

С.Сейфуллин атындағы Қазақ агротехникалық университетінің **Ғылым жаршысы (пәнаралық)** = **Вестник науки** Казахского агротехнического университета им. С.Сейфуллина (**междисциплинарный**). - 2022. - №2 (113). – Ч.1. – Р.238-243

STUDY OF THE OXIDATION KINETICS OF VEGETABLE OILS AT DIFFERENT TEMPERATURES

Lorenzo Guerrini

*PhD, Università di Firenze
Dipartimento di Scienze e Tecnologie
Firenze, Italy
e-mail: Lorenzo.guerini@unifi.it*

Mukhametov Almas Erekyly

*PhD, Kazakh National Agrarian
research university
Almaty, Kazakhstan
e-mail: myhametov_almas@mail.ru*

Kazhymurat Assemay Talgatkyzy

*Master of Technical Sciences,
Kazakh National Agrarian
research university
Almaty, Kazakhstan
e-mail: assemay2006.87@mail.ru*

Annotation

In this paper, oxidation was studied using the example of 4 types of refined vegetable oils: linseed, sunflower, corn and safflower. The kinetics of oxidation of vegetable oils at room temperature was studied. The peroxide value of sunflower, corn and flaxseed oils steadily increased during oil storage compared to safflower oil.

The kinetics of oxidation of vegetable oils (sunflower, corn, olive, safflower, rapeseed and linseed) at different temperatures was also studied. Among the studied samples at 100 °C, for linseed, rapeseed and safflower, the acceleration of the growth of peroxide formation is significantly higher than for olive, corn and sunflower by 2-3 times.

The growth rate of the peroxide value in sunflower, olive and corn oil increased significantly at temperatures above 100°C.

According to the results of the study of the temperature dependence of the oxidation rate of vegetable oils, it is recommended in the production process in order to achieve greater oxidative stability of oils, the temperature regime for linseed and safflower oils should not exceed 60 °C, for sunflower oil - 80 °C. With a further increase in temperature above the identified values, an increase in

the rate of formation of secondary oxidation products is observed, which reduce the taste of the oil, especially linseed and safflower.

Key words: peroxide value; storage of vegetable oils.

Materials and methods

The priority national projects of Kazakhstan include the development of the agro-industrial complex, the basic industry of which is the oil and fat industry, which forms the raw material supply for the food and processing industries, as well as the production of socially significant fatty foods. One of the promising areas of its innovative development is the development of new and improvement of existing technologies for the production and processing of vegetable oils, which make it possible to obtain oils of high nutritional and biological value, which are necessary for the production of high-quality food products [1].

Fatty acids containing omega-3, omega-6 and omega-9 fatty acids are of particular nutritional importance. Omega-3 is recommended for the following diseases: diabetes, cardiovascular disease, vision problems, immune disorders, overweight and underweight, osteoarthritis and rheumatoid arthritis.

Omega-6 is an important fatty acid, the only one that can be converted into other acids and protect the body from their deficiency. Only Omega-6 is the basis for the synthesis of arachidonic acid, which guarantees the correct fat metabolism and the correct synthesis of prostaglandins [2,3].

One of the reasons for the deterioration of vegetable oils is the process of their oxidation during

storage. It leads not only to a decrease in quality, but also to the destruction of pharmacologically valuable components, and in some cases to the formation of toxic compounds [4].

Peroxide value are one of the indicators of the commercial value of oils, since they increase as a result of the oxidation and hydrolytic decomposition of a neutral triglyceride molecule into free fatty acids. By the amount of free fatty acids contained in the oil, one can judge its freshness, because there are few of them in natural fats. During storage and heating of fat, the amount of free fatty acids increases. Their further oxidation leads to the appearance of defects in taste and smell, and with a deeper process - to the unsuitability of the use of fat for food purposes [5].

To reduce the oxidation of oils during production and storage, it is recommended to reduce the temperature, exclude exposure to light and air, remove metals and oxidized compounds, and use appropriate concentrations of antioxidants [6, 7]. It is obvious from the literature how many factors can affect the oxidative stability of oils, and it is often a difficult task to identify the individual contribution of each of them.

The physicochemical properties, stability and nutritional value of oils are related to the fatty acid profile. The major classes of oils and fats include saturated fatty acids, monounsaturated fatty acids, and

polyunsaturated fatty acids, present in varying proportions in different types of oils [8].

In this work, the change in the peroxide value of vegetable oils at

Results

The study of oxidation was carried out at room temperature on the example of 4 types of refined vegetable oils: linseed, sunflower, corn and safflower.

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Experiments on the oxidation of mixtures of vegetable oils were carried out in weighing bottles at room temperature, free access of atmospheric oxygen and the ratio of the surface area of contact with air to the volume of oil 2.5 cm^{-1} , sample weight 6 g. every 2 weeks.

