DOI https://doi.org/10.32782/2078-0877-2025-25-2-18
UDC 664.857.081.6:663.81.05

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REVIEW AND ANALYSIS OF MEMBRANE JUICE PROCESSING IN FOOD INDUSTRY ENTERPRISES

Summary. The equipment used for clarification and concentration of fruit and berry and vegetable juice is analyzed. The technologies for obtaining clarified juice are considered. The characteristic shortcomings of existing technological processes are identified. The directions for improving the processes of concentration and clarification of juice are identified and the need to develop equipment for their implementation is justified. The existing methods of membrane processing are analyzed, as well as new promising directions that have been developed recently. The application of membrane technologies for the processing of juices from fruit raw materials is proposed. The main advantages of introducing membrane technologies into the processing process are given. The shortcomings that complicate the use of membrane technologies in the production process of processing liquid food media are identified. The feasibility of using ultrafiltration and microfiltration membrane plants for clarifying fruit juices is substantiated.

Keywords: membrane processing, juices, fruit and berry raw materials, ultrafiltration, microfiltration.

Formulation of the problem. The modern fruit and vegetable industry must provide the population with products of high nutritional and biological value. One of such products is fruit and vegetable juices, which play an important role in the human diet, as they contain a complex of essential nutrients, including vitamins, macro- and microelements, and other useful components.

Today, the consumption of juices is constantly growing, which is due to their high nutritional value and economic feasibility of production. The use of modern technologies and equipment developed on the basis of the latest scientific achievements helps to optimize production processes and allows for the effective processing of significant volumes of fruits and vegetables for the production of both concentrated and natural juices. Juices contain valuable biologically active substances, such as vitamins, minerals, phenolic compounds, and antioxidants [1].

For example, freshly squeezed juices contain a significant amount of pectin, insoluble biopolymers, lipids, polysaccharides, and other compounds. It is these substances that can cause turbidity. The main reason for this phenomenon is the presence of colloidal particles, which over time coalesce to form a precipitate. Initially, a slight turbidity appears, and then the particles gradually settle [2].

In the process of producing clarified juices, colloidal substances are removed, while in the manufacture of unclarified juices, only partial clarification is used without removing these compounds. Juice clarification is a technological process of separating fruit juice into sediment and a clear liquid. In this case, the colloidal structure of the juice is destroyed, and the concentration of colloidal particles is reduced by 20-30%. As a result of clarification, a liquid phase of the product is obtained, which contains dissolved substances isolated from the fruit tissue [3].

The process of clarification and concentration of juices is a key stage in the production of quality beverages, but it is accompanied by a number of problems that affect the final characteristics of the product and the overall efficiency of the production process. One of the main production problems is the turbidity of the juice and the presence of sediment. This occurs due to the fact that natural colloidal particles, such as pectin, proteins, tannins, form suspensions that are difficult to remove. In this case, clarification using traditional methods such as settling, centrifugation, and the use of enzymes is time-consuming and requires a significant number of auxiliary substances [4].

You should also pay attention to the loss of useful components. Filtration and thermal methods can reduce the concentration of vitamins, phenolic compounds and aromatic substances. Thermal treatment during concentration leads to partial caramelization of sugars and changes in organoleptic properties. During clarification and concentration, equipment becomes contaminated. In this case, the use of traditional filters causes their rapid clogging. At the same time, the equipment for implementing clarification processes has a high energy consumption, since thermal concentration requires large energy costs [5].

In addition, the issue of preserving the natural taste and color of the finished product arises. It is known that during traditional concentration, some volatile aromatic compounds are lost. Some pigments, for example, anthocyanins in berries, are destroyed under the influence of temperature [6]. Membrane technologies, such as microfiltration, ultrafiltration, nanofiltration and reverse osmosis, allow you to improve the clarification and concentration of juices, minimizing the loss of quality characteristics of the product.

Analysis of recent research and publications. Juice purification is carried out to ensure colloidal stability of the product during storage, as well as to improve its organoleptic properties and attractive appearance. To comply with international production standards, it is necessary to introduce modern technologies and equipment based on the latest scientific and technical developments [7]. The use of membrane technologies allows to improve the taste characteristics, appearance and nutritional value of fruit juices. An important task of membrane processing is to preserve vitamins, amino acids and other biologically active compounds, which can be achieved by avoiding thermal sterilization and the use of preservatives. Membrane systems contribute to the creation of effective juice concentration technologies and the expansion of the product range [8].

