ISSN: 2690- 912X

Research Article

Journal of Genetic Engineering and Biotechnology Research

Optimization of the Deodorization Process of Cotton Oil with the Participation of Floating Plants

Sultanov Sardor Xudayberdiyevich*, Adashev Bekhzod Sheraliyevich, Bozorov Sardor Abdumajitovich and Sobuddinov Soxibjon Maxmudjonovich

Namangan Institute of Engineering Technology, Russia

*Corresponding Author
Sultanov Sardor Xudayberdiyevich, Namangan Institute of Engineering Technology, Russia.

Submitted: 2024, Nov 01; **Accepted:** 2024, Nov 27; **Published:** 2024, Dec 18

Citation: Xudayberdiyevich, S. S., Sheraliyevich, A. B., Abdumajitovich, B. S., Maxmudjonovich, S. S. (2024). Optimization of the Deodorization Process of Cotton Oil with the Participation of Floating Plants. *J Gene Engg Bio Res, 6*(3), 01-05.

Abstract

The quality of vegetable oils intended for consumption depends on the complete and perfect deodorization process. Unpleasant taste and odor volatile substances contained in vegetable oils are composed of a complex complex of substances with different composition in terms of quality and quantity. They have more vapor elasticity compared to triglycerides, that is, they create volatility. In the process of deodorization, the odorous substances in the liquid layer move to the evaporation layer, and the molecules of the evaporated substances are lost. Based on the scientific results obtained on the improvement of the deodorization technology of oils on the basis of the computer model of the deodorization process in the liquid-steam-floating nozzle system: in a short time and using modern cleaning methods, it is possible to recommend the optimal conditions for the preparation of high-quality, harmless cottonseed oil for the human body.

1. Introduction

Global demand for consumer oils, including soybean, palm, sunflower, rapeseed and cottonseed oils, is growing at a high rate. Vegetable oils are first-class consumer products for human consumption. They have high nutritional value. The physiological norm of vegetable oil consumption is 9-10 kg per person per year. Also, the possibility of residues of organochlorine pesticides and toxins in oils obtained from plant raw materials grown in unfavorable climatic and agrochemical conditions determines the need for deodorization of oils and fats. For this reason, it is of particular importance to find a solution to the technical and technological problems related to the production of high-quality vegetable oils that meet the requirements of international standards in oil and oil enterprises. After that, the obtained oil goes through several more technological cycles until it is delivered to the consumer. As vegetable oils are a first-class product, it is an important task to improve their quality and ensure their nutritional safety. That is, it is urgent to improve the technology of vegetable oil production.

Comprehensive scientific research is being conducted to improve the existing technologies of vegetable oil production and to create modern technologies based on targeted disposal of technological waste. In this regard, special attention is being paid to the creation of modern technologies that allow for the maximum extraction of taste and odor accompanying substances, to the improvement of process organization methods and to the creation of new, intensive and energy-efficient constructions of technological equipment at the stages of crude oil refining and deodorization. As a result of the conducted scientific research, wooden nozzles were used to ensure the intensity of the process in the deodorization of vegetable oil. That is, it was observed that the movement of the nozzles increases the bubbles formed in the liquid layer, the bubbles burst, the contact surface between the liquid and gas increases, and the flight of light volatile components in the oil accelerates. As a result, the duration of the process was shortened.

2. Materials and Methods

The results of computer modeling of the process of deodorization of cottonseed oil allow to recommend the optimal conditions for the preparation of high-quality cottonseed oil, safe for the human body, in cases where the minimum production costs are minimal [1-7].

The optimization of technological processes has been considered by a number of scientists in particular, for the processes of concentration of solutions [8-10].

Based on the results of the latest research, a generalized indicator of costs that takes into account the consumption of water vapor, electricity, cold water for condensing the steam-gas mixture and depreciation deductions for equipment used in technological processes as an optimality criterion is the technological cost of the finished product *ΔC* were selected [11,18].

