, J. M., Prange, R. K., Harrison, P. A. (2004). Erratum to "The influence of pre-storage delayed cooling on quality and disorder incidence in 'Honeycrisp' apple fruit". *Postharvest Biology and Technology*, 34 (3), 351. doi: 10.1016/j.postharvbio.2004.10.002
2. Sun, J., Chu, Y.-F., Wu, X., Liu, R. H. (2002). Antioxidant and Antiproliferative Activities of Common Fruits. *Journal of Agricultural and Food Chemistry*, 50 (25), 7449–7454. doi: 10.1021/jf0207530
3. Hajrutdinov, Z. N. (2011). *Sovershenstvovanie tehnologii hraneniya plodov jagodnykh kul'tur putem intensivatsii processa ohlazhdeniya*. *Vestnik MichGAU*, 1, Part 1, 206–209.
4. Choi, J.-H., Yim, S.-H., Cho, K.-S., Kim, M.-S., Park, Y.-S., Jung, S.-K., Choi, H.-S. (2015). Fruit quality and core

- breakdown of “Wonhwang” pears in relation to harvest date and pre-storage cooling. *Scientia Horticulturae*, 188, 1–5. doi: 10.1016/j.scienta.2015.03.011
5. Wang, Y., Xie, X., Long, L. E. (2014). The effect of postharvest calcium application in hydro-cooling water on tissue calcium content, biochemical changes, and quality attributes of sweet cherry fruit. *Food Chemistry*, 160, 22–30. doi: 10.1016/j.foodchem.2014.03.073
 6. Pathare, P. B., Opara, U. L., Vigneault, C., Delele, M. A., Al-Said, F. A.-J. (2012). Design of Packaging Vents for Cooling Fresh Horticultural Produce. *Food and Bioprocess Technology*, 5 (6), 2031–2045. doi: 10.1007/s11947-012-0883-9
 7. Moiseeva, N. A., Volkind, I. L. (2007). Rekomenduemye rezhimy prodolzhitel'nosti holodil'nogo hranenija nekotoryh plodov i ovoshhej. *Ovoshhevodstvo i teplichnoe hozjajstvo*, 3, 50.
 8. Vigneault, C., Goyette, B. (2002). Design of plastic container opening to optimize forced air precooling of fruits and vegetables. *Applied Engineering in Agriculture*, 18 (1), 73–76. doi: 10.13031/2013.7697
 9. Kolodjaznaja, V. S., Kiprushkina, E. I., Baranenko, D. A., Rumjanceva, O. N., Shestopalova, I. A. (2013). Prodovol'stvennaja bezopasnost' i holodil'naja tehnologija. *Vestnik Mezhdunarodnoj akademii holoda*, 1, 24–28.
 10. Liu, B., Guo, Y., Guan, W. (2003). Study on Forced Air Pre-cooling Mode of Fruit and Vegetable. *J. Storage and Process*, 6, 7.
 11. Wijewardane, R. M. N. A., Guleria, S. P. S. (2011). Effect of pre-cooling, fruit coating and packaging on postharvest quality of apple. *Journal of Food Science and Technology*, 50 (2), 325–331. doi: 10.1007/s13197-011-0322-3
 12. Lal Basediya, A., Samuel, D. V. K., Beera, V. (2011). Evaporative cooling system for storage of fruits and vegetables – a review. *Journal of Food Science and Technology*, 50 (3), 429–442. doi: 10.1007/s13197-011-0311-6
 13. Dehghannya, J., Ngadi, M., Vigneault, C. (2010). Mathematical Modeling Procedures for Airflow, Heat and Mass Transfer During Forced Convection Cooling of Produce: A Review. *Food Engineering Reviews*, 2 (4), 227–243. doi: 10.1007/s12393-010-9027-z
 14. Soliva-Fortuny, R. C., Martín-Belloso, O. (2003). New advances in extending the shelf-life of fresh-cut fruits: a review. *Trends in Food Science & Technology*, 14 (9), 341–353. doi: 10.1016/S0924-2244(03)00054-2
 15. Oliveira, M., Abadias, M., Usall, J., Torres, R., Teixidó, N., Viñas, I. (2015). Application of modified atmosphere packaging as a safety approach to fresh-cut fruits and vegetables – A review. *Trends in Food Science & Technology*, 46 (1), 13–26. doi: 10.1016/j.tifs.2015.07.017
 16. Janisiewicz, W. J., Korsten, L. (2002). Biological control of post-harvest diseases of fruits. *Annual Review of Phytopathology*, 40 (1), 411–441. doi: 10.1146/annurev.phyto.40.120401.130158
 17. Argenta, L. C., Fan, X., Mattheis, J. P. (2003). Influence of 1-methylcyclopropene on ripening, storage life, and volatile production by d'Anjou cv. pear fruit. *Journal of agricultural and food chemistry*, 51 (13), 3858–3864. doi: 10.1021/jf034028g
 18. Priss, O. P. (2016). Effect of heat treatment with antioxidants on the content of bioactive compounds during storage of zucchini. *Technology audit and production reserves*, 1 (1 (27)), 72–76. doi: 10.15587/2312-8372.2016.60339
 19. Cisneros-Zevallos, L. (2003). The Use of Controlled Post-harvest Abiotic Stresses as a Tool for Enhancing the Nutritional Content and Adding-Value of Fresh Fruits and Vegetables. *Journal of Food Science*, 68 (5), 1560–1565. doi: 10.1111/j.1365-2621.2003.tb12291.x
 20. Serdyuk, M., Kalitka, V., Baiberova, S. (2014). Influence of exogenous treatment with antioxidants on dynamics of phenolic compounds during storage of apples. *Eastern-European Journal of Enterprise Technologies*, 5 (11 (71)), 17–22. doi: 10.15587/1729-4061.2014.27584
 21. Serdyuk, M., Gaprindashvili, N. (2013). Zmina vmistu askorbinovoi kysloty v plodakh hrushi pry tryvalomu zberihanni z vykorystanniam antyoksydantiv. *Pratsi Tavrijs'koho derzhavnogo ahrotekhnolohichnoho universytetu*, 13 (7), 89–94.
 22. Serdyuk, M., Stepanenko, D., Baiberova, S., Gaprindashvili, N., Kulik, A. (2016). The study of methods of preliminary cooling of fruits. *Eureka: Life Sciences*, 3 (3), 57–62. doi: 10.21303/2504-5695.2016.00148
 23. Najchenko, V. M., Zamors'ka, I. L. (2010). Tehnologija zberigannja i pererobki plodiv ta ovochiv. *Uman': «Sochins'kij»*, 328.