The use of ultrafiltration and microfiltration makes it possible to regulate the mineral and carbohydrate composition of the final product. Today, the main areas of use of membrane technologies in juice production are clarification and concentration processes. Clarification is carried out to destroy the colloidal structure of the juice, remove high-molecular proteins, pectin and polyphenolic substances, as well as microorganisms. It is important to preserve valuable biologically active components, in particular vitamins, sugars, acids, minerals and aromatic compounds [9].

Ultrafiltration is one of the types of membrane technologies widely used in the food industry. It differs in the size of the pores of the membranes, which are used for the distribution, fractionation and concentration of liquids. The diameter of the pores of the membranes varies from 0.01 to 0.20 microns, and the operating pressure is in the range of 0.1–1.0 MPa. Thanks to ultrafiltration, small bacteria, viruses and large protein molecules are removed from the initial solution. As a result, the initial liquid is separated into two products: low-molecular (filtrate), which passes through the membrane and is removed, and high-molecular concentrate [10]. Unlike microfiltration, ultrafiltration can be accompanied by adsorption of dissolved substances on the membrane surface and their intermolecular interaction [11].

In the process of ultrafiltration and microfiltration, semipermeable membranes are used that act as a barrier, passing only certain components of the liquid mixture. They must have high selectivity, significant specific productivity, chemical resistance to the components of the solution and sufficient mechanical strength. The service life of the membranes largely depends on the process of sediment formation, which can clog the pores, creating additional resistance to fluid flow and mass transfer. This phenomenon, known as concentration polarization, leads to a decrease in membrane performance and is characteristic of most baromembrane processes [12].

Microfiltration effectively removes suspended particles and microorganisms without the use of chemical reagents. Ultrafiltration allows the removal of colloidal substances, pectin compounds and proteins, making the juice transparent. The reverse osmosis method is used to remove water using dense membranes, which allows the juice to be concentrated without heat treatment. Nanofiltration allows partial removal of water and minerals, while preserving sugars and aromatic compounds [13]. The main advantages of membrane technologies include the ability to preserve biologically active substances, such as vitamins, phenolic compounds and antioxidants [14].

The membrane treatment process is characterized by high energy efficiency, since it does not require evaporation of water. Membrane technologies ensure the production of a high-quality final product: the juice becomes clean, transparent and rich in aroma. In addition, the shelf life of the product increases due to the effective removal of bacteria and fungi [15]. Membrane technologies are becoming a promising solution for the production of fruit and berry juices with high organoleptic and nutritional indicators, replacing traditional methods of clarification and evaporation.

Formulation of the purpose of the article. The purpose of the article is to review and analyze membrane processes used for processing fruit and berry juices at food industry enterprises, to determine their advantages, disadvantages, and prospects for use in comparison with traditional technologies for clarification and concentration of juices.

Presentation of the main research material. Baromembrane processes, in particular reverse osmosis, ultrafiltration and microfiltration, are based on the pressure difference across the thickness of membranes, which are usually made of polymeric materials. They are used to separate solutions and colloidal systems at temperatures of 5...30 °C. The difference between reverse osmosis and ultrafiltration from traditional filtration is that instead of the product settling on the filter surface, as in conventional filtration, two solutions are formed in these processes: one of them contains a concentrated solute. It is important to avoid the accumulation of this substance near the membrane, as this can lead to a decrease in its selectivity and permeability. One of the negative factors of baromembrane processes is concentration polarization. It occurs due to the different rates of passage of the mixture components through the membrane, which leads to the accumulation of a substance with a low penetration rate in the membrane boundary layer [16]. This reduces the efficiency of the separation of liquid mixtures, as the driving force of the process decreases, the selectivity and productivity of the membranes deteriorate, and their service life is also shortened. In addition, precipitation of poorly soluble salts and the formation of gel-like high-molecular compounds is possible, which requires periodic cleaning of the membranes. To minimize the effect of concentration polarization and improve the efficiency of membrane systems, mixing is used in the technological process. This helps to equalize the concentration of components in the membrane boundary layer and the main liquid flow. Mixing can be carried out by increasing the flow velocity (up to 3-5 m/s), using turbulizers (for example, meshes, perforated or corrugated sheets, spirals, balls), using ultrasound and other methods [17.

