



## CHEMICAL AND TECHNOLOGICAL SYSTEMS

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## PREPARATION OF POROUS SILICA NANOCOMPOSITES FROM MONTMORILLONITE USING SOL-GEL APPROACH

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The object of research is montmorillonite, which due to its properties and structure shows high sorption characteristics. However, the significant barrier to its use in industrial water purification technologies is the tendency of montmorillonite to be self-dispersed in aqueous solutions on elementary structural layers and to form stable suspensions. It creates difficulties with separating the solid and liquid phases after the sorption process. The authors used the sol-gel method for the synthesis of nanocomposite materials based on montmorillonite using tetraethoxysilane as a gelling agent. The synthesis involves the hydrolysis reaction of tetraethoxysilane and the subsequent polycondensation of silica molecules with hydroxyl groups of montmorillonite. The obtained samples inherit good sorption properties from a layered mineral and a solid frame structure from silica. Such a structure of synthesized nanocomposites is ensured by the presence of siloxane bonds, which help to bound together the elementary particles of montmorillonite. This, in turn, improves the water resistance of samples. Based on the results of rheological studies, it has been shown that the basic processes of the structure formation in the initial water-alcohol suspensions of the hydrolysis products of tetraethoxysilane and montmorillonite occur at a concentration of 1 % silica, which is due to the colloidal and chemical properties of the investigated systems. It has been shown that the treatment of montmorillonite with tetraethoxysilane hydrolysis products leads to the formation of a material with lower ability to swell and with better separation of liquid and solid phases. The optimum content of silica in the sample, which is in the range of 0.1 to 14 %, makes it possible to reduce the optical density of solutions by 2.5 times compared with the original montmorillonite. It has been shown

that the synthesized materials retain a sufficiently high sorption capacity to remove the cationic dye methylene blue (up to 158 mg/g), which rises with increasing clay mineral content. And has been having a higher selectivity (up to 3.4 dm<sup>3</sup>/mg).

**Keywords:** sol-gel synthesis, surface modification, sorption isotherm, montmorillonite, tetraethoxysilane, methylene blue.

## References

1. Uddin, M. K. (2017). A review on the adsorption of heavy metals by clay minerals, T with special focus on the past decade. *Chemical Engineering Journal*, 308, 438–462. doi: <http://doi.org/10.1016/j.cej.2016.09.029>
2. Tian, G., Wang, W., Kang, Y., Wang, A. (2016). Ammonium sulfide-assisted hydrothermal activation of palygorskite for enhanced adsorption of methyl violet. *Journal of Environmental Sciences*, 41, 33–43. doi: <http://doi.org/10.1016/j.jes.2015.03.036>
3. Petra, L., Billik, P., Melichova, Z., Komadel, P. (2017). Mechanically activated saponite as materials for Cu<sup>2+</sup> and Ni<sup>2+</sup> removal from aqueous solutions. *Applied Clay Science*, 143, 22–28. doi: <http://doi.org/10.1016/j.clay.2017.03.012>
4. Cakmak, M., Tasar, S., Selen, V., Ozer, D., Ozer, A. (2017). Removal of astrazon golden yellow 7GL from colored wastewater using chemically modified clay. *Journal of Central South University*, 24 (4), 743–753. doi: <http://doi.org/10.1007/s11771-017-3476-y>
5. Huang, W., Chen, J., He, F., Tang, J., Li, D., Zhu, Y., Zhang, Y. (2015). Effective phosphate adsorption by Zr/Al-pillared montmorillonite: insight into equilibrium, kinetics and thermodynamics. *Applied Clay Science*, 104, 252–260. doi: <http://doi.org/10.1016/j.clay.2014.12.002>
6. Pylypenko, I. V., Kornilovych, B. Y., Kovalchuk, I. A. (2015). Synthesis and sorption properties of Ti- and Al-pillared montmorillonite. *Himia, Fizika Ta Tehnologija Poverhni*, 6 (3), 336–342. doi: <http://doi.org/10.15407/hftp06.03.336>
7. Zhang, S., Lyu, Y., Su, X., Bian, Y., Yu, B., Zhang, Y. (2016). Removal of fluoride ion from groundwater by adsorption on lanthanum and aluminum loaded clay adsorbent. *Environmental Earth Sciences*, 75 (5), 401. doi: <http://doi.org/10.1007/s12665-015-5205-x>
8. Anirudhan, T. S., Ramachandran, M. (2015). Adsorptive removal of basic dyes from aqueous solutions by surfactant modified bentonite clay (organoclay): kinetic and competitive adsorption isotherm. *Process Safety and Environmental Protection*, 95, 215–225. doi: <http://doi.org/10.1016/j.psep.2015.03.003>
9. Omorgie, M. O., Agunbiade, F. O., Alfred, M. O., Olaniyi, O. T., Adewumi, T. A., Bayode, A. A. et al. (2018). The sequestration capture of fluoride, nitrate and phosphate by metal-doped and surfactant-modified hybrid clay materials. *Chemical Papers*, 72 (2), 409–417. doi: <http://doi.org/10.1007/s11696-017-0290-9>
10. Xue, A., Zhou, S., Zhao, Y., Lu, X., Han, P. (2010). Adsorption of reactive dyes from aqueous solution by silylated palygorskite. *Applied Clay Science*, 48 (4), 638–640. doi: <http://doi.org/10.1016/j.clay.2010.03.011>
11. Moreira, M. A., Ciuffi, K. J., Rives, V., Vicente, M. A., Trujillano, R., Gil, A. et al. (2017). Effect of chemical modification of palygorskite and sepiolite by 3-aminopropyltriethoxysilane on adsorption of cationic and anionic dyes. *Applied Clay Science*, 135, 394–404. doi: <http://doi.org/10.1016/j.clay.2016.10.022>