Determination of the peroxide number of vegetable oils according to GOST R 51487-99 GOST R 51487-

Discussion

The study of the kinetics of oxidation of vegetable oils at room temperature is presented in Figure 1.

According to the content of fatty acids, these oils differ and belong to different groups according to the ability to form films when dried. Linseed oil belongs to drying oils that form a smooth and transparent film in air and is

different temperatures was studied to identify the improvement in quality indicators in increasing storage stability.

99 “Vegetable oils and animal fats. Method for measuring peroxide value.

Experiments to study the kinetics of oxidation of some types of oils (refined sunflower, corn, olive and linseed, safflower and rapeseed) and to establish the temperature dependence were carried out as follows: 10 cm^3 samples of oils placed in colorless glass bottles without lids with a volume of 20 cm^3 were oxidized in the dark at temperatures (20 ± 2), 60, 80, 120°C , free access of air oxygen and ratio of contact surface area with air to oil volume 0.45 cm^{-1} .

The samples of refined sunflower, corn, safflower, rapeseed and linseed oils used in the studies were of domestic production. Olive oil is imported. All samples of oils were purchased from the distribution network.

characterized by the shortest shelf life due to high oxidizing ability. Sunflower and corn oils are semi-drying oils and have similar peroxide values during storage at room temperature [9].

Safflower oil is characterized by high oxidation stability when stored for a long time [10,11].

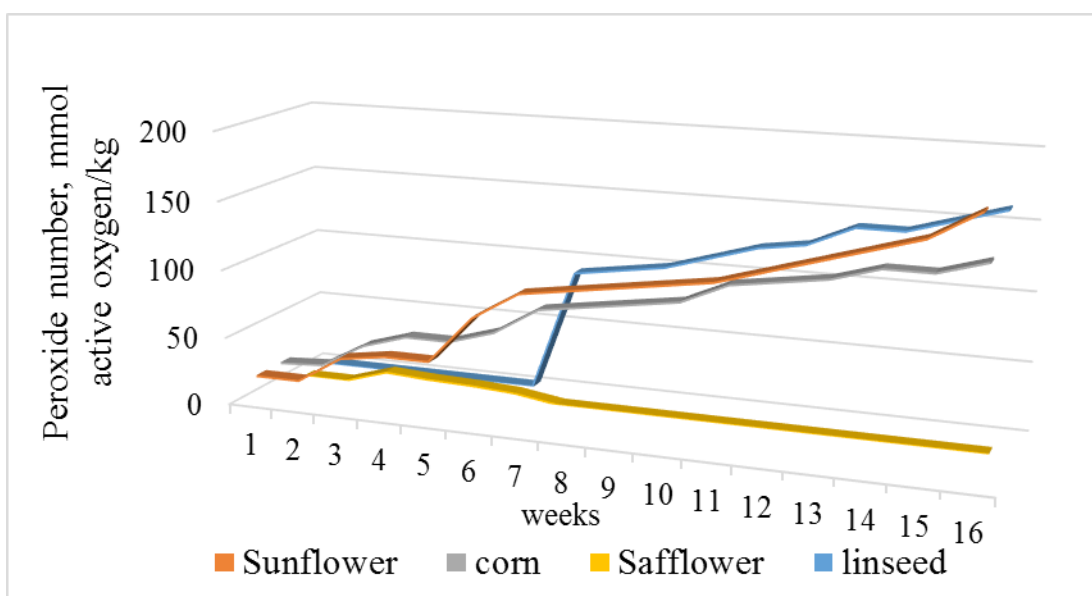


Figure 1 - Change in peroxide value during storage of oils at room temperature

During the experiment at room temperature, the peroxide value of sunflower oil increased from 1 to 112 mol active oxygen / kg (112 times), corn oil - from 2 to 110 mol active oxygen / kg (55 times), linseed oil increased from 5 to 150 mol active oxygen/kg (30 times), safflower - from 5 to 7 mol active oxygen/kg (1.4 times).

The peroxide value of sunflower, corn and flaxseed oils constantly increased during oil storage. Figure 1 shows the change in the peroxide value of linseed oil when stored at room temperature is more intense in comparison with other types of oils. The value of the peroxide number of safflower oil

changed little over the period of the experiment.

The established dependences of the change in the peroxide number for the studied types of oils at room temperature are natural and confirm the influence of the fatty acid composition of oils on their stability to oxidation during storage.

The study of the oxidation kinetics of refined vegetable oils on the example of sunflower, corn, olive, safflower, rapeseed and linseed oils at different storage temperatures is shown in Table 1.

The study of changes in the rate of oxidation of vegetable oils was carried out at temperatures of 60°C, 80°C, 100°C and 120°C.

