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THE INFLUENCE OF THE MAIN TECHNOLOGICAL PARAMETERS OF COLD PRESSING OF LOCAL VARIETIES OF SUNFLOWER SEEDS ON THE YIELD AND QUALITY OF OIL

Gafurov K. Kh. [1]***, Safarova D.N.*** [1]

Bukhara Engineering-Technological Institute, Uzbekistan

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Abstract

The scientific research studied the influence of the main technological parameters (rotation speed of the screw shaft and the thickness of the press outlet slot) during cold pressing on the yield and quality of oil from local varieties of sunflower seeds. Using Response surface methodology, it was revealed that, at a shaft rotation speed of 35 rpm and a slot thickness of the outlet opening of 7.5 mm, the residual oil content of the cake will be in the range of 10–10.5%; and the acid number of the resulting oil is in the range of 1.65–1.7 mg KOH.

Keywords: *sunflower seeds, oil, pressing, shaft rotation speed, outlet slot thickness, oil yield, acid number*

Introduction

In the world practice of producing vegetable oils in general, and sunflower oil in particular, there are two fundamentally different ways of extracting oil from seeds: pressing, i.e., mechanically squeezing oil from seeds suitably prepared for pressing; extraction of oil with a highly volatile organic solvent (extraction method). These two main methods are used in the technology of production of vegetable oils either independently or in a certain combination of one with the other, which is determined, as a rule, by the type and quality of the initial processed oilseed raw materials (Shcherbakov V.G., 1992). With the pressing method, the depth of oil removal is limited with the current state of technology. As a result, the oil content of the cake fluctuates on average between 8.0–15.0%. With the extraction method, the depth of oil extraction increases, the oil content of the resulting meal is on average about 1.0% (Shcherbakov V.G., 1992; O'Brien R., 2007).

Increasing the depth of oil extraction by the pressing method requires the use of higher temperatures and pressure during extraction, which, in turn, causes an increase in the specific metal consumption of pressing units, an increase in the specific consumption of electricity, labor and production costs for restoration and repair work (Zaitseva L.V. and Nechaev A.P., 2019; Gupta M., 2017; Dijkstra A., Duijn G., 2016). The use of higher temperatures (110–120 °C) leads to a decrease in the quality of extracted oils due to an increase in their content of oxidation products, free fatty acids, coloring matter, etc. (Zaitseva L.V. and Nechaev A.P., 2019; Gupta M., 2017; Dijkstra A., Duijn G., 2016).

The most effective, in terms of maintaining the quality characteristics of vegetable oil, is cold pressing at low temperatures (Proctor A., 2013; Gafurov K. Kh., 2020). This method is the most "natural" way to produce vegetable oils. At the same time, the oil does not heat up much (no more than 40 °C), which ensures the preservation of all nutritional and beneficial components. It contains the entire range of nutrients and beneficial substances (microelements, macroelements and vitamins) that are necessary in the human diet. This happens because at this processing temperature, many healing substances and vitamins inherent in this product are preserved (Proctor A., 2013; O'Brien R., 2007; Gafurov K. Kh., Safarova D.N., 2022).

The work (Mustafaev S.K., Kalienko E.A., Sonina D.V. and Efimenko S.G., 2014) noted that the term "cold pressing" does not have clear boundaries in terms of process temperature. The temperature at which pressing is considered cold in the EU is 27–30 °C, while in the USA a pressing temperature in the range of 60–99 °C is still considered cold pressing. There are other temperature ranges for cold pressing in the literature. According to (Mustafaev S.K., Kalienko E.A., Sonina D.V. and Efimenko S.G., 2014), the optimal temperature on the press should not exceed 60 °C.

The work (Çakaloğlu B., Özyurt V.H. and Ötleş S., 2018) provides a review analysis of the cold pressing method, where traditional extraction methods are assessed in terms of advantages, disadvantages of technology and operating principles equipment, which states that cold-pressed oils are generally suitable for direct consumption and do not require refining, and to optimize oil recovery, the product must be pre-treated with heat until the material reaches a moisture content of no more than 10%. Cold pressing has been shown to be preferred over other methods of oil extraction (for example, extraction) due to its ease of use, low cost, environmental friendliness, and absence of harmful organic substances.