12. Thue, P. S., Sophia, A. C., Lima, E. C., Wamba, A. G. N., de Alencar, W. S., dos Reis, G. S. et al. (2018). Synthesis and characterization of a novel organic-inorganic hybrid clay adsorbent for the removal of acid red 1 and acid green 25 from aqueous solutions. *Journal of Cleaner Production*, 171, 30–44. doi: <http://doi.org/10.1016/j.jclepro.2017.09.278>
13. Pawar, R. R., Lalthumsiam, Kim, M., Kim, J.-G., Hong, S.-M., Sawant, S. Y., Lee, S. M. (2018). Efficient removal of hazardous lead, cadmium, and arsenic from aqueous environment by iron oxide modified clay-activated carbon composite beads. *Applied Clay Science*, 162, 339–350. doi: <http://doi.org/10.1016/j.clay.2018.06.014>
14. Diagboya, P. N. E., Dikio, E. D. (2018). Silica-based mesoporous materials; emerging designer adsorbents for aqueous pollutants removal and water treatment. *Microporous and Mesoporous Materials*, 266, 252–267. doi: <http://doi.org/10.1016/j.micromeso.2018.03.008>
15. Doroshenko, D., Pylypenko, I., Kornilovych, B. (2018). Sorption of cobalt and methylene blue ions by montmorillonite-silica nanocomposites. *KPI Science News*, 3, 7–14. doi: <http://doi.org/10.20535/1810-0546.2018.3.126410>
16. Qian, Z., Hu, G., Zhang, S., Yang, M. (2008). Preparation and characterization of montmorillonite–silica nanocomposites: A sol–gel approach to modifying clay surfaces. *Physica B: Condensed Matter*, 403 (18), 3231–3238. doi: <http://doi.org/10.1016/j.physb.2008.04.008>
17. Shramm, G. (2003). *Osnovy prakticheskoy reologii i reometrii*. Moscow: KolosS, 312
18. Kimura, Y., Haraguchi, K. (2017). Clay–alcohol–water dispersions: anomalous viscosity changes due to network formation of clay nanosheets induced by alcohol clustering. *Langmuir*, 33 (19), 4758–4768. doi: <http://doi.org/10.1021/acs.langmuir.7b00764>
19. Chen, T., Zhao, Y., Song, S. (2017). Comparison of colloidal stability of montmorillonite dispersion in aqueous NaCl solution with in alcohol-water mixture. *Powder Technology*, 322, 378–385. doi: <http://doi.org/10.1016/j.powtec.2017.09.032>
20. Bi, W., Song, R., Meng, X., Jiang, Z., Li, S., Tang, T. (2007). In situ synthesis of silica gel nanowire/Na<sup>+</sup>–montmorillonite nanocomposites by the sol–gel route. *Nanotechnology*, 18 (11), 115620. doi: <http://doi.org/10.1088/0957-4484/18/11/115620>
21. Ngulube, T., Gumbo, J. R., Masindi, V., Maity, A. (2017). An update on synthetic dyes adsorption onto clay based minerals: A state-of-art review. *Journal of Environmental Management*, 191, 35–57. doi: <http://doi.org/10.1016/j.jenvman.2016.12.031>
22. Hegyesi, N., Vad, R. T., Pukanszky, B. (2017). Determination of the specific surface area of layered silicates by methylene blue adsorption: The role of structure, pH and layer charge. *Applied Clay Science*, 146, 50–55. doi: <http://doi.org/10.1016/j.clay.2017.05.007>
23. Florence, N., Naorem, H. (2014). Dimerization of methylene blue in aqueous and mixed aqueous organic solvent: A spectroscopic study. *Journal of Molecular Liquids*, 198, 255–258. doi: <http://doi.org/10.1016/j.molliq.2014.06.030>
24. Mukherjee, K., Kedia, A., Jagajjani Rao, K., Dhir, S., Paria, S. (2015). Adsorption enhancement of methylene blue dye at kaolinite clay–water interface influenced by electrolyte solutions. *RSC Advances*, 5 (39), 30654–30659. doi: <http://doi.org/10.1039/c5ra03534a>

## ECOLOGY AND ENVIRONMENTAL TECHNOLOGY

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### SUBSTANTIATION OF PROPOSALS ON THE USE OF INSULATING APPARATUS IN THE LIQUIDATION OF EMERGENCIES WITH THE RELEASE OF HAZARDOUS CHEMICALS

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In work, the technical possibilities of using personal respiratory protective equipment are considered as an object of research. Such funds are used in fire and rescue units, during emergency rescue operations related to the liquidation of emergency situations with the release of hazardous chemicals. It is shown that one of the most problematic places for the participation of personnel of fire-rescue units is the contradiction between the protective properties of personal protective equipment and the danger that may be in the organization of the release of a hazardous substance. This applies to the personnel of firefighting and rescue units, which are the first to start carrying out appropriate rescue operations. As a result, even with the full implementation of existing regulatory requirements, work in isolating devices can be dangerous for the rescuer.

At the heart of the chosen approach to the solution of the task in view lay the assessment of the possibility to provide such a general protection factor of the insulating device in the assembly with the front part, which will exceed the coefficient of toxic environmental hazard. The study used an analytical definition of the requirements for the testing of compressed air equipment equipped with helmet-masks. It showed that rescuers can work at the epicenter of an accident with the release of hazardous chemicals, if in checking the tightness with the help of devices when creating a test vacuum of 2000 Pa, the rate of the decrease in vacuum will not exceed 32 Pa/min. However, experimental veri-

fication of the obtained theoretical results allows to state that the fire and rescue unit will not be able to achieve this requirement. Increasing the test dilution to a level that exceeds 1000 Pa is accompanied by a significant increase in the suction in the system «insulating apparatus – respiratory organs».

It has been proven by experience that protection devices are provided with compressed air, equipped with pulmonary automatic devices, which create an overpressure air in the UMS. In this case, the threaded connection of the insulating device with the front part must not be used. This allows to recommend the use of compressed air devices equipped with pulmonary automatic devices as a basic set of isolating apparatuses, creating air overpressure in the UMS

Exceptions are subdivisions, in the area of operational departure of which there are facilities on which there is a large number of hazardous chemicals with a toxic hazard coefficient of more than  $2.3 \cdot 10^5$ . In this case, they should be completed with complexes of personal protective equipment of ampoule type.

