

ISSN 2181-8622

Manufacturing technology problems



Scientific and Technical Journal Namangan Institute of Engineering and Technology

INDEX  COPERNICUS
I N T E R N A T I O N A L

**Volume 9
Issue 4
2024**



THEORETICAL ASPECTS OF OBTAINING OXIDATION-STABLE VEGETABLE OILS

ZUFAROV OYBEK

Tashkent Chemical Technological Institute, Tashkent, Uzbekistan
E-mail.: zufarovoybek81@gmail.com

ISROILOVA SHOIRA

Tashkent Chemical Technological Institute, Tashkent, Uzbekistan
E-mail.: sherliverpool.211@gmail.com

YULCHIEV ASLBEK

Andijan State University, Andijan, Uzbekistan
E-mail.: yulchiev@mail.ru
**Corresponding author*

SERKAYEV KAMAR

Tashkent Chemical Technological Institute Tashkent, Uzbekistan
E-mail.: serkayev@mail.ru

Abstract: The purpose of the research was to theoretically substantiate the principles of oxidation and directions in the development of ways to prevent the appearance of derivatives of oxidation of vegetable oils based on existing modern concepts and patterns. The article substantiates the sequence of oxidation stages and the factors influencing the intensity of the process. The authors, relying on the results of numerous studies conducted by scientists, argue that high-temperature treatment in the presence of enzymes, metal ions, phospholipid residues and various pigments, especially in a relatively humid environment, is a very important component in initiating the process of autooxidation of fatty acids. It is noted that inhibition or at least reduction of the factors of initiation of the primary oxidation process by forrafination in the presence of highly effective reagents leads to an increase in the shelf life of vegetable oils.

Keywords: oxidation, initiation, peroxides, aldehydes, malondialdehyde, inhibition.

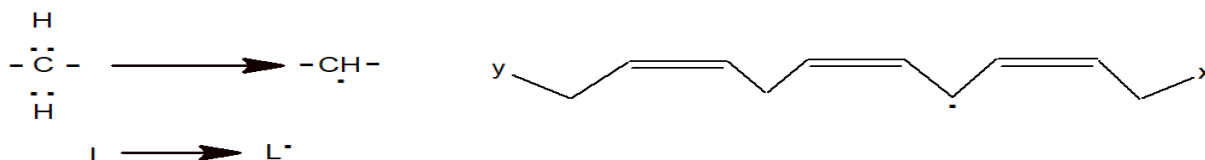
Introduction. As is known, autooxidation of lipids of native vegetable oils is a rather slow process, which is slowed down by natural antioxidants. However, by creating conditions under which lipids can be exposed to free-radical action, the cis-configuration loses a hydrogen atom from the chain and turns into a free radical $L\bullet$ and the possibility of interaction with molecular oxygen appears. When interacting with oxygen, lipid peroxidation occurs and the fatty acid is peroxidized by the formation of the $LO\bullet$ structure.

At the first stage, i.e. when the oxidation reaction is initiated, a free hydrogen radical and a free radical of fatty acids are formed by homolytic decomposition of covalent compounds of the hydrocarbon chain C-H. Vegetable oils always contain trace amounts of hydroperoxides, which are formed under the influence of lipoxigenases in plants and pass into the oil during production.

The energy needed to decompose fatty acid molecule compounds can come from various sources, such as thermal energy during heating, ultraviolet radiation, or light.

The decomposition of the molecule can also be caused by reactions with other free radicals or metals.

Initiation: The reaction is most often initiated by the hydroxyl radical, which removes hydrogen from the CH₂ groups of the polyenoic acid, which leads to the formation of a lipid radical.



The resulting free radical of fatty acids is very active and easily reacts with an oxygen molecule, resulting in a peroxy radical. The resulting radical separates a hydrogen atom from an unsaturated fatty acid molecule, resulting in hydroperoxide and a free radical of fatty acids.

The second stage of autoxidation is called propagation. The two stages of the propagation stage can be repeated several times (we are talking about a chain reaction) [1, 2]. At the beginning of this stage, the first organoleptic signs of fat spoilage begin to appear [3, 4].