Concentration polarization leads to a decrease in membrane performance due to an increase in the osmotic pressure of the solution, which reduces the driving force of the process. At the same time, precipitation of insoluble salts and gelation of high-molecular compounds are possible, which reduces the permeability and selectivity of the membranes, as well as shortens their service life. To reduce this effect, various technological approaches are used, depending on the design of the membrane apparatus, the type of membrane, the cost of the final product and the performance of the equipment. One of the most effective methods for minimizing concentration polarization is to create turbulence in the solution. This allows you to reduce the concentration of dissolved substances in the boundary layer, which contributes to an increase in the permeability and selectivity of the membranes, a decrease in osmotic pressure and, accordingly, an increase in the efficiency of the separation process. Additionally, the use of a pulsating flow helps to increase the velocity of the near-wall liquid layers, which reduces the likelihood of sediment formation on the membrane [18].

Concentration polarization is a typical phenomenon for all membrane processes, including microfiltration and ultrafiltration. It consists in increasing the concentration of the dissolved substance on the membrane surface, which reduces its permeability and selectivity, and also shortens its service life. To minimize this effect, various engineering solutions are used, such as creating a turbulent flow in the surface layer of the liquid, which allows accelerating the transfer of the dissolved substance to the center of the flow. Such technologies include the use of magnetic stirrers, vibration devices, increasing the speed of the liquid flow along the membrane and installing turbulators [19].

Another design solution to improve the efficiency of membrane systems is the use of devices with narrow channels. This contributes to the creation of a laminar mode of fluid movement, which allows maintaining high equipment productivity with reduced device dimensions [20].

Increasing the temperature of the liquid can reduce the viscosity of the solution being separated, while increasing the diffusion coefficient of the solute. However, this method may not be suitable for juice purification. It is also possible to apply the effect of ultrasonic vibrations on the membrane boundary layer. The main technological parameters of baromembrane processes are the filtration rate, selectivity and permeability of the membrane components. The main factors affecting the membrane separation processes are temperature, pressure, hydrodynamic conditions and the formation of sediment on the membranes. However, the main factor affecting the microfiltration and ultrafiltration processes is the operating pressure. The driving force of the process increases with increasing pressure and, consequently, the permeability of the membrane increases. The operating pressure is set depending on the filtration process, the solution being separated, the type of membrane, the design of the apparatus, the hydraulic resistance of the intermembrane channel and drainage. The effect of the temperature of the solution on the filtration process is complex. With increasing temperature, the viscosity and density of the solution decrease. At the same time, the osmotic pressure increases [21]. Reduced viscosity and density increase permeability. An increase in osmotic pressure reduces the driving force of the process and reduces the permeability of membranes. When the temperature increases in the processes of microfiltration and ultrafiltration, the permeability and selectivity of the membrane increase. This is due to a decrease in the viscosity of the permeate, as well as a decrease in the influence of concentration polarization on the characteristics of the membranes [22]. With an increase in the concentration of the solution, the driving force of the process decreases, the viscosity and density of the solution increase, and the permeability of the membranes decreases [23]. Concentration also affects the selectivity of the membranes. In solutions of low concentration, the selectivity of the membranes does not change significantly with a change in concentration. An increase in the concentration of solutes in the solution worsens the operation of the membranes, and the specific productivity and selectivity of the apparatus decrease [24]. An increase in concentration increases the osmotic pressure of the solution, which, in turn, reduces the effective driving force of the separation process. Viscosity also increases, which leads to a decrease in mass transfer [25]. The consequence of this is a decrease in the specific productivity of the membranes to a minimum. In this case, the practical use of baromembrane processes becomes impractical.

Figure 1 shows a diagram illustrating the complete membrane juice processing process, showing the flow from the raw material to the final concentrated product.