**Keywords:** dangerous chemicals, insulating apparatus, compressed air apparatus, front part.

### References

1. Didenko, N. S. (1984). *Regenerativnye respiratory dlya gornospasatel'nykh robot.* Moscow: Nedra, 296.
2. *Kodeks tsyvilnoho zakhystu Ukrainy.* Iz zminamy i dopovneniamy, vnesenymy zakonamy Ukrainy 14.05.2013 No. 224-VII, OVU, 2013., No. 44, st. 1568. 20.06.2013. No. 353-VII (zminy, vneseni Zakonom Ukrainy 20.06.2013. No. 353-VII, vvodiatsia v diuu z 1.07.2013). Available at: <http://zakon5.rada.gov.ua/laws/show/5403-17>
3. *NFPA 1500 Standard on Fire Department Occupational Safety and Health Program.* 2002 Edition. Available at: <http://www.fsans.ns.ca/pdf/research/nfpa1500.pdf>
4. Subburajah, J. (2015). *OSHA's Interpretation for Fire Emergency Planning.* Available at: <https://www.linkedin.com/pulse/oshas-interpretation-fire-emergency-planning-subburajah-j>
5. *Occupational Safety and Health Administration.* Available at: <https://www.osha.gov/about.html>
6. 29 CFR 1910.156. *Fire brigades. General requirements.* Available at: [https://www.osha.gov/pls/oshaweb/owalink.query\\_links?src\\_doc\\_type=STANDARDS&src\\_unique\\_file=1910\\_0156&src\\_anchor\\_name=1910.156](https://www.osha.gov/pls/oshaweb/owalink.query_links?src_doc_type=STANDARDS&src_unique_file=1910_0156&src_anchor_name=1910.156)
7. OSHA 1910.134. *Respiratory Protection.* Available at: [https://www.osha.gov/pls/oshaweb/owadisp.show\\_document?p\\_table=STANDARDS&p\\_id=12716](https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=12716)
8. NFPA 1001. *Standard for Fire Fighter Professional Qualifications.* Available at: <https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1001>
9. WAC 296-305-05109. *Technical rescue equipment.* Available at: <http://apps.leg.wa.gov/WAC/default.aspx?cite=296-305-05109>
10. *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies.* NFPA 1991: 2005 Edition. Available at: <http://hamyarenergy.com/static/fckimages/files/NFPA/Hamyar%20Energy%20NFPA%201991%20-%202005.pdf>
11. NFPA 1981. *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services* (2007). Current Edition: 2007 Next Revision Cycle: Fall 2011, 117.
12. Jeffrey, O., Grace, G. S. (2016). *How good are firefighter SCBAs at keeping chemicals out?* Fire Chief. Available at: <https://www.firechief.com/2016/03/14/how-good-are-firefighter-scbas-at-keeping-chemicals-out/>
13. *Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles Part 1: Performance requirements for ventilated and non-ventilated «gas-tight» (Type 1) and «non-gas-tight» (Type 2) chemical protective suits:* prEN 943-1:2002. Available at: [http://www.standardsdirect.org/standards/standards2/StandardsCatalogue24\\_view\\_17935.html](http://www.standardsdirect.org/standards/standards2/StandardsCatalogue24_view_17935.html)
14. *Liquid chemicals for limited life/use (liquid-tight) Type 3 equipment:* prEN 1511. Available at: <http://www.outsource-safety.co.uk/safety-news/british-standards-relating-to-health-and-safety/>
15. *Prepare for emergencies.* Cabinet Office. Available at: <https://www.gov.uk/government/publications/preparing-for-emergencies/preparing-for-emergencies>
16. *Fire prevention and rescue.* Available at: <https://www.gov.uk/government/policies/fire-prevention-and-rescue>
17. Johnson, A. T. (2016). Respirator masks protect health but impact performance: a review. *Journal of Biological Engineering*, 10 (1). doi: <http://doi.org/10.1186/s13036-016-0025-4>
18. Dahlbäck, G. O., Balldin, U. I. (1984). Physiological Effects of Pressure Demand Masks During Heavy Exercise. *American Industrial Hygiene Association Journal*, 45 (3), 177–181. doi: <http://doi.org/10.1080/15298668491399604>
19. Balkhyour, M. (2013). Evaluation of Full-Facepiece Respirator Fit on Fire Fighters in the Municipality of Jeddah, Saudi Arabia. *International Journal of Environmental Research and Public Health*, 10 (1), 347–360. doi: <http://doi.org/10.3390/ijerph10010347>
20. Rengasamy, S., Shaffer, R., Williams, B., Smit, S. (2016). A comparison of facemask and respirator filtration test methods. *Journal of Occupational and Environmental Hygiene*, 14 (2), 92–103. doi: <http://doi.org/10.1080/15459624.2016.1225157>
21. Sawada, S., Kuklane, K., Wakatsuki, K., Morikawa, H. (2017). New development of research on personal protective equipment (PPE) for occupational safety and health. *Industrial Health*, 55 (6), 471–472. doi: <http://doi.org/10.2486/indhealth.55-471>
22. Grine, L., Bouzid, A.-H. (2013). Analytical and Experimental Studies of Liquid and Gas Leaks through Micro and Nano-Porous Gaskets. *Materials Sciences and Applications*, 4 (8), 32–42. doi: <http://doi.org/10.4236/msa.2013.48a004>
23. *Rekomendatsii shchodo zakhystu osobovoho skladu pidrozdiliv Operatyvno-riativalnoi sluzhby tsyvilnoho zakhystu MNS Ukrainy pid chas hasinnia pozhezh ta likvidatsii naslidkiv avarii za naiavnosti nebezpechnykh khimichnykh rehovyn (amiak, khlor, azotna, sirchana, soliana ta fosforna kysloty)* (2008). Nakaz No. 733 MNS Ukrainy vid 13.10.2008. Kyiv: MNS Ukrainy, 88.
24. Strilets, V. M., Vasyliiev, M. V. (2010). Analiz zakhysnykh vlastyvoستي zasobiv indyvidualnoho zakhystu, yaki pryznacheni dlia roboty v umovakh vykydu nebezpechnykh khimichnykh rehovyn. *Zbirnyk naukovykh prats Kharkivskoho universytetu povitrianykh syl*, 1 (23), 197–200.
25. Kuzmenko, V. A., Mykhalska, L. L., Shcherbak, S. M. (2002). Analiz mozhlyvosti vykorystannia izoliuiuchykh aparativ pid chas likvidatsii avarii na ob'iektakh iz synodiuchymy otruinymy rehovynamy. *Problemi pozharnoi bezopasnosti. Sbornyk nauchnykh trudov APB Ukrainy*, 12, 162–169.
26. Strelets, V. M. (2014). Osobennosti vybora sredstv individual'noy zashhity dlya roboty spasateley v usloviyakh, kotorye sushhestvenno otlichayutsya ot naikhudshikh usloviy pozhara. *Sistemi ozbroennya i viys'kova tekhnika*, 4 (40), 150–153.
27. *Nastanova z orhanizatsii hazodymozakhysnoi sluzhby v pidrozdilakh Operatyvno-riativalnoi sluzhby tsyvilnoho zakhystu MNS Ukrainy* (2011). Nakaz MNS Ukrainy 16.12.2011. No. 1342. URL: <http://dprch11.pp.ua/slugbova-pidgotovka/psp/208-nakaz-mns-1342-vid-16-12-2011-nastanova-z-organi-zatsiji-gazodimozakhisnoji-sluzhbi-v-pidrozdilakh-operativno-riativalnoi-sluzhbi-tsvilnogo-zakhystu-mns-ukrajini>

28. Strilets, V. M., Kovalov, P. A., Borodych, P. Yu., Rosokha, S. V. (2014). *Osnovy stvorennia ta ekspluatatsii zasobiv individualnoho zakhystu*. Kharkiv: NUTsZU, 360.
29. *Kompleksy sredstv individual'noy zashchity spasateley*. Obshhie tekhnicheskie trebovaniya: GOST R 22.9.05-95. Available at: <http://www.gr-obor.narod.ru/document.htm>
30. *Apparat ASV-2. Tekhnicheskoe opisanie i instruktsiya po ekspluatatsii* (2011). Lugansk: OAO Zavod gornospasatel'noy tekhniki «Gorizont», 42.
31. *Pribor kontrol'nyy «Aerotest». Rukovodstvo po ekspluatatsii* (2011). Lugansk: OAO Zavod gornospasatel'noy tekhniki «Gorizont», 24.

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**ANALYSIS OF DYNAMICS OF MAN-MADE FIRES IN CONDITIONS OF URBANIZATION IN UKRAINE**

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Research subject is the dynamics of manifestations of fires of man-made origin in urban settlements in relation to the demographic changes in urbanization processes in the period 1997–2017. The problem cause of increase of urbanization is global climatic changes which initiates fires. Those fires are one of the most dangerous events with large numbers of victims and significant material losses.

The methodology for studying the dynamics of manifestations of emergencies of man-made origin has never considered relationship between the rate of urbanization in Ukraine over the past 20 years and demographic changes.

The study uses a statistically-analytical and functional method for estimating the number of fires. The study shows a high degree of correlation between the decrease in the number of fires and the reduction in population density with a slow pace of urbanization over the last 20 years. The basis for the positive dynamics of the manifestations of fires is the objective conditions of the technogenic-urban environment and the subjective factors associated with the human factor.