In this case, the goal of optimization is to solve two problems:
• Determination of the optimal value of the total working pressure during the deodorization process of cottonseed oil;
• Determining the optimal number of nozzles in the deodorizing device.
For the first problem, the objective function of optimization for a short period of time will have the following form:

$$P_{ym} = f\left(a_{kj}, t, G_m, G_b\right)$$
$$a_{kj} \leq 0{,}1\ \%;\ t \leq 220°\text{C};\ P_{ym} \geq 0.$$

here P_{ym} – total working pressure in the deodorizer, Pa; a_{kj} - final concentration of cottonseed oil, %; t – working temperature, °C; $G_м$- oil consumption, kg/sec; G_b - water vapor consumption, kg/sec.
The objective function formed according to the second problem

$$n_{ym} = f\left(a_{kj}, t, G_m, G_b, n\right)$$
$$a_{kj} \leq 0{,}1\ \%;\ t \leq 220°\text{C};\ P_{ym} \geq opt.$$

here n_{ym} - total number of nozzles to be loaded into the deodorizer, pcs

In the study, the problem of reducing the cost of the product produced in a deodorizer operating in a periodic mode was considered. For this reason, the cost of the manufactured product C_{prt} was chosen as the optimality criterion for the formulation of the optimization problem and the procedures for solving it.

The cost of the product C_{prt} includes all costs incurred for its production, including the price of raw materials $C_{x.a}$, production (technological) costs $C_{t.x}$ and fixed costs C_k:

$$C_{prt} = C_{x.a} + C_{т.x} + C_{к}\,.$$

The amount of technological costs is determined as follows:

$$C_{t.x} = C_t^{'}B,$$

where C_t' is the cost of producing a unit of product.
The structure of these costs will consist of payments for auxiliary materials, electricity, steam and drinking water.

In the research work, the sum of the cost of raw materials Sh.a and fixed costs C_k was included among the initial technological costs. Since the amount of these costs does not directly depend on the volume of the produced product and does not change during the deodorization process, they are taken as a constant quantity ^{0}C.

3. Results

Technological costs related to the process of periodic deodorization of cottonseed oil Stx consists of initial technological costs, water vapor required for heating and deodorizing the oil, cold water for condensing secondary vapors, creating a vacuum in the system and amortization of technological equipment will consist of discounts for and payments for wooden nozzles used in the deodorization process.

Taking into account the above, we can write the objective function of the optimality criterion for the deodorization process as follows:

$$C_{prt} = C_0 + C_{prt} = C_0 + (G_{steam} B_{steam} + G_{water} B_{water} + B_q{*}E + n\,B_n),$$

where C_0 -is initial technological costs; G_{steam} is the unit consumption of water vapor required for the deodorization process, tn/tn; B_{steam} - cost of steam, soum/ton; G_{water} - unit consumption of cold water, tn/tn; C_{water} - cost of water, soum/ton; B_q - deodorant price, soum; E - discount for deodorizer depreciation (normative coefficient, 0.15); The number of nozzles to be loaded into the n-deodorizer, units/m^3, Bn - the price of 1 m^3 nozzle, UZS.

Using the determined values of technological parameters according to the results of mathematical modeling of the cotton oil deodorization process, we determine the values of current costs for the production of a unit quantity of products.

When the concentration of light volatile components in the oil is 0.05% and its temperature is 220 °C, at different values of the total pressure in the apparatus, the water vapor consumption required to process 1 ton of oil has the following values:

Gb = 0.06 tn/tn when Rum = 0.133 kPa; Gb = 0.12 tn/tn when Rum = 0.66 kPa; Gb = 0.24 tn/tn when Rum = 1.33 kPa;

In enterprise conditions, payments for water vapor are made according to its energy value. The cost of 1 Gcal of heat is 158,781 soums. If we consider that the heat energy of 1 ton of water vapor is 2.53 Gcal, then the costs associated with the water vapor used to process 1 ton of oil in the deodorization process are the following values:

P_{ym} = 0,133 kPa when, $G_{steam} B_{steam}$ = 0,06 Г kal/т * 158781 UZS /G_{kal} = 9526 UZS /tn;
P_{ym} = 0,66 kPa when, $G_{steam} B_{steam}$ = 0,12 Г kal/тн*158781 UZS / G_{kal} = 19053 UZS /tn;
P_{ym}=1,33 kPa when, $G_{steam} B_{steam}$ = 0,24 Г kal/тн * 158781 UZS / G_{kal} = 38107 UZS /tn.