Propagation (development): The chain develops with the addition of O₂, resulting in the formation of a lipoperoxy radical LOO• or lipid peroxide LOOH. Lipid peroxidation is a free radical chain reaction, i.e. each radical formed initiates the formation of several others:



The resulting peroxide radical reacts with the next fatty acid molecule to form a hydroperoxide molecule and a new fatty acid radical:



The enthalpy of propagation reactions is low compared to the enthalpy of the initiation reactions. That is why the chain oxidation reaction at the second stage occurs at an accelerated rate

Research methods. The color number of the cottonseed oil under study was determined in red units using a Lovibond tentometer (Model E), in a 1 cm thick cuvette and at a constant 35 yellow units [7]. The color number of sunflower oil was determined using the iodine scale in mg iodine.

When determining the acid number of the oils under study, it was assumed that this indicator characterizes the presence of free fatty acids in the fat and is expressed by the amount of potassium hydroxide (mg) required to neutralize free fatty acids and alkali-neutralized accompanying substances contained in 1 g of fat (mg KOH/g). The acid number for refined vegetable oils should not exceed 0.4 mg KOH/g [8].

Since free fatty acids are oxidized faster than bound ones, an increase in the acid number accelerates the processes of both chemical and enzymatic oxidative rancidity of unsaturated fatty acids. On the other hand, oxidation of free unsaturated fatty acids by

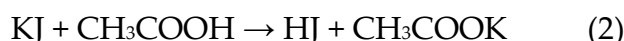
lipooxygenases promotes an increase in the acid number. However, an increased acid number does not always indicate fat spoilage. Fats with a high acid number are often not rancid, while the acid number of rancid fats can be low.

To determine the acid number, an oil sample was first dissolved in a neutralized mixture of ethanol and diethyl ether (1:2). Ethyl alcohol is used not only for dissolution formed during soap titration, but also to eliminate the reverse reaction - soap hydrolysis. About 3 g of vegetable oil were weighed into a 100 ml flask on an analytical scale, 50 ml of an alcohol-ether mixture (1:2) were added, and 1-2 drops of an alcohol solution of phenolphthalein were introduced. The analyzed solution was carefully titrated (one drop at a time) with 0.1 N aqueous potassium hydroxide solution until a faint pink color was obtained. The acid number (AN, mg KOH/g) was determined using formula (1):

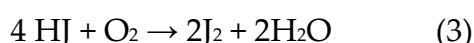
$$KЧ = \frac{5,611 \cdot V_{KOH}}{m} \quad (1)$$

The peroxide value serves as a quantitative indicator of the presence of primary oxidation products of peroxides and hydroperoxides, i.e. oxidative changes occurring in fats.

In the experiments, a titrimetric method was used to determine the peroxide value, based on the ability of peroxides to oxidize hydroiodic acid with the release of free iodine [9]. Hydroiodic acid is formed as a result of the reaction of potassium iodide and acetic acid (2):



If the fat does not contain peroxide compounds, then free iodine is not released for 3-5 minutes. After this time, the release of free iodine becomes noticeable due to the oxidation of hydroiodic acid by atmospheric oxygen. The released iodine was titrated with sodium thiosulfate (3):



If the release of free iodine occurred immediately after adding acetic acid and potassium iodide to the fat solution, this indicated the presence of peroxide compounds in the fat.

To do this, a sample of oil was weighed into a flask with a ground stopper on an analytical scale based on the degree of expected oxidation of the oil being studied. 10 ml of ethyl alcohol and 15 ml of glacial acetic acid were poured along the wall of the flask, washing away traces of fat. Then 1 ml of freshly prepared 50% potassium iodide solution was added. The mixture was thoroughly mixed, then closed with a stopper and left in a dark place at a temperature of 15-25 °C. After 3 minutes, 75 ml of distilled water was poured into the flask, to which 5 drops of a 1% starch solution were added in advance, until a violet-blue color appeared. The released iodine was titrated with a 0.01 N sodium thiosulfate solution until a milky white color was obtained, which was stable for 5 seconds.

The peroxide value (PV, mmol $\frac{1}{2}O/kg$) of fat was calculated using formula (4):

$$ПЧ = \frac{(V_0 - V_K) \cdot 0,001269}{m} \cdot 100 \quad (4)$$

Where: V_o is the volume of 0.01 N sodium thiosulfate solution used to titrate the test sample, ml;

V_K is the volume of 0.01 N sodium thiosulfate solution used to titrate the control sample, ml;

0.001269 is the titer of 0.01 N sodium thiosulfate solution, g/ml; 100 is the conversion factor for 100 g of the analyzed oil;

m is the mass of the studied oil, g.