It is shown that the demographic factor affects the growth of the risk of human deaths on one side and the number of fires of man-made origin is reduced on the other side, in case of urbanization on the level of up to 67 %. Next level up of urbanization leads to a sharp increase in the number of emergencies. At the same time, the tendency to reduce the risk of death from fires with a decrease in population density and an increase in the level of urbanization above 67 %.

The effect of reducing the vulnerability of the urban population, except demographic factor, is related of providing cities with significant human, technical and material resources.

Due to the revealed correlations of demographic and urban factors with the dynamics of the manifestation of fires, we are able to develop measures to monitor, prevent and eliminate the consequences of fires in populated areas. A risk-based fire-fight-

ing strategy is applicable to protect people and property in areas of high population density.

**Keywords:** urbanization processes, ecological safety, emergency, fire of man-made genesis, risk to the population.

**References**

1. *Analiz masvyu kartok obliku pozhezh. DSNS Ukrainy*. Available at: <http://undicz.dsns.gov.ua/ua/Analiz-masivu-kartok-obliku-pozhezh.html>. Last accessed: 14.03.2018
2. *Natsionalna dopovid pro stan tekhnohennoi ta pryrodnoi bezpeky v Ukraini*. VDISP UKkrNDITsZ. Available at: <http://undicz.dsns.gov.ua/ua/Nacionalna-dopovid-pro-stan-tehnogennoi-ta-prirodnoi-bezpeky-v-Ukrayini.html>. Last accessed: 24.02.2018
3. *Analitichnyi ohliad stanu tekhnohennoi ta pryrodnoi bezpeky v Ukraini*. Available at: <http://www.dsns.gov.ua/ua/Analitichniy-oglyad-stanu-tehnogennoi-ta-prirodnoi-bezpeky-v-Ukrayini-za-2015-rik.html>. Last accessed: 10.03.2018
4. Pelling, M. (2007). *Urbanization and Disaster Risk. Panel contribution to the Population-Environment Research Network Cyberseminar on Population and Natural Hazards*. Available at: <https://pdfs.semanticscholar.org/c64e/27e09397149d4fdb7997ace325571275782e.pdf>. Last accessed: 15.04.2018
5. El Garouani, A., Mulla, D. J., El Garouani, S., Knight, J. (2017). Analysis of urban growth and sprawl from remote sensing data: Case of Fez, Morocco. *International Journal of Sustainable Built Environment*, 6 (1), 160–169. doi: <http://doi.org/10.1016/j.ijsbe.2017.02.003>
6. Tan, Y., Xu, H., Zhang, X. (2016). Sustainable urbanization in China: A comprehensive literature review. *Cities*, 55, 82–93. doi: <http://doi.org/10.1016/j.cities.2016.04.002>
7. Hodson, M., Marvin, S. (2009). “Urban Ecological Security”: A New Urban Paradigm? *International Journal of Urban and Regional Research*, 33 (1), 193–215. doi: <http://doi.org/10.1111/j.1468-2427.2009.00832.x>
8. Wamsler, C. (2004). Managing urban risk: perceptions of housing and planning as a tool for reducing disaster risk. *Global Built Environment Review*, 4 (2), 11–28. Available at: <http://portal.research.lu.se/portal/files/2698440/3629168.pdf>. Last accessed: 06.12.2017
9. Kolesnik, V. Ye., Borysovs'ka, O. O., Pavlychenko, A. V., Shirin, A. L. (2017). Determination of trend and regularities of occurrence of emergency situations of technogenic and natural character in Ukraine. *Scientific Bulletin of National Mining University*, 6, 124–131. URL: <http://nvngu.in.ua/index.php/en/home/1518-engcat/archive/2017-eng/contents-6-2017/environmental-safety-labour-protection/4238-determination-of-trends-and-regularities-of-occurrence-of-emergency-situations-of-technogenic-and-natural-character-in-ukraine>. Last accessed: 14.02.2018
10. Tiutiunyk, V. V. (2015). Otsinka vidnosnoi intensyvnosti mizh nadzvychainymy sytuatsiyamy pryrodnoho ta tekhnohennoho kharakteru v rehionakh Ukrainy. *Problemy nadzvychainykh sytuatsii*, 21, 112–120. Available at: <http://nuczu.edu.ua/sciencearchive/ProblemsOfEmergencies/vol21/Tiutiunyk.pdf>. Last accessed: 20.03.2018
11. Shevchenko, O. H. (2014). Vrazlyvist urbanizovanoho sere-dovyscha do zminy klimatu. *Fizychna heohrafiia ta heomorfolohiia*, 4 (76), 167–172.
12. Moldan, B., Janouskova, S., Hak, T. (2012). How to understand and measure environmental sustainability: Indicators and targets. *Ecological Indicators*, 17, 4–13. doi: <http://doi.org/10.1016/j.ecolind.2011.04.033>
13. Hulida, E. M., Voitovykh, D. P., Movchan, I. O. (2017). Potik pozhezh ta yikh odnochasnist u mistakh. *Pozhezhna bezpeka*, 31,

- 30–35. Available at: <https://journal.ldubgd.edu.ua/index.php/PB/article/view/101> Last accessed: 15.03.2018
14. Kruchina, V. V., Kleev's'ka, V. L., Veremeenko, O. Yu., De-eva, A. D. (2015). Prognozuvannya naslidkiv pozhezh za dopomogoyu informatsiynikh sistem. *Otkrytye informatsionnye i komp'yuternye integrirovannye tekhnologii*, 68, 167–172. URL: <https://www.khai.edu/csp/nauchportal/Arhiv/OIKIT/2015/OIKIT68/p167-172.pdf>. Last accessed: 16.03.2018
  15. Vasiutynska, K., Arsirii, O., Ivanov, O. (2017). Development of the method for assessing the action zones of hazards in an emergency at a city filling station using geoinformation technology. *Technology Audit and Production Reserves*, 6 (3 (38)), 29–38. doi: <http://doi.org/10.15587/2312-8372.2017.119505>
  16. Vasiutynska, K., Smyk, S., Ivanov, O., Shevchuk, I. (2017). Visualization of the pool fire action zones with using MapInfo GIS for the number of filling stations of the Odessa (Ukraine) residential district. *Technology Audit and Production Reserves*, 1 (3 (39)), 30–39. doi: <http://doi.org/10.15587/2312-8372.2018.124241>
  17. Tiutiunyk, V. V., Chornohor, L. F., Kaluhin, V. D. (2016). Vykorystannia enerhetychnoho pidkholdu dlia otsinky efektyvnosti funktsionuvannia kompleksnoi avtomatyzovanoi systemy monitorynhu, poperedzhennia ta likvidatsii nadzvychainykh situatsii na lokalnii terytorii. *Systemy obrobky informatsii*, 1 (138), 183–194. Available at: [http://nbuv.gov.ua/UJRN/soi\\_2016\\_1\\_40](http://nbuv.gov.ua/UJRN/soi_2016_1_40) Last accessed: 24.03.2018
  18. Jennings, C. R. (2013). Social and economic characteristics as determinants of residential fire risk in urban neighborhoods: A review of the literature. *Fire Safety Journal*, 62, 13–19. doi: <http://doi.org/10.1016/j.firesaf.2013.07.002>
  19. Clare, J., Garis, L., Plecas, D., Jennings, C. (2012). Reduced frequency and severity of residential fires following delivery of fire prevention education by on-duty fire fighters: Cluster randomized controlled study. *Journal of Safety Research*, 43 (2), 123–128. doi: <http://doi.org/10.1016/j.jsr.2012.03.003>
  20. *Publikatsii dokumentiv Derzhavnoi sluzhby statystyky Ukrainy*. Available at: [https://ukrstat.org/uk/operativ/operativ2010/ds/kn/kn\\_u/kn1210\\_u.html](https://ukrstat.org/uk/operativ/operativ2010/ds/kn/kn_u/kn1210_u.html). Last accessed: 24.03.2018