A surface condenser is used to condense the secondary vapors released from the deodorizer. At this time, the consumption of cold water required for condensation of vapors was determined according to the following equation:

$$Gwater = \frac{G_{steam}\left(i_{steam} - c_{kn}t_{kn}\right)}{\left(c_{\text{water }out}t_{\text{water }out} - c_{water\,ingress}t_{water ingress}\right)},$$

where steam is the enthalpy of secondary steam, kJ/kg; ckn - heat capacity of steam condensate, kJ/(kg . °C); t_{kn} - condensate temperature, °C; $t_{water\ ingress}$ = 15÷20 °C and $t_{water\ out}$ = 30 °C - temperatures of water entering and leaving the condenser, °C; C_{water} - heat capacity of water, kJ/(kg .K); C_{water} = 4.19 when $t_{water\ out}$ = 10÷20 °C, C_{water} = 4.18 kJ/(kg .K) when $t_{water\ out}$ = 30÷40 oC.

Cold water consumption required to condense the secondary vapors formed during the processing of 1 ton of oil when the total pressure in the apparatus is 0.133 kPa

$$Gwater=\frac{0,2(2753-136,2)}{4,18(32,5-15)}=\frac{523,3}{73,15}=7,15\ \text{tn/tn}$$

The cost of water is 2650 soums/m^3 (1m^3 of water = 1 ton, so we take 2650 UZS/ton). The amount of payments for water was determined as follows:

G_{water} B_{steam} = 7.15 tn/tn*2650 UZS/tn = 18947 UZS/tn.

The amount of payments for electricity was determined based on the power consumption of the piston vacuum pump (Nn = 5.5 kW):

Nn•E = 58•295 = 17110 UZS/tn, where E is the price of electricity, UZS/kW. Depreciation costs for a floating nozzle deodorizer: A*An = Bq * E = 30,000,000*0.15 = 4,500,000 UZS,

where Bq = 30000000 soums - the price of the deodorizer in the balance sheet of the enterprise; E- normative coefficient (E = 0.15).

The amount of heat used for primary heating of the oil supplied to the device is determined as follows:

$$Q=G_m c_m(t_o-t_b)=1000*2,3*(220-30)=437000\ \text{kJ},$$

where Gm = 1000 kg/h - oil consumption; S_m = 2.3 kJ/(kg .K) - specific heat capacity of oil; tb = 30 °C - initial oil temperature; to = 220 °C - boiling temperature of oil in the device. Water steam with a temperature of 250 °C is used to heat the oil. The enthalpy of water vapor at this temperature is 2792 kJ/kg. Water vapor consumption required to heat 1 ton of oil 437000/2792 = 156.5 kg (0.1565 t).

The amount of payments for heating water steam is determined as follows: B_{steam}*$G_{m\ steam}$ = 158781*0.1565 = 24849 UZS/tn.

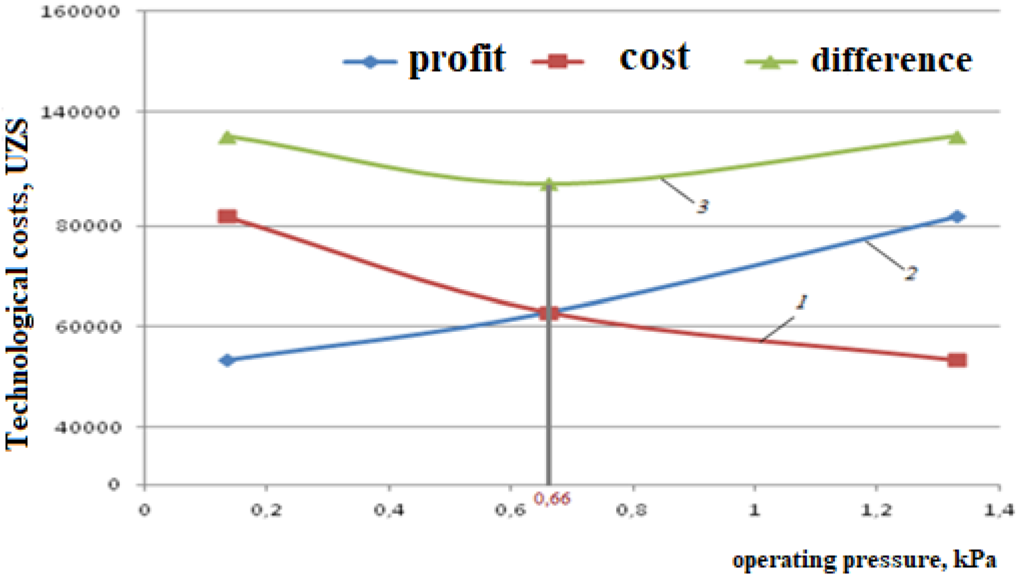

Figure 1: Dependence of Working Pressure on Technological Costs
1. Cost; 2. Profit; 3. Difference

The results of the experiments conducted in the laboratory of the enterprise to determine the number of fatty acids in deodorized cottonseed oil in different technological regimes are presented in the table below.