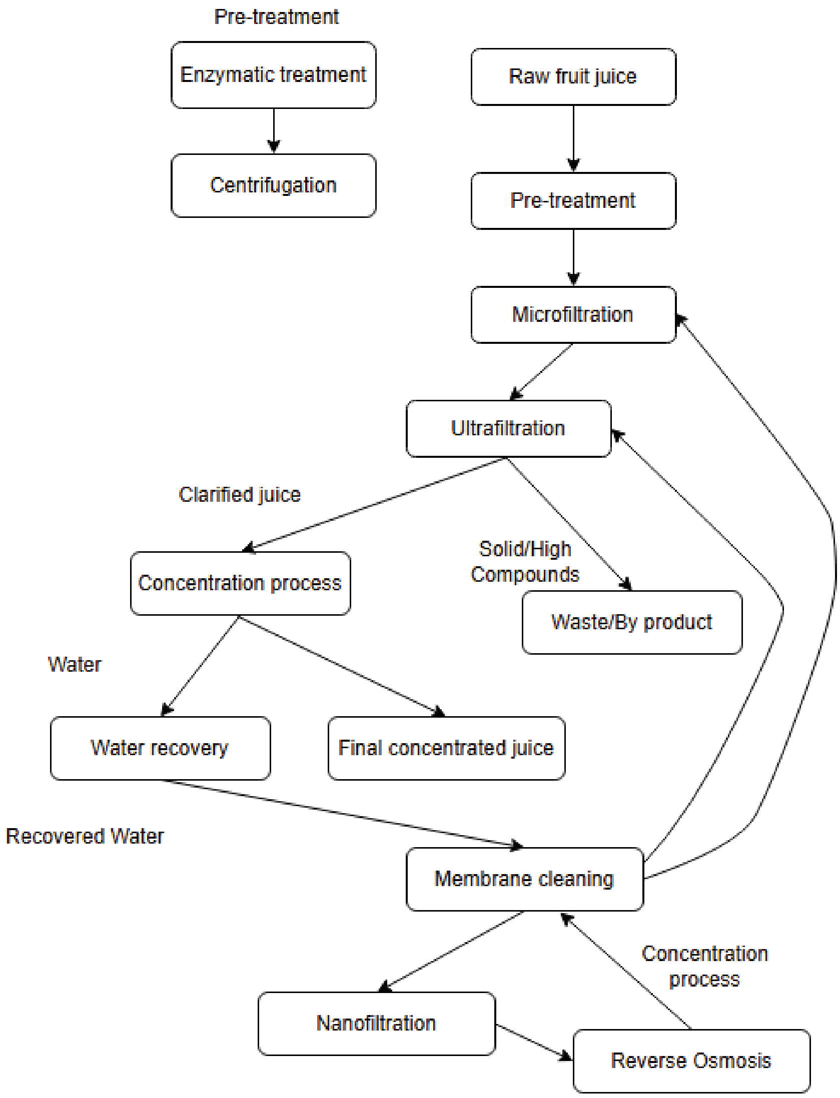

Fig. 1. Scheme of membrane processing of fruit and berry juice

The system receives raw materials, such as fruit juice. In the pre-treatment stage, enzymatic treatment is carried out to break down pectins and other complex molecules. Centrifugation ensures the removal of large particles and pulp. The purification process consists of microfiltration and ultrafiltration. Microfiltration is used mainly for initial clarification. The ultrafiltration process is necessary for fine clarification of the raw materials and the removal of high-molecular compounds, colloids and microorganisms. The next stage is the concentration process. Nanofiltration is the first stage of concentration. At this stage, solids are concentrated to 25-30%. Reverse osmosis is used for final concentration. At this stage, solids are concentrated to 45-50%. During this stage, the permeate water is collected. Auxiliary processes include a water recovery process for stable operation and a membrane cleaning cycle to maintain efficiency. The use of membrane juice treatment solves many traditional problems that arise during juice processing. First of all, it provides operation at low temperatures to preserve nutrients and taste. The need for product clarifiers is eliminated. Energy consumption is also significantly reduced compared to thermal evaporation, microbiological stability of the product and the possibility of its continuous processing are ensured. Dead-end and tangential filtration are widely used in modern food industry enterprises. Dead-end filtration is an effective and economical method of food purification, and the equipment for its implementation is compact and easy to use. (Fig. 2).

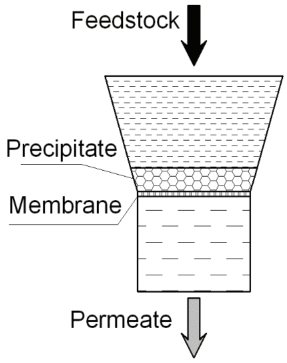

Fig. 2. Dead-end membrane filtration scheme

Tangential filtration is characterized by the passage of the product flow over the surface of the membrane (Fig. 3).