The oxidizing agent was an air flow in the amount of 20 l per hour. Samples of vegetable oils were taken at 3 g, and a parallel analysis was carried out for each sample. The criterion of antioxidant activity is the protective factor (PF), which is calculated by the difference in the induction period (an increase in the induction period indicates stable oxidative stability, the higher the induction period, the higher the oxidative stability of vegetable oils and fats) of vegetable oils treated with different reagents to reduce the iron content in them [11-13].

Results and discussion. As shown by the analysis of the conducted works on lipid oxidation, the sequence of the oxidation stage occurs according to the following mechanism of chain reaction: At the beginning of initiation, the methylene group of fatty acids is attacked by the hydroxyl radical located between the double bonds and releases the hydrogen atom. Then there is a rearrangement of the double bonds of the fatty acid, a shift of the radical group and its interaction with active oxygen, as a result of which an intermediate oxidation product appears - an unstable lipoperoxide radical. These radicals are often presented in the form of hydroperoxides and diene conjugates (primary oxidation products) of fatty acids. The resulting lipoperoxide radical reacts with other fatty acids in the medium, which leads to its neutralization and the formation of new lipoperoxide radicals, causing a chain reaction with the formation of new oxidized forms of fatty acids.

However, radiation in the presence of metal ions in the environment leads to the formation of branched forms of peroxides, which is facilitated by the production of electrons of metals by hydroperoxides according to the scheme shown in Fig. 2.

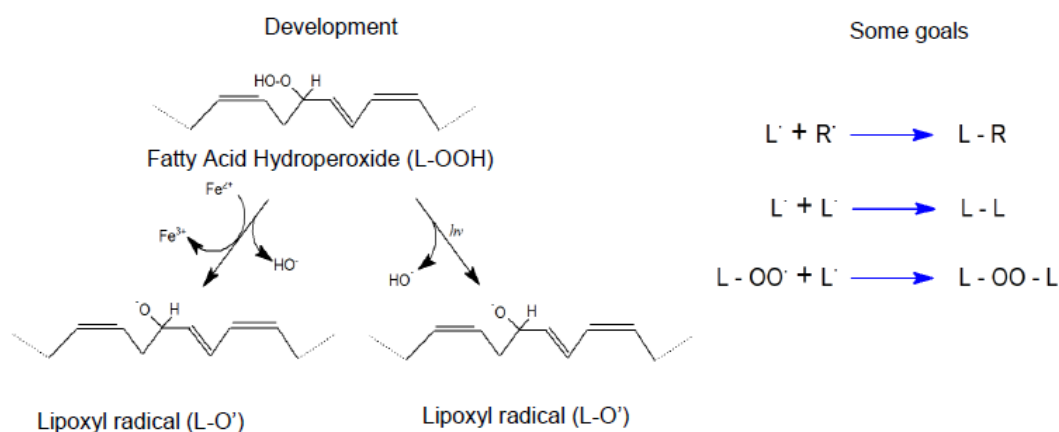


Figure 2. The fluttering reaction of the appearance of lipoperoxides

The primary products of peroxidation of fatty lipid systems are hydroperoxides, which undergo further decomposition to form secondary products of peroxidation, which include alcohols, aldehydes, ketones, and epoxy compounds. The most significant secondary product of peroxidation is malonic dialdehyde, the sequence of appearance of which is shown in Fig. 3.