3.1 Results of Conducted Experiments

№	Temperature, °C	Pressure, kPa	Water vapor consumption, kg/s	Number of fatty acids in finished oil, mg KOH
1	180	0.67	0.07	0.22
2	200	0.67	0.07	0.20
3	220	0.67	0.07	0.18
4	240	0.67	0.07	0.16
5	180	1.33	0.08	0.28
6	200	1.33	0.08	0.25
7	220	1.33	0.08	0.22
8	240	1.33	0.08	0.21
9	200	2.0	0.06	0.28
10	220	2.0	0.06	0.24

Initially, experiments were conducted when the oil temperature was heated to 220 oC. When the excess pressure in the apparatus was 0.67 kPa, and the consumption of open water steam was given in the amount of 0.07 kg/sec, the acid number in the finished oil decreased to 0.20 mg KOH. When the oil consumption was increased to 0.08 kg/sec, a KOH reading of 0.22 mg was obtained. At a pressure of 2.0 kPa, the acid number was 0.28 mg of KOH when the consumption of open water steam was reduced to 0.06 kg/sec.

3.2 Performance Indicators of a Floating Mobile Wooden Propeller Device

Indicators	Without nozzle	with nozzle
Heating (up to 200 °C) and deaeration	40	25
Deodorization	150	105
Refrigeration (transfer to receiver cooler)	60	35
Cycle duration, min (hours)	250 (4.17)	165 (2.75)

The tests were carried out using deodorizers operating in periodic mode at the cotton oil production enterprise belonging to "Namangan Tola-Textil" LLS.

4. Conclusion

The following conclusion was reached in the conducted scientific research. Today, the vegetable oils produced in oil-oil products production enterprises are processed. In the process of processing vegetable oils, they are cleaned of volatile substances that give unpleasant taste and smell [12-21]. Compared to existing deodorizing devices used to remove unpleasant taste and odorous substances in oils, the effectiveness of the device with a floating movable wooden nozzle has been proven in the experiment. The processing of cottonseed oil in a new recirculating device reduced the various volatile components in the finished oil for a short period of time. The new method of deodorization led to an improvement in the quality of the oil. A computer model of the deodorization process in the liquid-steam-floating nozzle system was developed. The oil refining process was improved based on the developed computer model. Scientific results on deodorization of vegetable oils were obtained. Based on the obtained scientific results, it was possible to recommend the optimal conditions for the production of high-quality, harmless cottonseed oil for the human body in a short period of time and using a modern cleaning method.