But with the cold production method, up to 30–40% of the oil present in the seeds is extracted. To completely extract it, it is necessary to thoroughly destroy the cellular structure of the oil-containing raw material (Shcherbakov V.G., 1992). To achieve this, many researchers have proposed various electrophysical effects on oil-containing raw materials. This is a short-term exposure to electromagnetic microwave waves, infrared radiation and other influences (Ilyasov S.G., Krasnikov V.V., 1978; Krajewska M., Ślaska-Grzywna B. and Andrejko D., 2018; Cai Z., Li, K., Lee W.J., Reaney M., Zhang N. Wang Y., 2021).

The purpose of this work is to study the technological modes of pressing sunflower seeds subjected to preliminary infrared (IR) heat treatment, followed by a study of the indicators of the resulting oil and cake.

Object and methods of research

The object of study was the Dushko sunflower hydride, included in the State Register of Agricultural Crops Recommended for Sowing in the Republic of Uzbekistan. Before pressing, the sunflower seed mince was treated with infrared rays with a heat flux density of 7.2 kW/m ^{2} and an irradiation duration of 60 s in the mode: +60–120+35–120+35–‒120+35–120+30 (sign "+ " «indicates the duration of IR irradiation; the sign «–» indicates the duration of exposure without irradiation).

To extract oil by pressing, a laboratory screw press *KK6–3 was used*. A frequency converter was used to change the screw rotation speed. Changing the thickness of the exit slot at the exit of the press from the press is carried out by a conical device at the end of the press.

The residual oil content of the cake was determined according to the state standard *O'z DSt 2438:2012* Oil seeds. Methods for determining oil content.

The acid number of the oil was determined according to the state standard

O'z DSt 1203:2015 Vegetable oils. Methods for determining acid number.

Analysis of results

The study uses compositional design of experiments (Murray P.M. et al. 2016; Georgakis C., 2013). The changing input factors were the rotation speed of the screw shaft z_1, rpm and the thickness of the outlet slot z_2, mm. These indicators largely determine the value of the pressing pressure, which affects the yield and quality of the resulting oil. The rotation speed of the screw shaft was chosen z_1^- =30 rpm and z_1^+ =40 rpm, and the thickness of the outlet slot z_2^- =6 mm and $z_2^{\mp}$ =10 mm.

The response functions were the residual oil content of the cake, y_1,% and the acid number of the oil, y_2, mg KOH.

The experimental results were processed using mathematical and statistical methods. To assess the homogeneity of variances with an equal number of repetitions of each experiment, the Cochran criterion was used, the significance of the coefficients of the empirical model was determined using the Student's test, the adequacy of the equations was proven using the Fisher criterion (Murray P.M. et al, 2016; Georgakis C., 2013).

Empirical models in coded values of influencing factors were obtained in the following form.

For oil yield: $$y_1 = 11.89–2.02\,x_1 + 0.70\,x_2 + +1.66\,x_1 x_2 +1.23\,x_1^{2}–0.63\,x_2^{2} \quad (1)$$

For the acid number of the oil: $$y_2 = 1.97+0.28\,x_1–0.34\,x_2–0.4\,x_1 x_2 \quad (2)$$

We write out mathematical models in natural values of the variables, substituting their expressions through z_i instead of x_i. After performing arithmetic operations, we obtain an equation in natural values of the influencing factors:

For oil yield: $$Y_1 =119.9–5.17\,z_1–2.94\,z_2+ +0.166\,z_1 z_2 +0.049\,z_1^{2}–0.157\,z_2^{2} \quad (3)$$

For the acid number of the oil: $$Y_2 = = –9.83+0.376\,z_1 +1.23\,z_2–0.04\,z_1 z_2 \quad (4)$$

Conclusion

Using *Response surface methodology* (Sinha B.K. et al., 2014) and models (3 and 4) we construct response surfaces that take into account the dependence of the residual oil content of sunflower seed mint cake (Fig. 1) and dependence of the acid number of the resulting oil (Fig. 2) on the influencing factors – rotation speed of the screw shaft z_1, rpm and thickness of the outlet slot z_2, mm.