## FOOD PRODUCTION TECHNOLOGY

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### RESEARCH OF FATTY ACID COMPOSITION OF TOMATO SEEDS

page 24–27

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The object of research is secondary products of tomato processing, namely, tomato seeds of technical and biological maturation. One of the most problematic places in the tomato processing industry is the formation of a large amount (up to 30 % of the total mass of tomatoes) of waste containing a large amount of proteins, lipids, carbohydrates, minerals and biologically active compounds. The solution of the problem of recycling of secondary tomato resources becomes possible provided that they are determined by their chemical composition and biological value and the selection of technological parameters for further processing.

During the studies, the chemical composition of tomato seeds was analyzed and it was found that tomato seeds are an excellent source of carotenoids, proteins, sugars, fibers, waxes and oils. At the same time, the seeds of the technical stage of maturity differ from the biologically mature seeds with high content of proteins – by 0.81 %, fiber – 0.4 % and sugars – by 0.21 %. The obtained results of the analysis of the fatty acid composition of tomato seeds of technical and biological maturity allowed to establish that among the fatty acids in the analyzed samples contained 47.72 % polyunsaturated tomato seeds of technical maturity and

50.96 % – biological maturity. There are no trans isomers, and the ratio between the unsaturated omega-3 and the omega-6 acids in the seed corresponds to the latest recommendations for nutrition of the population in accordance with the principles of enthusiasm.

The obtained results of the analysis of the chemical composition of the secondary tomato raw material have shown that the issue of improving the technologies of complex processing of tomatoes, which will provide high economic and social effects, remains an important issue. Thanks to the use of semolina food products from tomato seeds, it becomes possible to obtain foods that have high levels of essential amino acids, salts and water soluble proteins, carbohydrates and lipids that are represented by poly unsaturated fatty acids.

**Keywords:** secondary products of tomato processing, fatty acid composition of tomato seeds, technologies of complex processing of tomatoes.

### References

1. *Kontseptsiia derzhavnoi naukovy-tekhnichnoi prohramy «Biofortyfikatsiia ta funktsionalni produkty na osnovi roslynnoi syrovynny na 2012–2016 roky»* (2011). Kyiv. Available at: [http://www1.nas.gov.ua/infrastructures/Legaltexts/nas/2011/regulations/OpenDocs/110608\\_189\\_concept.pdf](http://www1.nas.gov.ua/infrastructures/Legaltexts/nas/2011/regulations/OpenDocs/110608_189_concept.pdf)
2. Mizrahi, S. (2010). Syneresis in food gels and its implications for food quality. *Chemical Deterioration and Physical Instability of Food and Beverages*, 324–348. doi: <http://doi.org/10.1533/9781845699260.2.324>
3. Navarro-González, I., García-Alonso, J., Periago, M. J. (2018). Bioactive compounds of tomato: Cancer chemopreventive effects and influence on the transcriptome in hepatocytes. *Journal of Functional Foods*, 42, 271–280. doi: <http://doi.org/10.1016/j.jff.2018.01.003>
4. Jabbari, S.-S., Jafari, S. M., Dehnad, D., Shahidi, S.-A. (2018). Changes in lycopene content and quality of tomato juice during thermal processing by a nanofluid heating medium. *Journal of Food Engineering*, 230, 1–7. doi: <http://doi.org/10.1016/j.jfoodeng.2018.02.020>
5. Zhu, Y., Klee, H. J., Sarnoski, P. J. (2018). Development and characterization of a high quality plum tomato essence. *Food Chemistry*, 267, 337–343. doi: <http://doi.org/10.1016/j.foodchem.2017.07.160>
6. Bosona, T., Gebresenbet, G. (2018). Life cycle analysis of organic tomato production and supply in Sweden. *Journal of*

- Cleaner Production*, 196, 635–643. doi: <http://doi.org/10.1016/j.jclepro.2018.06.087>
7. Wu, B., Patel, B. K., Fei, X., Jones, O., Campanella, O. H., Reuhs, B. L. (2018). Variations in physical-chemical properties of tomato suspensions from industrial processing. *LWT*, 93, 281–286. doi: <http://doi.org/10.1016/j.lwt.2018.03.005>
  8. Bertin, N., Génard, M. (2018). Tomato quality as influenced by preharvest factors. *Scientia Horticulturae*, 233, 264–276. doi: <http://doi.org/10.1016/j.scienta.2018.01.056>
  9. Gadzhieva, A. M., Muradov, M. S., Kas'yanov, G. I., Ismailov, E. Sh. (2014). Ispol'zovanie innovatsionnykh tekhnologiy kompleksnoy pererabotki tomatnogo syr'ya. *Politematicheskii setevoy elektronnyy nauchnyy zhurnal Kubanskogo gosudarstvennogo agrarnogo universiteta*, 100, 358–377.
  10. Ksenz, M. V., Bukhtoyarova, Z. T., Kalmanovich, S. A., Bugaets, N. V. (2007). Retseptury sousov na osnove belkovo-tomatnoy maslyanoy pasty. *Izvestiya vysshikh uchebnykh zavedeniy. Pishhevaya tekhnologiya*, 4, 45–46.
  11. Mosolova, N. I., Myakotnykh, A. S. (2004). Ispol'zovanie novykh kormovykh dobavok v ratsionakh laktiruyushchikh korov v zonakh povyshennogo tekhnogennoho zagryazneniya. *Izvestiya Nizhnevolzhskogo agrouniversitetskogo kompleksa: nauka i vysshee professional'noe obrazovanie*, 3, 136–138.
  12. Héron, S., Dreux, M., Tchaplal, A. (2004). Post-column addition as a method of controlling triacylglycerol response coefficient of an evaporative light scattering detector in liquid chromatography-evaporative light-scattering detection. *Journal of Chromatography A*, 1035 (2), 221–225. doi: <http://doi.org/10.1016/j.chroma.2004.02.052>
  13. De Caterina, R. (2011). n–3 Fatty Acids in Cardiovascular Disease. *New England Journal of Medicine*, 364 (25), 2439–2450. doi: <http://doi.org/10.1056/nejmra1008153>
  14. Zhuravel, I. O. (2010). Vychennia lipofilnykh spoluk roslyn rodyny Zingiberaceae. *Ukrainskyi medychnyi almanakh*, 3, 87–89.
  15. Gaudin, K., Chaminade, P., Baillet, A. (2004). Retention behaviour of unsaturated fatty acid methyl esters on porous graphitic carbon. *Journal of Separation Science*, 27 (1-2), 41–46. doi: <http://doi.org/10.1002/jssc.200301622>
  16. Mondello, L., Tranchida, P. Q., Stanek, V., Jandera, P., Dugo, G., Dugo, P. (2005). Silver-ion reversed-phase comprehensive two-dimensional liquid chromatography combined with mass spectrometric detection in lipidic food analysis. *Journal of Chromatography A*, 1086 (1-2), 91–98. doi: <http://doi.org/10.1016/j.chroma.2005.06.017>
  17. O'Brien, R. *Fats and Oils. Formulating and Processing for Applications*. CRC Press, 2003. 616 p. doi: <http://doi.org/10.1201/9780203483664>
  18. Morlion, B. J., Torwesten, E., Wrenger, K., Puchstein, C., Fürst, P. (1997). P98 What is the optimum ω-3 to ω-6 fatty acid (FA) ratio of parenteral lipid emulsions in postoperative trauma? *Clinical Nutrition*, 16, 49. doi: [http://doi.org/10.1016/s0261-5614\(97\)80222-1](http://doi.org/10.1016/s0261-5614(97)80222-1)