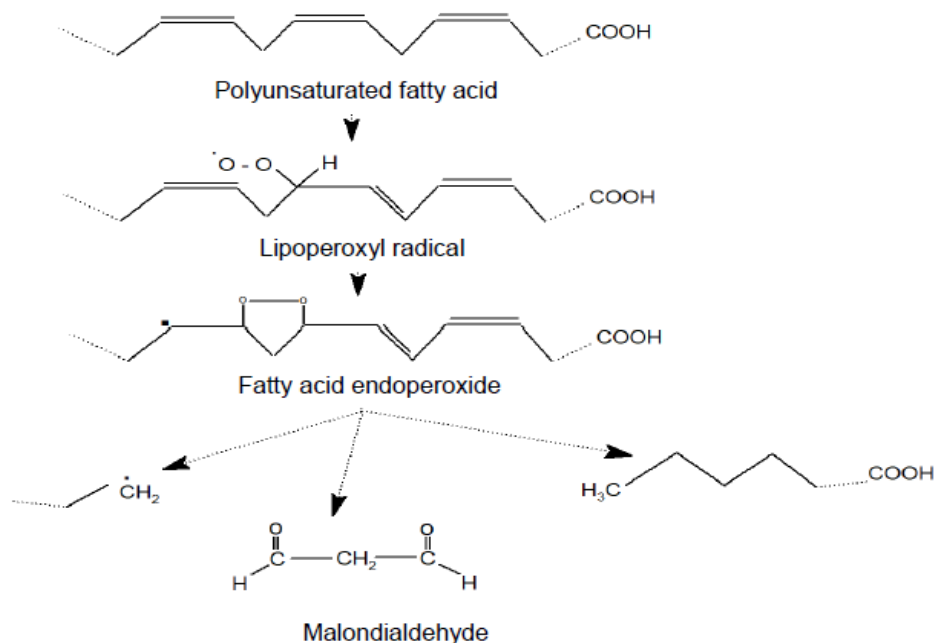


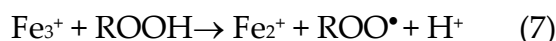
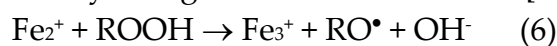
Fig. 3. The sequence of formation of malondialdehyde

Malondialdehyde promotes the formation of covalent bonds with NH₂ groups of proteins and molecules of other Schiff base substances according to the scheme shown in Fig. 4

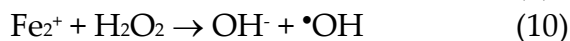
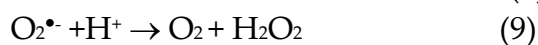
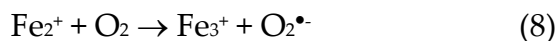
- moisture. The activity of enzymes, the activity of oxygen and hydroxyl groups, in general, the initiation of the oxidation reaction is not possible without moisture, even in small quantities;

- phospholipids. Lipid peroxidation is inextricably linked with the composition of phospholipids. Intensification of the process leads to an acceleration of phospholipid metabolism and a change in their composition. Also, the intensification of lipid peroxidation leads to the enrichment of lipids with fractions of phosphatidylcholine, sphingomneline and cholesterol that are more resistant to oxidation [21]. According to some researchers, lipid peroxidation is initiated by phospholipase. Phospholipase catalyzes the hydrolysis of phospholipid peroxides into fatty acid hydroperoxides.

- metals of variable valence. During lipid oxidation, despite their insignificant content, metals of variable valence are catalysts for the reaction, especially if during the decomposition of hydroperoxides by a single-electron mechanism [22, 23]:



The oxidation-reduction capacity of iron activates free hydroxyl and superoxide radicals [24]:



Accordingly, the hydroxyl radical is capable of separating a hydrogen atom from polyunsaturated fatty acids, which is the beginning of a chain reaction.

When the reaction medium contains substances capable of removing radicals from the reaction medium or regenerating oxidized products of natural antioxidants, a synergistic effect is observed. Synergists can be substances that have a weak oxidation-reduction potential and easily pass from the oxidized form to the reducing one. Such synergists in vegetable oils can be ascorbic and citric acids [29, 30].

At low concentrations, when the reaction medium contains metal ions with variable valence, vitamin C acts as a catalyst for the oxidation process. At high concentrations, when there are a sufficient number of centers for binding metals, vitamin C functions as an antioxidant [15, 29].

Thus, the process of free radical oxidation of lipids caused by the free oxygen radical $\bullet\text{OH}$ is a consequence of a complex of circumstances:

- the rate of the process depends on the fatty acid composition of the oil, the enzyme environment, temperature and moisture of the reaction environment;
- the quantitative content of accompanying substances, including phospholipids and ions of metals of variable valence, determine the duration of the oxidation period;
- the increased reactivity of lipid oxidation products determines two different types of their action in the human body. Primarily oxidized forms have a beneficial effect on the human body, consisting in hydrophilic-hydrophobic derivatives of phospholipids, with a change in the functional state of biomembranes and activation of enzymes;
- secondary products appearing in the process of propagation of oxidative processes, i.e. aldehydes and ketones destroy the functional state of biomembranes in the body. The most significant secondary product of peroxidation is malonic dialdehyde, which promotes the polymerization of membrane components and ultimately destroys the cellular structure, which is why it is a strong carcinogen;
- lipid peroxidation is initiated mainly by the enzyme phospholipase, which catalyzes the hydrolysis of phospholipid peroxides into fatty acid hydroperoxides;
- low content of variable metal ions in oils, in particular iron, activates and, conversely, a significant content inhibits the oxidation process. However, as studies show, the content of variable metal ions in vegetable oils is relatively low (approximately 1 mg / kg) and act as catalysts for the oxidation process, and therefore, like phospholipids, should be blocked and eliminated from vegetable oils.