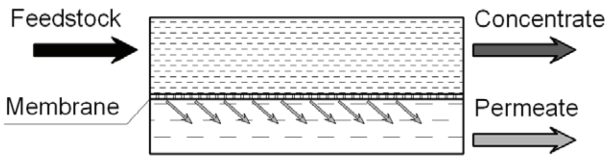

Fig. 3. Tangential membrane filtration scheme

Dead-end and tangential filtration have significant differences. In the process of dead-end filtration, the liquid moves perpendicular to the filter surface, while in tangential filtration the flow is directed parallel to the membrane. Typically, in tangential filtration systems, a circulation pump creates a liquid flow along the membrane, which prevents the accumulation of sediment on its surface. Unlike dead-end filtration, tangential filtration provides a continuous working process, since the pores of the membrane do not clog. In this method, the liquid does not pass through the membrane completely, but moves along it, creating a pressure difference. Part of the liquid penetrates the membrane in the form of filtrate, and the rest of the flow with impurities continues to circulate, cleaning the membrane surface. A characteristic feature of tangential filtration is the recirculation of the concentrate, which helps to reduce membrane fouling, maintains a high filtration rate and ensures maximum product yield. The use of membrane units with tangential filters helps to preserve the structural and organoleptic characteristics of the product. In addition, such filters have the ability to self-clean and do not require significant operating costs.

Conclusions. Membrane technologies are an effective tool for solving key problems during clarification and concentration of fruit and berry juices. They ensure high product quality, energy efficiency and environmental friendliness of production. The complex application of various types of membrane processes (microfiltration, ultrafiltration, nanofiltration, reverse osmosis) allows to achieve optimal results and solve most of the problems characteristic of traditional technologies Studies have shown that the use of ultrafiltration units allows to preserve colloidal substances, while passing all valuable components of the juice, in particular sugars, organic acids, minerals, soluble vitamins and amino acids. Due to this, the nutritional and biological value of clarified juices remains unchanged. The prospect of using microfiltration and ultrafiltration membrane treatment for clarification and concentration of juices from fruit and berry raw materials has been established. The most common in the design of membrane systems are hollow fibers and roll membrane elements, since they provide high productivity and are economically viable.

References

1. Deynichenko, G., Guzenko, V., Dmytrevskyi, D., Chervonyi, V., Omelchenko, O., Horielkov, D., Korolenko, O. Developing a technique for the removing of a gel layer in the process of membrane treatment of pectin extract. *Eastern-European Journal of Enterprise Technologies*. 2020. 4(11–106), 63–69. https://doi.org/10.15587/1729-4061.2020.208984

2. Deynychenko, G., Guzenko, V., Dmytrevskyi, D., Chervonyi, V., Kolisnichenko, T., Omelchenko, O., Nykyforov, R. Study of the new method to intensify the process of extraction of beet pulp. *Eastern-European Journal of Enterprise Technologies*. 2018. 4(11–94), 15–20. https://doi.org/10.15587/1729-4061.2018.140126

3. Miyoshi, T., Yuasa, K., Ishigami, T., Rajabzadeh, S., Kamio, E., Ohmukai, Y., Saeki, D., Ni, J., Matsuyama, H. Effect of membrane polymeric materials on relationship between surface pore size and membrane fouling in membrane bioreactors, *Applied Surface Science*. 2015. Vol. 330, pp. 351–357. https://doi.org/10.1016/j.apsusc.2015.01.018

4. Zhao, D., Lau, E., Huang, S., Moraru, C.I. The effect of apple cider characteristics and membrane pore size on membrane fouling. *LWT-Food Science and Technology*. 2015. Vol. 64, pp. 974–979. https://doi.org/10.1016/j.lwt.2015.07.001

5. Hutomo, G.S., Rahim, A., Kadir, S. Pectin Isolation from Dry Pod Husk Cocoa with Hydrochloride Acid. *International Journal of Current Microbiology and Applied Sciences*. 2016. 5(11), 751–756. https://doi.org/10.20546/ijcmas.2016.511.086

6. Iskakova, G., Kizatova, M., Baiysbayeva, M., Azimova, S., Izembayeva, A., Zharylkassynova, Z. Justification Of Pectin Concentrate Safe Storage Terms By Pectin Mass Ratio. *Eastern-European Journal of Enterprise Technologies*. 2021. 4(11–112), 25–32. https://doi.org/10.15587/1729-4061.2021.237940

7. Jia, T., Zeng, J., Gao, H., Jiang, J., Zhao, J., Su, T., Sun, J. Effect of pectin on properties of potato starch after dry heat treatment. *Tropical Journal of Pharmaceutical Research*. 2019. 18(7), 1375–1384. https://doi.org/10.4314/tjpr.v18i7.2