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**DEVELOPMENT OF THE TECHNOLOGY OF MUSHROOM SAUCE WITH FUNCTIONAL INGREDIENTS**

page 28–34

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The object of research is mushroom powders of champignons (*Agaricus campestris*), reishi (*Ganoderma lucidum*), shiitake (*Lentinula edodes*) and technology mushroom sauce with a thickener.

In Ukraine, the consumption of cultivated mushrooms, namely mushrooms, shiitake and reishi is growing more and more, as evidenced by the growing volumes of mushroom cultivation by Ukrainian farms. The scientific literature does not adequately cover the issue of effective technologies for obtaining mushroom powder-like semi-finished products and finished products from them for restaurants. The use of mushroom powders from shiitake, reishi and champignons mushrooms to prepare mushroom sauces leads to an increase in the number of essential amino acids, B vitamins, PP, extractives in the finished product. As a result, biological value improves, organoleptic quality parameters of mushroom sauces improve. This will increase the popularity of mushroom sauces among modern consumers of restaurants.

In the course of research the assortment of sauce products of high biological value and the specifics of physiological influence of shiitake, reishi and champignons mushrooms on the human body have been analyzed. A scientifically-determined technology of sauce of mushroom of increased biological value with functional ingredients – mushroom powders of champignons mushrooms, reishi, and shiitake has been developed.

The optimization of the recipe of the newly created product has been optimized and the optimum prescription composition of the mushroom sauce with mushroom powders with a ratio of mushroom powders in the recipe composition of 1:1:2 (shiitake:reishi:champignon mushrooms) has been proposed. The structural and mechanical properties of an innovative sauce were compared and compared with the control sample of mushroom sauce prepared according to the traditional technology. So, at a shear rate of 200 s<sup>-1</sup>, the viscosity of the developed sauce is 0.38 Pa·s, whereas the viscosity of the mushroom sauce prepared according to the traditional technology is 0.3 Pa·s.

It is established that mushroom sauce with mushroom powders has high biological value, optimal rheological and organoleptic quality indices.

The developed sauce with mushroom powders will enable to expand the assortment of sauce products of high biological value on vegetable raw materials for restaurants. The introduction of innovative technology will significantly save the time of production of own production sauces and financial costs, since the developed technology involves the production of mushroom powders from non-conformal mushroom raw materials.

**Keywords:** mushroom powder, cultivated mushrooms, technology mushroom sauce, functional ingredients, dynamic viscosity.

**References**

1. *Regionalnyi obzor prodovolstvennoi bezopasnosti* (2017). Budapest: Prodovolstvennaya i selskohozyaystvennaya organizaciya Obedinennykh Nacii, 46. Available at: <http://www.fao.org/3/a-i6877r.pdf>. Last accessed: 22.04.2018
2. *Kharchove vyrobnytstvo* (2018). UkrAhroKonsal'tynh. Available at: <http://www.ukragroconsult.com/uk/news-main/harchove-vyrobnytstvo> Last accessed: 12.04.2018
3. Vasser, S. P. (Eds.) (2011). *Biologicheskie svoystva lekarstvennykh makromicetov v kulture*. Vol. 1. Kyiv: Alterpres, 212.
4. Cheung, P. C. K. (Ed.) (2008). *Mushrooms as functional foods*. Hoboken: John Wiley & Sons, Inc., 259. doi: <http://doi.org/10.1002/9780470367285>
5. Chang, S. T., Miles, Ph. G. (2004). *Mushrooms. Cultivation, nutritional value, medicinal effect and environmental impact*.

- Boca Raton: CRC Press, 480. doi: <http://doi.org/10.1201/9780203492086>
6. Ma, G., Yang, W., Zhao, L., Pei, F., Fang, D., Hu, Q. (2018). A critical review on the health promoting effects of mushrooms nutraceuticals. *Food Science and Human Wellness*, 7 (2), 125–133. doi: <http://doi.org/10.1016/j.fshw.2018.05.002>
  7. Giavasis, I. (2014). Bioactive fungal polysaccharides as potential functional ingredients in food and nutraceuticals. *Current Opinion in Biotechnology*, 26, 162–173. doi: <http://doi.org/10.1016/j.copbio.2014.01.010>
  8. Sokovic, M., Glamoclija, J., Ciric, A., Petrovic, J., Stojkov, D. (2018). *Mushrooms as Sources of Therapeutic Foods*. Therapeutic Foods. Elsevier, 141–178. doi: <http://doi.org/10.1016/b978-0-12-811517-6.00005-2>
  9. Miachykova, N. I. (2006). *Tekhnolohiia napivfabrykativ z kultivovanykh hrybiv hlyca zvychnaina ta kulinarnoi produktsii z yikh vykorystanniam*. Kharkiv.
  10. Zhang, Z., Song, H., Peng, Z., Luo, Q., Ming, J., Zhao, G. (2012). Characterization of stipe and cap powders of mushroom (*Lentinus edodes*) prepared by different grinding methods. *Journal of Food Engineering*, 109 (3), 406–413. doi: <http://doi.org/10.1016/j.jfoodeng.2011.11.007>
  11. Mukhutdynova, S. M., Zharykova, H. H. (2007). Ispolzovanye hrybnykh poroshkov razlychnoho sostava v obschestvennom pytanii. *Fundamentalnye issledovaniya*, 12 (1), 84.
  12. Choe, J., Lee, J., Jo, K., Jo, C., Song, M., Jung, S. (2018). Application of winter mushroom powder as an alternative to phosphates in emulsion-type sausages. *Meat Science*, 143, 114–118. doi: <http://doi.org/10.1016/j.meatsci.2018.04.038>
  13. Kravchenko, M. F. (2006). *Tekhnolohiia produktiv z kharchovymy dobovkamy roslynnoho pokhodzhennia dlia ozdorovchoho kharчування*. Kyiv, 390.
  14. Zdobnov, A. I., Cyganenko, V. A. (2009). *Sbornik receptur blyud i kulinarnykh izdeliy: dlya predpriyatiy obshestvennogo pitaniya*. Kyiv: OOO Izdatelstvo «Ariy», 680.
  15. Horalchuk, A. B., Pivovarov, P. P., Grinchenko, O. O., Pogozhikh, M. I., Polevich, V. V., Gurs'kiy, P. V. (2006). *Reolohichni metody doslidzhennia syrovyny i kharchovykh produktiv ta avtomatyzatsiia rozrakhunkiv reolohichnykh kharakterystyk*. Kharkiv: Khark. derzh. un-t kharch. ta torhivli, 63.
  16. Kublinska, I. A., Kravchenko, M. F. (2017). Pat. No. 120650 UA. *Sposib vyrobnytstva poroshku hrybnoho z pecheryts, shyitake ta flamuliny*. MPK: A23L 27/10. No. 120650/17; declared: 02.06.2017; published: 10.11.2017, Bul. No. 21.