In our opinion, using the above-mentioned regularities and the results of studies on the effect of antioxidants on the regulation of the lipid oxidation process, it is necessary to improve the technology of processing vegetable oils.

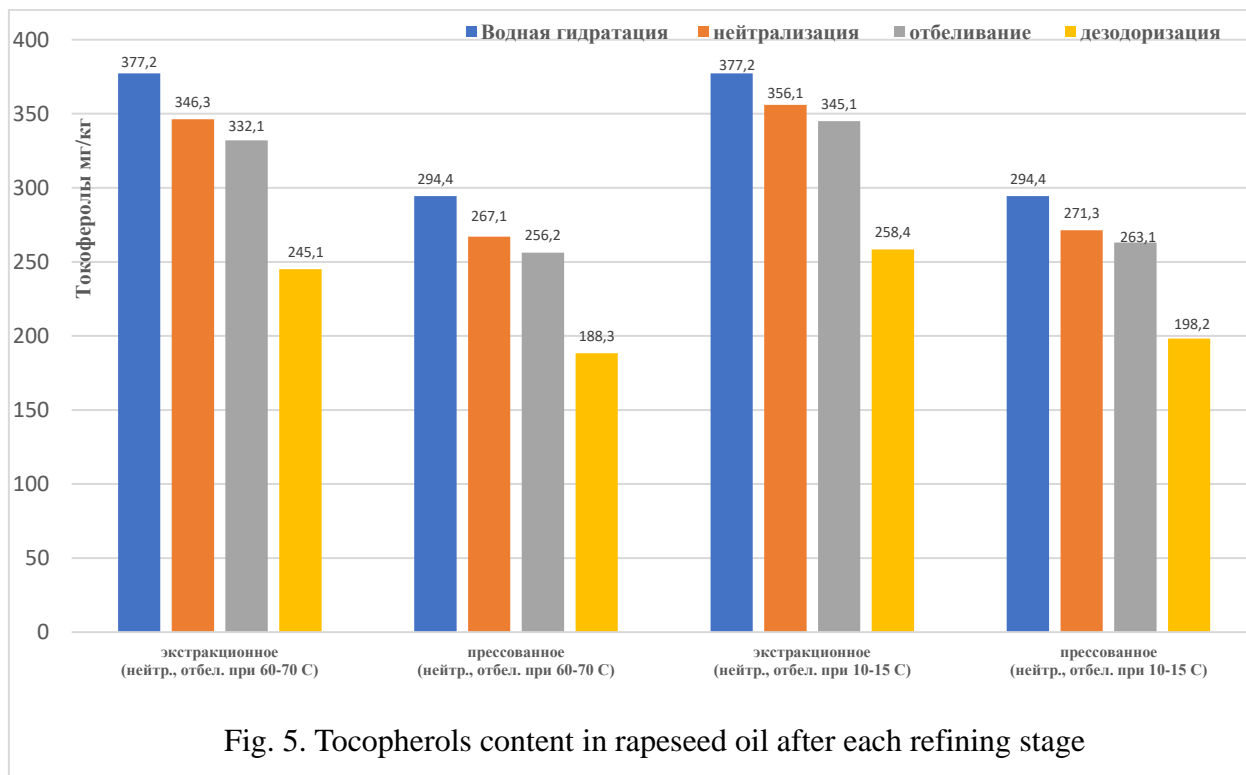


Fig. 5. Tocopherols content in rapeseed oil after each refining stage

Also, by carrying out various effects on unrefined rapeseed oil, the change in the content of phosphorus and iron in the oil was determined. Table 1 shows data on the change in the content of phosphorus and iron with different methods of processing rapeseed oil.

Table 1. Changes in the content of phosphorus and iron in rapeseed oil with different refining methods

Processing method	Content phosphorus		in iron		oil phosphorus		(mg/kg): iron	
	Press	oil	Press	oil	Extraction	oil	Press	oil
Water hydration	61,4		0,5		85,6		0,9	
Processing with MEA	7,5		0,2		9,6		0,4	
Processing with DEA	12,3		0,3		18,9		0,7	
Processing with TEA	14,3		0,4		21,5		0,8	
TOP hydration	10,4		0,2		15,8		0,3	
Neutralization (60-70 °C)	17,1		0,4		24,2		0,7	
Neutralization (10-15 °C)	15,1		0,2		21,1		0,4	

As can be seen from the data given in Table 1, monoethanolamine treatment was the most effective for removing phospholipids from sunflower oil, since this treatment reduced the phosphorus content to 7.5 mg/kg.