Table 1 - Change in the value of the peroxide value of vegetable oils at various oxidizing temperatures, mmol of active oxygen / kg

Temperature, °C	Name of the oil					
	sunflower	corn	Olive	safflower	rape seed	Linen
20	1,44	2,88	3,4	6,53	1,79	0,95
60	2,83	1,99	1,12	2,68	1,84	2,09

80	3,36	1,97	2,42	5,23	2,44	2,59
100	3,43	5,5	2,8	9,9	7,26	8,74
120	47,51	31,22	25,47	123,42	79	106,56

Laboratory studies of changes in the peroxide number for various types of vegetable oils at different temperatures have shown that at temperatures above 100 degrees Celsius, the rate of formation of peroxide compounds increases

dramatically. Among the studied samples for linseed, rapeseed and safflower oils, the acceleration of the growth of peroxide formation is significantly higher than for olive, corn and sunflower oils by 2-3 times.

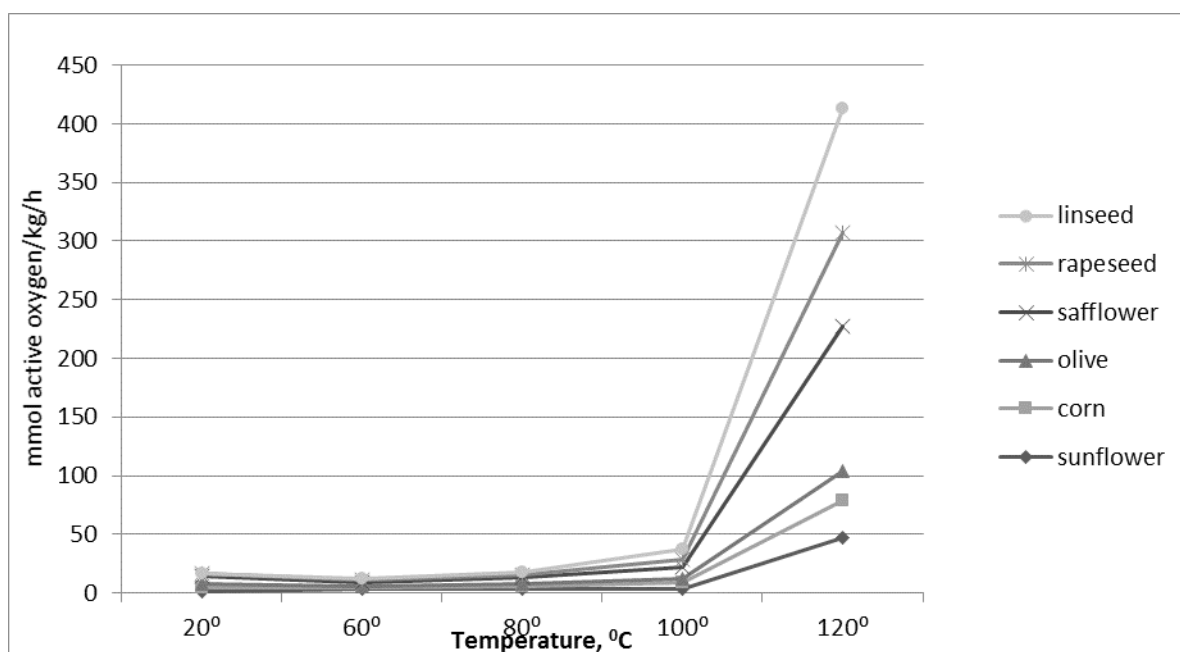


Figure 2 - The rate of change in the peroxide value of vegetable oils at different temperatures, mmol active oxygen/kg/h

The growth rate of the peroxide value in sunflower, olive and corn oil increased significantly at temperatures above 100°C - 9.1 times for sunflower and 13.9 times for olive oil. The sharp increase in the peroxide value for safflower oil by 12.5 times, rapeseed oil by 10.9 times and linseed oil by 12.2 times can be explained by their ability to dry out for linseed and safflower oils.

In further studies, to create vegetable oil compositions, domestic refined vegetable oils will be selected as components - sunflower oil, which has greater oxidative stability, as well as flaxseed oil as a source of Omega-3 fatty acids and safflower oil, which is characterized by high oxidation stability during storage.

Conclusions

According to the results of studying the temperature dependence of the oxidation rate of vegetable oils,

it is recommended in the production process, for example, during pressing, deodorization and other processing

processes, in order to achieve greater stability of oils, the temperature regime for linseed and safflower oils should not exceed 60 ° C, for sunflower oil more than 80 ° C. With a further increase in temperature above the identified values, an increase in the rate of formation of secondary oxidation products is

observed, which reduce the taste of the oil, especially linseed and safflower.