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**DEVELOPMENT OF A COMPLEX BAKERY IMPROVER «FRESHNESS SMS SUPER» TO EXTEND THE FRESHNESS OF WHEAT BREAD**

page 35–40

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The object of research is wheat bread, one of the biggest drawbacks of which is staling during storage. The intensity of the processes in the finished product, which determine the staling, depend on the quality of the raw materials, in particular, the baking properties of the flour.

The solution to the problem of prolonging the freshness of wheat bread is possible using non-traditional raw materials, food additives and complex bakery improvers.

During the development of the complex bakery improver «Freshness SMS Super», dry whey enriched with Mn and Mg was selected as a functional basis, the technology of which was developed by scientists of the National University of Food Technologies (Kyiv, Ukraine). The active part of the improver includes carboxymethyl cellulose, emulsifier, enzyme preparation of amylolytic action with maltogenic amylase, ascorbic acid, maltodextrin, apple pectin.

Based on the Sheffe's centrifugal plan, we obtained graphical models that predict the optimal dosage of a complex bakery improver «Freshness SMS Super» in the case of processing flour with various baking properties. According to the graphical models it is found that in the case of using medium-strength flour that has a normal gas-tongue ability and water-repellent capacity in the range of 59–61 %, the optimal dosage of the complex bakery improver «Freshness SMS Super» is 1.5 % of the weight of flour.

It is established that when using a complex bakery improver «Freshness SMS Super» the products become harder. This is due to the fact that the recipe for a complex bakery improver includes moisture-retaining food additives that, during the storage of bakery products, release moisture more slowly than biopolymers of flour. Also in the composition of the improver is an enzyme preparation with maltogenic  $\alpha$ -amylase, which slows the process of starch retrogradation, reducing the loss of moisture by starch.

Thanks to the use of the complex bakery improver Freshness SMS Super, bakery products keep freshness up to 72 hours of storage unpacked regardless of the baking properties of the flour.

**Keywords:** freshness of wheat bread, complex baking improver, functional basis, active part.

**References**

1. Tyurina, E. B. (2010). Rynok pishchevykh ingredientov dlya hlebopekarnoy promyshlennosti. *Pishchevye ingrediety. Syr'e i dobovki*, 1, 19.
2. Ukrainets, A., Kochubei-Lytvynenko, O., Bilyk, O., Zakharevych, V., Vasylchenko, T. (2016). A study of the effect of enriched wheat powder on the quality of a special-purpose bread. *Eastern-European Journal of Enterprise Technologies*, 2 (11 (80)), 32–41. doi: <https://doi.org/10.15587/1729-4061.2016.65778>

3. Lagrain, B., Thewissen, B. G., Brijs, K., Delcour, J. A. (2007). Impact of Redox Agents on the Extractability of Gluten Proteins during Bread Making. *Journal of Agricultural and Food Chemistry*, 55 (13), 5320–5325. doi: <https://doi.org/10.1021/jf070639n>
4. Smith, E., Benbrook, C., Davis, D. R. (2012). *A Closer Look at What's in Our Daily Bread*. Grains: An In-depth Study. Part I – Your Daily Bread. The Organic Center, 17.
5. Joye, I. J., Lagrain, B., Delcour, J. A. (2009). Use of chemical redox agents and exogenous enzymes to modify the protein network during breadmaking – A review. *Journal of Cereal Science*, 50 (1), 11–21. doi: <https://doi.org/10.1016/j.jcs.2009.04.001>
6. Imeson, A. (Ed.) (2010). *Food Stabilisers, Thickeners and Gelling Agents*. Wiley-Blackwell: Oxford. doi: <https://doi.org/10.1002/9781444314724>
7. Zyz'ko, A. S., Korostova, E. V., Bondarenko, V. I. (2011). Razrabotka kompleksnogo uluchshitelya dlya povysheniya kachestva hleba iz pshenichnoy muki. *Izvestiya vysshih uchebnykh zavedeniy. Pishchevaya tekhnologiya*, 4, 24–25.
8. Fadda, C., Sanguinetti, A. M., Del Caro, A., Collar, C., Piga, A. (2014). Bread Staling: Updating the View. *Comprehensive Reviews in Food Science and Food Safety*, 13 (4), 473–492. doi: <https://doi.org/10.1111/1541-4337.12064>
9. Abu-Ghoush, M., Herald, T. J., Dowell, F., Xie, F., Aramouni, F. M., Walker, C. (2008). Effect of antimicrobial agents and dough conditioners on the shelf-life extension and quality of flat bread, as determined by near-infrared spectroscopy. *International Journal of Food Science & Technology*, 43 (2), 365–372. doi: <https://doi.org/10.1111/j.1365-2621.2007.01625.x>
10. Korshenko, L. (2014). Stabilization of wheat bread's quality with low baking properties. *On-line Journal «Naukovedenie»*, 6. doi: <https://doi.org/10.15862/115tvn614>
11. Korshenko, L. O., Chizhikova, O. G., Tanashkina, T. V., Docenko, S. M., Abdulaeva, N. N., Semenyuta, A. A. (2014). Obosnovanie ispol'zovaniya grechnevoogo soloda pri razrabotke kompozicii hlebopekarnogo uluchshitelya. *Tekhnika i tekhnologiya pishchevykh proizvodstv*, 1, 49–53.
12. Lazovenko, I. A., Stenycheva, N. V. (2015). Ispol'zovanie fermentnykh preparatov v sostave kompleksnogo uluchshitelya dlya sohraneniya svezhesti hleba. *Trudy BGTU. Himiya, tekhnologiya organicheskikh veshchestv i biotekhnologiya*, 4, 198–201.
13. Lebedenko, T. Ye., Pshenyshniuk, H. F., Sokolova, N. Yu. (2014). *Tekhnologiya khlibopekarskoho vyrobnytstva. Praktykum*. Odessa: «Osvita Ukrainy», 392.
14. Drobot, V. I. (Ed.) (2015). *Tekhnokhimichnyi kontrol syrovynny ta khlibobulochnykh i makaronnykh vyrobiv*. Kyiv: NUKhT, 902.
15. Pashchenko, L. P., Zharkova, I. M. (2014). *Tekhnologiya hlebopekarnogo proizvodstva*. Saint Petersburg: Lan', 372.