Iron ions are effectively reduced by TOP hydration and low-temperature neutralization at a temperature of 10-15°C.

Conclusions. Analysis of numerous studies by scientists on the nature of oxidation of vegetable oils shows that high-temperature treatment in the presence of enzymes, metal ions, phospholipid residues and various pigments, especially in a relatively humid environment, is a very important component in initiating the process of fatty acid autoxidation. Inhibition, or at least a decrease in the factors initiating the process of primary oxidation by forrefining in the presence of highly effective reagents leads to an increase in the shelf life of vegetable oils.

The refining process is complicated by the fact that it requires the preservation of some necessary substances, such as tocopherols, and at the same time the removal of accompanying substances that interfere with stability, such as iron ions, residues of phosphorus-containing substances, etc.

We have experimentally determined that water hydration of vegetable oils removes only a certain portion of phospholipids and iron. However, complete removal of iron can be a difficult task, and the degree of its removal depends on the specific method of processing vegetable oils.

Processing oils with ethanolamines (MEA, DEA, TEA) forms complexes with metals by chelation, which helps to reduce the iron content in the oil.

Neutralization and bleaching of vegetable oils at a temperature of 10-15°C leads to a lower iron content compared to processing at higher temperatures.

The method of processing MEA oils, TOP hydration and neutralization at 10-15°C followed by bleaching of vegetable oils is the most effective for removing iron, where the content in the oil is reduced by less than 0.2 mg/kg, which in the presence of tocopherols ensures long-term inhibition of oxidative processes activated by iron ions.

References

1. Manuela M., Luis M., Ana M Gomes., Manuela P. Vegetable oils oxidation: mechanisms, consequences and protective strategies. *Food reviews international*, 2023, 39 (7), 4180-4197. doi.org/10.1080/87559129.2022.2026378
2. Hong Sik Hwang., Jill K. Winkler-Moser. Physical and Oxidative Stability of Oleogels During Storage. *Advances in Oleogel Development, Characterization and Nutritional Aspects*. 2024, 2, 365-395. doi.org/10.1007/978-3-031-46831-5_16
3. Kamal-Eldin A, Pokorný J. *Analysis of Lipid Oxidation*. Champaign, Illinois: AOCS PRESS, 2005. 293-299.
4. Bandana Vineet Sharma., Aparna Khagwal., Deepali Bansal. Oil Absorption, Peroxide Values and Shelf-life of Different Oils on Potato Processing. *International Journal of Engineering Research & Technology*. 2023, V. 12, 11, 1-10.

5. Pokorný J. Impact of food processing on antioxidant plant phenols. Natural antioxidant phenols. 2006, Vysoke Tatry conference, 56-64
6. Pokorný, J.; Schmidt, Š. *Natural antioxidant functionality during food processing. Antioxidants in Food*. Elsevier: Amsterdam, 2001, 331-354.
7. ISO 15305:1998. Animal and vegetable fats and oils - Determination of Lovibond colour. Moscow, Standartinform Publ., 2001, 18.
8. ISO 660:2020. Animal and vegetable fats and oils. Determination of acid value and acidity. Moscow, Standartinform Publ., 2021. 16
9. ISO 3960:2020. Animal and vegetable fats and oils Determination of peroxide value. Iodometric (visual) determination by end point. Moscow, Standartinform Publ., 2021, 12.
10. ISO 6886:2006. Animal and vegetable fats and oils. Determination of oxidation resistance. Accelerated oxidation test. Moscow, Standartinform Publ., 2008, 18.
11. Zufarov O., Serkayev K. Determination of oxidative stability of crude and refined vegetable oils by rancimat. *Chemical Technology Control and Management*, 2023, 5, 11-16. DOI: 10.59048/2181-1105.1500
12. Zufarov O., Serkayev K. Effect of degumming methods on quality of rapeseed and sunflower oils. *Chemical Technology Control and Management*, 2023, 6, 5-11. DOI: 10.59048/2181-1105.1499
13. Zufarov O., Isroilova Sh., Serkayev K. Oxidative stability of crude and refined vegetable oils. Conference: Science and innovation - modern concept. Moscow, 2024, 138-141. DOI: 10.34660/INF.2024.60.32.322
14. Freeman. B.A., Crapo. J.D. Free radical and tissue injury. *Biology of Disease. Laboratory Investigation*, 1982, 7, 412-426.
15. Zufarov O., Serkayev K. Antioxidants. *CAFET*, 2024, V.2, 1, 9-12. DOI: 10.5281/zenodo.10629890.