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ӨСІМДІЛІК МАЙЛАРЫНЫҢ ӘР ТҮРЛІ ТЕМПЕРАТУРАДАҒЫ ТОТЫҒУ КИНЕТИКАСЫН ЗЕРТТЕУ

Лоренцо Геррини

PhD, Firenze университеті

Ғылыми және технологиялар бөлімі

Фаренце, Италия

e-mail: Lorenzo.guerini@unifi.it

Мухаметов Алмас Ерекұлы

PhD, Қазақ ұлттық аграрлық

зерттеу университеті

Алматы қ, Қазақстан

e-mail: myhametov_almas@mail.ru

Қажымұрат Асемай Талғатқызы

Техника ғылымдарының магистрі,

Қазақ ұлттық аграрлық

зерттеу университеті

Алматы қ, Қазақстан

e-mail: assemay2006.87@mail.ru

Түйін

Бұл жұмыста тазартылған өсімдік майларының 4 түрі мысалында тотығу зерттелді: зығыр, күнбағыс, жүгері және мақсары. Өсімдік майларының бөлме температурасында тотығу кинетикасы зерттелді. Майды сақтау кезінде күнбағыс, жүгері және зығыр майларының асқын тотығы мақсары майымен салыстырғанда тұрақты өсті.

Өсімдік майларының (күнбағыс, жүгері, зәйтүн, мақсары, рапс және зығыр) әртүрлі температурада тотығу кинетикасы да зерттелді. Зерттелетін сынамалардың ішінде 100 °С температурада зығыр, рапс және мақсары үшін зәйтүн, жүгері және күнбағысқа қарағанда 2-3 есе асқын тотық түзілуінің өсу жеделдеуі айтарлықтай жоғары болды.

Күнбағыс, зәйтүн және жүгері майындағы пероксид мөлшерінің өсу қарқыны 100°С жоғары температурада айтарлықтай өсті.

Өсімдік майларының тотығу жылдамдығының температураға тәуелділігін зерттеу нәтижелері бойынша майлардың тотығу тұрақтылығына жоғарырақ жету үшін өндіріс процесінде ұсынылады, зығыр және мақсары майларының температуралық режимі 60°С аспауы керек. , күнбағыс майы үшін - 80 ° С. Анықталған мәндерден жоғары температураның одан әрі жоғарылауымен майдың, әсіресе зығыр және мақсары дәнінің дәмін төмендететін қайталама тотығу өнімдерінің түзілу жылдамдығының жоғарылауы байқалады.

Кілт сөздер: пероксидтің мәні; өсімдік майларын сақтау.

ИССЛЕДОВАНИЕ КИНЕТИКИ ОКИСЛЕНИЯ РОСТА МАСЕЛ ПРИ РАЗЛИЧНЫХ ТЕМПЕРАТУРАХ

*Лоренцо Геррини,
PhD, Университет Флоренции
Департамент науки и технологий
г. Флоренция, Италия
e-mail: Lorenzo.guerini@unifi.it*

*Мухаметов Алмас Ерекүлы
PhD, Казахский национальный аграрный
исследовательский университет
г. Алматы, Казахстан
e-mail: myhametov_almas@mail.ru*

*Кажымурат Асемай Талгаткызы
Магистр технических наук,
Казахский национальный аграрный
исследовательский университет
г. Алматы, Казахстан
e-mail: assemay2006.87@mail.ru*

Аннотация

В работе исследовано окисление на примере 4-х видов рафинированных растительных масел: льняном, подсолнечном, кукурузном и сафлоровом. Была исследована кинетика окисления растительных масел при комнатной температуре. Перекисное число подсолнечного, кукурузного и льняного масла постоянно увеличивалось в процессе хранения масла по сравнению с сафлоровым маслом.

Также была исследована кинетика окисления растительных масел (подсолнечного, кукурузного, оливкового, сафлорового, рапсового и льняного) при различной температуре. Среди исследуемых образцов при 100 °С выше для льняного, рапсового и сафлорового ускорение роста образования перекисей значительно выше, чем для оливкового, кукурузного и подсолнечного в 2-3 раза.

Скорость роста показателя перекисного числа в подсолнечном, оливковом и кукурузном масле значительно увеличивалась при температурах более 100°С.

По результатам исследования температурной зависимости скорости окисления растительных масел рекомендуется в производственном процессе в целях достижения большей окислительной стабильности масел температурный режим для льняного и сафлорового масла не должен превышать 60°С, для подсолнечного – 80°С. При дальнейшем повышении температуры более выявленных значений наблюдается увеличение скорости

образования вторичных продуктов окисления, которые снижают вкусовые достоинства масла, особенно льняного и сафлорового.

Ключевые слова: перекисное число, хранение растительных масел