References

1. Kafarov, V.V., Glebov, M.B. (1991). Mathematical modeling of the main processes of chemical production: Textbook for universities. 400 pp.
2. Sultanov, A. S., Khamdamov, A. Artikov. (2022). Effective use of floating wooden nozzles when intensifying mass transfer processes Universum: technical sciences. *Scientific journal Issue: 4*(97) Part 7 Moscow p.46-49.
3. Yusupbekov, N. R., Nurmuhamedov, H. S., Ismatullaev, P. R., Zokirov, S. G., Mannonov, U.V. (2000). Calculation and design of basic processes and devices of chemical and food industries. Oil processing technology. Textbook. - T.: "Economy-Finance". 300 p.
4. Jumaeva, D., Toirov, O., Okhunjanov, Z., Raximov, U., & Akhrorova, R. (2023). Investigation of the adsorption of nonpolar adsorbate molecules on the illite surface. *Journal of Chemical Technology and Metallurgy, 58*(2), 353-359.
5. Rakhimov U. Yu., Shamuratova M. R., Okhunzhonov Z. N. (2023). Research of Paragasactivated Adsorbents Based on Grape Seed Squeeze. *Science of the Young - the Science of the Future*. – P. 224-228.
6. Rakhimov U. Yu., Jumaeva D. J., Agzamova F. N. (2021). Determination of physical and chemical properties of thermally active adsorbent based on Chshchindi.
7. Rakhimov U. Yu., Zhumaeva D. Zh. (2021). Investigation of physico-chemical properties of thermally activated adsorbents on the basis of local waste. *NAMIT Scientific and Technical Journal.* No. 2. – pp. 92-97.
8. Atakhanov, Sh. N., Dadamirzaev, M. Kh., Rakhimov, U. Yu., Nishonov, U. R., & Khurramova, Kh. M. (2019). Study of physicochemical parameters and nutritional value of semi-finished vegetable sauces and pastes. *Universum: technical sciences,* (6 (63)), 60-63.
9. Atakhanov, Sh. N., Mallaboev, O. T., & Rakhimov, U. Yu. (2017). Study of the properties and quality of dessert made from Jerusalem artichoke juice. *Storage and processing of agricultural raw materials,* (1), 13-14.
10. Zhumaeva, D. Z., Rakhmatullaeva, N. T., Shamuratova, M. R., Bakronov, Kh. N., & Rakhimov, U. Yu. (2022). Differential Heats of Adsorption of Water Vapor on An Adsorbent Obtained Based on Wood Waste. *Universum: chemistry and biology,* (9-1 (99)), 63-68.
11. Juraevna, D. J., Yunusjonovich, U. R., & Karimovich, O. E. (2022). Studying on the Activated Absorbents Derived from Waste of a Grape Seed. *Journal of Chemical Technology and Metallurgy, 57*(5), 998-1005.
12. Rakhimov U.Yu., & Zhumaeva D.Zh. (2021). Obtaining and Research of Paragas-Activated Adsorbents Based on Grape Seed Waste. *The Scientific Heritage,* (78-2), 17-19.
13. Rakhimov, U. Yu. (2023). Development of an import-substituting adsorbent from food industry waste / U. Yu. Rakhimov // Science of Young - Science of the Future: collection of articles of the III International Scientific and Practical Conference, Petrozavodsk, February 02. Volume Part 2. – Petrozavodsk: International Center for Scientific Partnership "New Science" (IP Ivanovskaya I.I.), 2023. – P. 229-232. – EDN EVDTHV.
14. Aimurzaeva, L. G., Rakhimov, U. Yu., Zhumaeva, D. Z., & Eshmetov, I. D. (2022). Effective Clarification of Water Water from Textile Enterprises Using Coagulant-Adsorbents of the Apak Series. *Universum: chemistry and biology,* (3-1 (93)), 66-70.
15. Khamdamov A. M., Sultonov S. H., Bozorov S. A. (2022). The main results of the study of the processes of

deodorization of vegetable oils using wooden nozzles. *Journal of Pharmaceutical Negative Results.* S. 3844-3851.
16. Makhmudovich Khamdamov, A., Oydinhon, A., Kizi, K., Mansurov, O. A., Sultonov. H. S. (2021). Simulation of a Multistage Distillation Process in a Rotary Disc Device. *Annals of the Romanian Society for Cell Biology*.5939–5948.
17. Anvar, K., Makhmudovich, Akramzhanovna, S. D. (2020). "Modeling the deodorization process of cottonseed oil fatty acids." *Universum: Engineering Sciences*. no. 11-2 (80), pp. 94-98.
18. Sultanov S. Kh., Khamdamov A. M., Artikov A. A. Effective use of floating wooden nozzles for intensification of mass transfer processes. *Universe: technical sciences*. – 2022. – no. 4-7 (97). - S. 46-48.
19. Voqqosov, Z., Kanoatov, K. (2023). The influence of organo-mineral fertilizers on the growth of evening apple varieties throughout the year. *E3S Web of Conferences. – EDP Sciences*. – T. 390.
20. Zukhriddin, V., Murodillaevich, K. K., Elbekovich, S. B. (2022). Obtaing Organomineral Fertilizers on Base of Local Raw Materials and Nitrogen-fixing Microorganisms. *Chemical Science International Journal*. T. 31. №. 4. S. 44-53.
21. Sharipov S. Y., Azizov A. S., Vakkasov Z. K. (2022). Storage of apples in different methods in the valley region of Uzbekistan. *IOP Conference Series: Earth and Environmental Science*. – IOP Publishing. T. 1068. – №. 1. – S. 012029.