CONTENTS

PRIMARY PROCESSING OF COTTON, TEXTILE AND LIGHT INDUSTRY

Korabayev Sh.	3
From street traffic to space: innovations in autonomous vehicles	
Egamov N.	10
Investigation of vertical forced vibration in the longitudinal - vertical plane of a binder that softens the crush between cotton rows	
Khamraeva S., Kadirova D., Davlatov B.	15
Determination of alternative technological factors for the production of functional fabric with a complex structure	
Khamraeva S., Kadirova D., Daminov A.	21
Designing fabrics for a given stretchability	
Kuliyev T., Rozmetov R., Tuychiev T., Sharipov Kh.	28
The effect of the angle of heat agent supply to the drying - cleaning equipment on cotton quality and cleaning efficiency of the equipment	
Abdujabbarov M., Alieva D., Karimov R.	35
Determination of the influence of the length of the tested yarn samples on their mechanical characteristics	
Jurayeva M., Nabidjonova N.	41
Research on physical and mechanical properties of fabric selected for special clothing of preschool children	
Yangiboev R., Allakulov B., Gulmirzayeva S.	45
Studying the alternative technological factors of the loom in the production of textiles based on basalt yarn	
Ganikhanov Kh., Mavlyanov A., Abdusamatov A., Mirzaumidov A.	55
Analysis of the maintenance technological parameters of the condenser	
Mavlyanov A., Mirzaumidov A.	60
The scientific basis of the lightened shaft	
Elmanov A., Mirzaumidov A.	69
Modeling of laser processing of thin-walled steel gears	
Nurillaeva Kh., Mirzaumidov A.	77
Cotton cleaner with multifaceted grates	
Ganikhanov Kh., Mavlyanov A., Abdusamatov A., Mirzaumidov A.	83
The equation of motion of cotton fiber in the condenser	
Khuramova Kh., Xoshimxojaev M.	89
Progressive method of cotton regeneration	

Abdulkarimova M., Lutfullaev R., Usmanova N., Mahsudov Sh.	94
Evaluation of aestheticity of women's dress models based on deep learning models	

GROWING, STORAGE, PROCESSING AND AGRICULTURAL PRODUCTS AND FOOD TECHNOLOGIES

Zufarov O., Isroilova Sh., Yulchiev A., Serkayev K.	101
Theoretical aspects of obtaining oxidation-stable vegetable oils	
Toshboyeva S., Dadamirzaev M.	110
Filling sauces for canned fish and their layer kinetics	
Atamirzaeva S., Saribaeva D., Kayumova A.	115
Prospects for the use of rose hips in food technology	
Turgunpolatova Sh.	121
Study of the quality of fruit pastela products	
Sultanov S.	126
Analysis of experiments on the process of deodorization of vegetable oil using floating nozzles	
Adashev B.	132
Physical-chemical analysis of oil taken from seeds of safflower	
Ismailov M.	137
Influence of surface layer thickness on hydraulic resistance of the device	
Khurmamatov A., Boyturayev S., Shomansurov F.	142
Detailed analysis of the physicochemical characteristics of distillate fractions	
Madaminova Z., Khamdamov A., Xudayberdiyev A.	154
Preparing peach seed for oil extraction and improving oil extraction through pressing	
Aripova K.	162
Methods of concentration of fruit juices and their analysis	
Djuraev Kh., Urinov Sh.	168
Theoretical and experimental study of the crack formation device in the shell of apricot kernels	

CHEMICAL TECHNOLOGIES

Urinboeva M., Abdikamalova A., Ergashev O., Eshmetov I., Ismadiyarov A.	175
Study of the composition and main characteristics of petroleum oils and their emulsions	
Tursunqulov J., Kutlimurotova N.	182
Application of 1-(2-hydroxy-1-naphthoazo)-2-naphthol-4-sulfo acid in amperometric determination of scandium ion	
Kucharov A.	191