8. Cherevko O.I., Deinychenko G.V., Dmytrevskyi D.V., Guzenko V.V., Heiier H.V., Tsvirkun L.O. Application of membrane technologies in modern conditions of juice production. *Прогресивна техніка та технології харчових виробництв ресторанного господарства і торгівлі.* 2020. Вип. 2(32). С. 67м77. https://doi.org/10.5281/zenodo.4369743

9. Deinychenko G.V., Dmytrevskyi D.V., Zolotukhina I.V., Perekrest V.V., Guzenko V.V. Directions of improvement of processes of membrane separation of juices from fruit and berry raw materials. *Прогресивна техніка та технології харчових виробництв ресторанного господарства і торгівлі*. 2021. Вип. 1(33). pp. 89–98. https://doi.org/10.5281/zenodo.5036090

10. Дейниченко Г.В., Золотухіна І.В., Дмитревський Д.В., Гузенко В.В., Перекрест В.В., Гладкова О.С. Сучасні технології баромембранних процесів у харчовій промисловості. *Обладнання та технології харчових виробництв*. 2021. № 2(43). С. 86–93. https://doi.org/10.33274/2079-4827-2021-43-2-86-93

11. David Durán-Aranguren, D., Juliana Alméciga Ramírez, C., Catalina Villabona Díaz, L., Ayalde Valderrama, M., Sierra, R. Production of Pectin from Citrus Residues: Process Alternatives and Insights on Its Integration under the Biorefinery Concept. Pectins – *The New-Old Polysaccharides. IntechOpen*. 2022. https://doi.org/10.5772/intechopen.100153

12. Дейниченко Г.В., Дмитревський Д.В., Гузенко В.В., Афукова Н.О. Аналіз застосування мембранних апаратів для виробництва соків із плодової сировини. *Праці Таврійського державного агротехнологічного університету*. 2021. С. 36–43. https://doi.org/10.31388/2078-0877-2021-21-1-36-43

13. Deynichenko, G., Dmytrevskyi, D., Guzenko, V., Omelchenko, O., Perekrest, V. Prospects of using equipment for membrane separation of food liquids. *Науковий вісник Таврійського державного агротехнологічного університету.* 2023. Вип. 13.Т. 2. С. 1–11. https://doi.org/10.31388/2220-8674-2023-2-12

14. Yukun Li, Jianquan Luo, Yinhua Wan. Biofouling in sugarcane juice refining by nanofiltration membrane: Fouling mechanism and cleaning. *Journal of Membrane Science*. Vol. 612, 2020. 118432, ISSN 0376-7388. https://doi.org/10.1016/j.memsci.2020.118432

15. Emel Yilmaz, Pelin Onsekizoglu Bagci. Ultrafiltration of Broccoli Juice Using Polyethersulfone Membrane: Fouling Analysis and Evaluation of the Juice Quality. *Food and Bioprocess Technology*, 2019. Vol. 12, pp. 1273–1283. https://doi.org/10.1007/s11947-019-02292-0

16. Samreen, Ch V.V. Satyanarayana, L. Edukondalu,Vimala Beera. Srinivasa Rao. Effect of Pre-treatment on Aggregation, Biochemical Quality and Membrane Clarification of Pomegranate Juice. *Indian Journal of Ecology*, 2022. 49(3):910–918. https://doi.org/10.55362/IJE/2022/3615

17. David Inhyuk Kim, Gimun Gwak, Min Zhan, Seungkwan Hong. Sustainable dewatering of grapefruit juice through forward osmosis: Improving membrane performance, fouling control, and product quality. *Journal of Membrane Science*, 2019. Vol. 578, pp. 53–60. https://doi.org/10.1016/j.memsci.2019.02.031

18. Xiaochan An, Yunxia Hu, Ning Wang, Zongyao Zhou, Zhongyun Liu. Continuous juice concentration by integrating forward osmosis with membrane distillation using potassium sorbate preservative as a draw solute. *Journal of Membrane Science*. Vol. 573, 2019, pp. 192–199. https://doi.org/10.1016/j.memsci.2018.12.010

19. Omar, J.M., Nor, M.Z.M., Basri, M.S.M., Che Pa, N.F. Clarification of guava juice by an ultrafiltration process: analysis on the operating pressure, membrane fouling and juice qualities. *Food Research 4,* 2017. (Suppl. 1). pp. 85–92. https://doi.org/10.26656/fr.2017.4(s1).s30