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**JUSTIFICATION FOR USE OF TWO-COMPONENT MIXTURES FOR COOKING WHEAT BREAD**

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The object of research is wheat bread. One of the most problematic places is the need to correct the food ration of the population in order to enrich traditional food with vital nutrients. Taking into account that bread refers to the products that are in the daily diet of the majority of the population, improving its nutritional value helps to improve the diet as a whole. Improving the nutritional value of bread can be achieved by adding alternative types of flour – corn, oatmeal, spring wheat flour.

In the course of research, the modeling of formulations was used by the method of tasting evaluation. 9 formulations of bread based on two-component flour mixtures with the addition of corn, oats, buckwheat and spring wheat flour were developed (7.5 % and 15 %).

The obtained samples were examined for compliance with organoleptic and physicochemical parameters, as well as safety indices. According to the physicochemical indicators of quality (humidity and acidity), all the samples corresponded to the Ukrainian normative documentation, the safety indicators also did not exceed the permissible limits. The best organoleptic properties were bread, in the composition of the recipe which was added wheat flour in the amount of 7.5 % and 15 %. A high number of points received bread from a mixture of wheat and oat flour (7.5 %). Samples with the addition of corn and buckwheat



flour differed in organoleptic properties. This is due to the fact that different types of flour in different ways affect the taste characteristics of the finished product.

The received results of researches testify to expediency of application of two-component mixtures of flour. It is expected to improve the amino acid composition of the product, reduce energy value due to the chemical composition of flour used in new formulations.

Thanks to this, it is possible to obtain bread for functional and dietary purposes. In comparison with similar known formulations, the developed samples provide the following advantages: improvement of nutritional value, improvement of organoleptic properties of the product.

**Keywords:** nutritional value of bread, safety indicators, organoleptic indices, two-component flour mixture.

### References

1. Zavertanyi, D. V. (2015). Suchasnyi stan ta perspektyvy rozvytku khlibopekarskoi haluzi Ukrainy. *Rynkova ekonomika: suchasna teoriya i praktyka upravlinnia*, 14 (2), 194–203.
2. Martínez-Monzo, J., García-Segovia, P., Albors-Garrigos, J. (2013). Trends and Innovations in Bread, Bakery, and Pastry. *Journal of Culinary Science & Technology*, 11 (1), 56–65. doi: <http://doi.org/10.1080/15428052.2012.728980>
3. Szwaacka-Mokrzycka, J. (2010). Sources of competitive advantage in food industry. *11th International Conference of Social Responsibility, Professional Ethics, and Management*. Ankara, 823–844.
4. Nehir El, S., Simsek, S. (2011). Food Technological Applications for Optimal Nutrition: An Overview of Opportunities for the Food Industry. *Comprehensive Reviews in Food Science and Food Safety*, 11 (1), 2–12. doi: <http://doi.org/10.1111/j.1541-4337.2011.00167.x>
5. Makarova, O. V., Pshenishnyuk, G. F., Ivanova, A. S. (2014). Pishhevaya tsennost' khlebnykh izdeliy na osnove zernovykh smesey. *Naukovi pratsi ONAKHT*, 1 (46), 133–137.
6. Gambuś, H., Gambuś, F., Pisulewska, E. (2006). Całoziarnowa mąka owsiana jako źródło składników dietetycznych w chlebach pszennych. *Instytut Hodowli i Aklimatyzacji Roślin. Biul. IJAR. Blonie*, 239, 259–267.
7. Yaseen, A. A., Shouk, A. A., Ramadan, M. T. (2010). Corn-Wheat Pan Bread Quality as Affected by Hydrocolloids. *Journal of American Science*, 6 (10), 684–690.
8. Zhigunov, D. A. (2015). Issledovanie tekhnologicheskikh i biokhimicheskikh pokazateley kachestva muki iz razlichnykh zernovykh kul'tur. *Zernovi produkti i kombikormi*, 60 (4), 19–24.
9. Titova, M. (2006). Chem polezen ovsyanyy khleb. *Khlebo-produkty*, 12, 40.
10. Rybalka, O. I. (2011). Biolohichno tsinni kharchovi produkty iz zerna yachmeniu ta pshenytsi. *Yakist pshenytsi ta yii polipshen-nia*. Kyiv, 128–145.
11. Usembaeva, Zh. K., Dautkanova, D. R., Musaeva, S. D. (2004). Ispol'zovanie kukuruznoy muki v proizvodstve pshenichnogo khleba. *Khranenie i pererabotka zerna*, 11, 37–38.
12. Tipsina, N. N., Selezneva, G. K. (2011). Ispol'zovanie yachmennoy muki v proizvodstve khlebo-bulochnykh izdeliy. *Vesnik KrasGAU. Tekhnologiya pererabotki*, 10, 204–208.
13. Merko, I. T., Morgun, V. A., Zhigunov, D. A., Krotko, O. S. (2004). Sravnitel'niy analiz metodik probnoy vypechki khleba iz kompozitnykh smesey. *Zernovi produkti i kombikormi*, 4, 23–25.
14. Hordienko, T. V., Semenova, A. B., Mykhonik, L. A. (2012). Bilkovo-pshenychnyi khlib iz hrechanykh boroshnom. *Naukovi pratsi ONAKHT*, 1 (42), 143–146.
15. Gavrilova, O. M., Matveeva, I. V., Vakulenchik, P. I. (2007). Prigotovlenie hleba s ispol'zovaniem grechnevoy muki. *Hlebo-pechenie Rossii*, 3, 14–16.
16. Gavrilova, O., Matveeva, I., Tolmacheva, E. (2007). Vliyanie grechnevoy muki na kachestvo hleba iz pshenichnoy muki vyshego sorta. *Hlebo-produkty*, 4, 34–35.
17. Dewettinck, K., Van Bockstaele, F., Kühne, B., Van de Walle, D., Courtens, T. M., Gellynck, X. (2008). Nutritional value of bread: Influence of processing, food interaction and consumer perception. *Journal of Cereal Science*, 48 (2), 243–257. doi: <https://doi.org/10.1016/j.jcs.2008.01.003>
18. *Znachennia yaroi pshenytsi*. Available at: <https://agrosience.com.ua/plant/znachennya-yaroi-pshenytsi>
19. Chaldae, P. A., Zimichev, A. V. (2012). Ispol'zovanie ovsa i produktov ego pererabotki v hlebopechenii. *Hlebopechenie Ros-sii*, 2, 22–23.
20. Drobot, V. I., Pysarets, O. P., Kravchenko, I. M. (2013). Vykorystannia kukurudzianoi krupy u vyrobnytstvi pshenychnoho khliba. *Hranenie i pererabotka zerna*, 9 (174), 53–55.
21. Shchelakova, R. P. (2014). Ispol'zovanie kukuruznoy muki pri prigotovlenii pshenichnogo hleba. *Kharchova nauka i tekhnolo-hiia*, 1 (26), 83–86.
22. Vashchenko, V. (2010). Otsinka konkurentospromozhnosti khliba novoho asortymentu na rynku Ukrainy. *Tovary i rynky*, 1, 158–163.