Analyzing the graphs shown in Fig. 1 and Fig. 2, we can conclude that at a shaft rotation speed of n = 35 rpm and outlet slot thickness δ = 7.5 mm, the residual oil content of the cake will be within 10–10.5%; and the acid number of the resulting oil is within 1.65–1.7 mg KOH.

Figure 1. *Dependence of the residual oil content of sunflower seed cake on the influencing factors: shaft rotation speed, n and thickness of the outlet slot, δ*

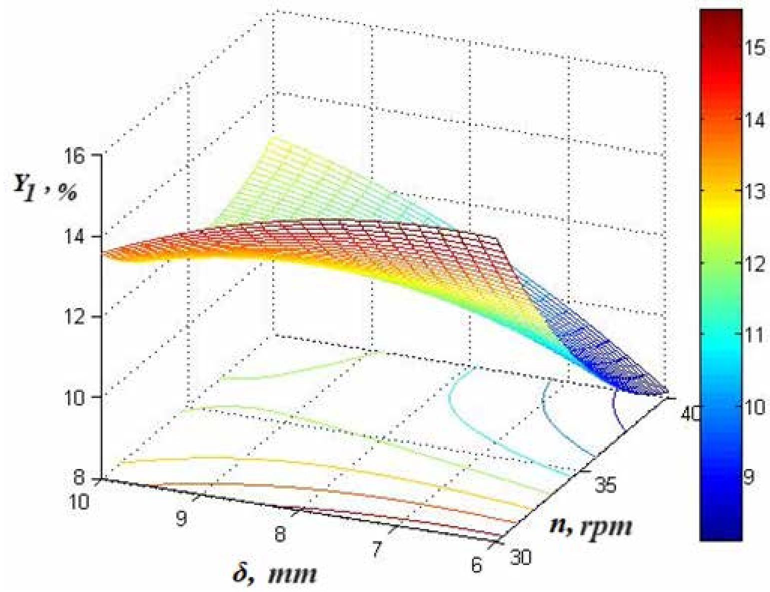
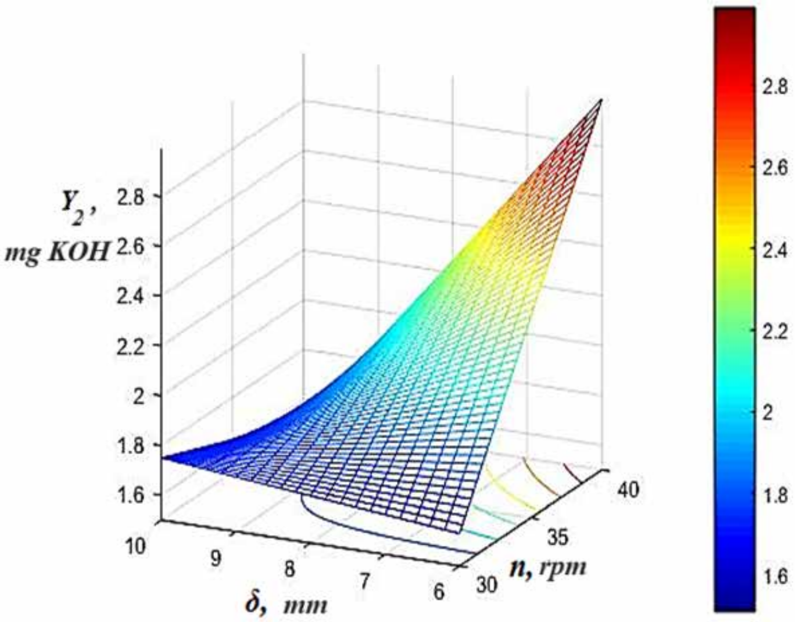


Figure 2. *Dependence of the acid number of the oil on the influencing factors: shaft rotation speed, n and thickness of the outlet slot, δ*



References

Gafurov, K. Kh. (2020). *Change of physiological and biochemical properties of plant raw materials during thermal preparation before extraction*. The American Journal of Engineering and Technology,– 11(2).– P. 197–205. URL: https://doi.org/10.37547/tajet/–Vol. 02. –Issue11–31.