20. Yee, W.P., Nor, M.Z.M., Basri, M.S. MRoslan, J. Membrane-based clarification of banana juice: pre-treatment effect on the flux behaviour, fouling mechanism and juice quality attributes. *Food Research 5*, 2021 (Suppl. 1). pp. 57–64. DOI: https://doi.org/10.26656/fr.2017.5(s1).046

21. Domingues R.C.C., Ramos A.A., Cardoso V., Reis M.H.M. (2014), Microfiltration of passion fruit juice using hollow fibre membranes and evaluation of fouling mechanisms, *Journal of Food Engineering*. 2014. Vol. 121, pp. 73–79. https://doi.org/10.1016/j.jfoodeng.2013.07.037

22. Verma S.P., Sarkar B., Analysis of flux decline during ultrafiltration of apple juice in a batch cell, *Food and Bioproducts Processing*. 2015. Vol. 94, pp. 147–157. https://doi.org/10.1016/j.fbp.2015.03.002

23. Sharifanfar, R., Mirsaeedghazi, H., Fadavi, A., Kianmehr, M.H. Effect of feed canal height on the efficiency of membrane clarification of pomegranate juice, *Journal of Food Processing and Preservation*. 2015. Vol. 39, pp. 881–886. DOI: https://doi.org/10.1111/jfpp.12299

24. Herbiga, A.- L., Delchierb, N., Striegelb, L., Rychlikb, M., Renarda C. Stability of 5-methyltetrahydrofolate in fortified apple and carrot purees. LWT – Food Science and Technology. 2019. Vol. 107, pp. 158–163. https://doi.org/10.1016/j.lwt.2019.03.010

25. Haci, A.G., Pelin, O.B., Ufuk, B. Clarification of Apple Juice Using Polymeric Ultrafiltration Membranes: a Comparative Evaluation of Membrane Fouling and Juice Quality, Food and bioprocess technology. 2017. Vol. 10, pp. 875–885. DOI: https://doi.org/10.1007/s11947-017-1871-x

Стаття надійшла до редакції 26.03.2025

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ОГЛЯД ТА АНАЛІЗ ПРОЦЕСІВ МЕМБРАННОЇ ОБРОБКИ СОКІВ НА ПІДПРИЄМСТВАХ ХАРЧОВОЇ ПРОМИСЛОВОСТІ

Анотація

Представлено результати аналізу сучасних методів мембранної обробки рідких харчових продуктів. Проведено огляд обладнання, що використовується для освітлення та концентрування соків. Розглянуто основні технології обробки, зокрема етапи отримання освітленого соку із застосуванням наявних методів і технічних рішень.

Обгрунтовано доцільність використання мембранних технологій для переробки плодово-ягідних соків. Визначено перспективні напрями вдосконалення процесів концентрування й освітлення, а також необхідність розроблення спеціалізованого обладнання для їх реалізації. Досліджено особливості мікрофільтраційної та ультрафільтраційної мембранної обробки соків, включаючи аналіз роботи мембран у тупиковому та тангенціальному режимах.

Виявлено основні переваги й обмеження цих методів у контексті переробки рідких харчових середовищ, а також чинники, що ускладнюють широке застосування мембранних технологій у соковій промисловості. Запропоновано використання мікрофільтраційних і ультрафільтраційних мембранних установок для обробки соку.

Тангенціальна фільтрація може застосовуватися як для мікрофільтрації, так і для ультрафільтрації фруктово-ягідних соків. Вона забезпечує високу прозорість і мікробіологічну стабільність продукту без використання допоміжних речовин та добавок, що усуває проблеми з їх утилізацією. Мембрани за правильної експлуатації та регулярного обслуговування мають довший термін служби порівняно з традиційною тупиковою фільтрацією.

Застосування тангенціальних фільтрів сприяє збереженню структури й органолептичних властивостей соку, а також забезпечує самоочищення мембран без потреби у дорогих витратних матеріалах. Упровадження мембранних технологій у процес обробки дає змогу збільшити вихід продукту, зберегти його харчову та біологічну цінність, а також покращити якість кінцевого продукту.

Ключові слова: мембранна обробка, соки, плодово-ягідна сировина, ультрафільтрація, мікрофільтрація.