Development of coal enrichment and gas extraction technology for the use of construction materials industrial enterprises	
Abdulkhaev T., Mukhammadjonov M., Mirzarakhimova F.	
Isotherm of benzene adsorption and differential heat of adsorption on AgZSM-5 zeolite	198
Vladimir L., Eshbaeva U., M.Ergashev	
Innovative environmental packaging for separating storage of two components, allowing to extend the lifetime without preservatives	204
Kodirov O., Ergashev O.	
Energetics of adsorption of water molecules to aerosol	212
Yusupov K., Erkabaev F., Ergashev D., Rakhimov U., Numonov M.	
Synthesis of melamine-formaldehyde resins modified with n-butanol	219
Ergashev O., Abdikamalova A., Bakhronov Kh., Askarova D., Xudoyberdiyev N., Mekhmonkhonov M., Xolikov K.	
Thermodynamics of Congo red dye adsorption processes on mineral and carbon adsorbents	228
Ergashev O., Maxmudov I.	
Water vapor adsorption isotherm in zeolites regenerated by microwave thermoxidation method	235
Jumaeva D., Zaripbaev K., Maxmudov F.	
The elements and oxide content of the chemical composition of the feldspar	242
MECHANICS AND ENGINEERING	
Khudoyberdiev U., Izzatillaev J.	
Analysis of research on small wind energy devices	249
Atajonova S.	
Mathematical model of system analysis of technological processes in the form of key principles for effective decision-making	258
Kuchkarbayev R.	
Mathematical modeling of heat transfer through single-layer and multi-layer cylindrical walls in buildings and structures	264
Atambaev D.	
Difference in the length of individual yarn composition of twisted mixed yarn and comparative analysis of single-thread elongation deformations	269
Abdullayev S.	
Modeling the functionalities of an automated system for managing movement in the air	276
Turakulov A.	
Describing computational domains in applications for solving three-dimensional problems of technological processes	285
Mamaxonov A.	

Mathematical model of machine aggregate of tillage equipment process	293
Khudayberdiyev A.	
Technical and economic aspects of processing pyrolysis distillate into motor fuel	304
Abdurahmonov J.	
Research results on the selection of the mesh surface of a lint-cleaning device	311
Vohidov M.	
Development of a program for determining eccentricity by analyzing the magnetic field in the air gap of an asynchronous motor	319
Utaev S., Turaev A.	
Analysis of methods and prospects for application of optical methods for control of working surfaces of cylinder liners of internal combustion engines	327
Boltabayev B.	
Determination of seed damage in the pneumatic transport system by conducting experiments	335
Azizov Sh., Usmanov O.	
Simulation of equation of motion of the new construction gin machine	339
Sharibaev N., Homidov K.	
Theoretical analysis of the coefficient of friction induced by the pressure force of a vertical rope acting from above and below	347
Aliyev B., Shamshidinov M.	
Improvement of the linter machine and development of its working scheme	356
Mukhametshina E.	
Analysis of cotton flow behavior in different pneumatic pipes	362
Yangiboev R., Allakulov B.	
Obtaining and analyzing correlational mathematical models of the sizing process	369
Mirzakarimov M.	
Efficient separation of fibers from saw teeth in the newly designed gin machine	379
Azambayev M.	
Measures to improve the quality of fluff	387
Abdullayev R.	
Scientific innovative development of cotton gining	392
Kholmiraev F.	
Air flow control factors in pneumatic transport device	397
Sharibaev N., Makhmudov A.	
Separation of cotton from airflow in pneumatic transport systems of the cotton industry	404
Sharibaev N., Mirzabaev B.	

Effect of steam temperature on yarn moisture regulation in textile industry	410
Sultanov S., Salomova M., Mamatkulov O.	
Increasing the useful surface of the mesh surface	415
Muhammedova M.	
Kinematics of the foot in a healthy person's foot and ankle injury	421
ADVANCED PEDAGOGICAL TECHNOLOGIES IN EDUCATION	
Abdullayev H.	429
Algorithm for creating structured diagrams of automatic control systems	
Kodirov D., Ikromjonova N.	437
On delayed technological objects and their characteristics	
Uzokov F.	444
Graphing circles, parabolas, and hyperbolas using second-order linear equations in excel	
ECONOMICAL SCIENCES	
Zulfikarova D.	449
Issues of developing women's entrepreneurship	
Ergashev U., Djurabaev O.	455
Methods for assessing the effectiveness of waste recycling business activities in the environmental sector	