Gafurov, K. Kh., Safarova, D. N. (2022). *Development of Technology for Oil Extraction from Local Sunflower Seeds at Moderate Temperature*. Global Scientific Review,– 8.– P. 33–37. Retrieved from URL: https://www.scienticreview.com/index.php/gsr/article/view/56

Georgakis, C. (2013). *Design of Dynamic Experiments: A Data-Driven Methodology for the Optimization of Time-Varying Processes*. Industrial & Engineering Chemistry Research,– 52.– P. 12369–12382.

Gupta, Monoj. (2017). *Practical Guide to Vegetable Oil Processing*. Lynnwood, USA: AOCS Press.

Çakaloğlu, B., Özyurt, V.H. & Ötleş, S. (2018). *Cold press in oil extraction. A review*. Ukrainian Food Journal.– 7(4).– P. 640–654. Retrieved from: URL: http://dx.doi.org/10.24263/2304–974X-2018-7-4-9

Cai, Z., Li, K., Lee, W. J., Reaney, M., Zhang, N. & Wang, Y. (2021). *Recent progress in the thermal treatment of oilseeds and oil oxidative stability: A review*. Fundamental Research,– 6(1).– P. 767–784. Retrieved from: URL: https://doi.org/10.1016/j.fmre.2021.06.022

Dijkstra, A., Duijn, G. (2016). *Vegetable Oils: Oil Production and Processing*. Encyclopedia of Food and Health. Retrieved from: URL: https://www..net/publication/301702726_Vegetable_Oils_Oil_Production_and_Processing

Ilyasov, S. G., Krasnikov, V. V. (1978). *Physical basis of infrared irradiation of food products*.– Moscow, Russia: Food industry.

Krajewska, M., Ślaska-Grzywn, A. B. & Andrejko, D. (2018). *Effect of infrared thermal pre-treatment of sesame seeds (sesamum indicum l.) on oil yield and quality*. Ital. J. Food Sci.,– 30.– P. 487–496

Murray, P. M. et al. (2016). *The application of design of experiments (DoE) reaction optimization and solvent selection in the development of new synthetic chemistry*, Org. Biomol. Chem.,– 14.– P. 2373–2384.

Mustafaev, S. K., Kalienko, E. A., Sonina, D. V., & Efimenko, S. G. (2014). *The influence of flax seed pressing conditions on the yield and quality of oil*. Scientific journal of KubSAU,– 100(06). Retrieved from: URL: http://ej.kubagro.ru/2014/06/pdf/103.pdf

O'Brien R. (2007). *Fats and oils. Production, composition and use* (translation from English).– St. Petersburg, Russia: Profession.

Proctor, A. (2013). *Green Vegetable Oil Processing*. Retrieved from: URL: https://ru.everand.com/book/282669726/Green-Vegetable-Oil-Processing-Revsied-First-Edition

Shcherbakov, V. G. (1992). *Technology for obtaining vegetable oils*.– Moscow, Russia: Kolos.

Zaitseva, L.V., Nechaev, A.P. (2019). *Fats and oils: modern approaches to modernizing traditional technologies*.– Moscow, Russia: DeLi.

Sinha, B. K. et al. 2014. *Optimal Mixture Experiments, Lecture Notes in Statistics*.– India: Springer.

Stanciu, Ioana (2023). *Technology of vegetable oils: Technology of oils*. LAP LAMBERT Academic Publishing.

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Contact: kgafurov@yahoo.com