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VEGETABLE OILS – RAW MATERIALS FOR PRODUCING BIODIESEL

This paper presents the results of a study of the physical and chemical properties of samples of vegetable oils (sunflower, rapeseed, olive), and also shows the possibility of obtaining biodiesel fuels on their basis.

Keywords: biodiesel fuel, vegetable oils, sunflower oil, rapeseed oil, olive oil, IR spectrum, iodine value.

Introduction

Currently the global energy policy is based on two fundamental principles – economic rationality and sustainability, the main goal of which is to significantly reduce greenhouse gas emissions, enhance the diversification of initial energy sources, economical and efficient use of resources.

Transport is in the highest demand for energy, accounting for over 40 % of the total energy volume. Therefore, there is a need to minimize the use of fossil fuel resources and pay attention to renewable resources such as waste oil to produce cheaper and biodegradable fuels [1].

Biodiesel is a clean, renewable and degradable fuel that has the ability to reduce the greenhouse effect and acid rain with low emissions of carbon monoxide, unburned hydrocarbons, polycyclic aromatic hydrocarbons and particulate matter [2]. It is known that this fuel can be produced as a result of the transformation of green plants by esterification [3] or transesterification reactions with edible and non-edible oils [4].

In this work, the possibility of producing biodiesel using sunflower, rapeseed and olive oils as raw materials is considered, and the study of their physical and chemical composition and characteristics is the purpose of this work.

Materials and methods

For the study, 3 samples of oils were selected: sunflower seeds, rapeseed and olive oil.

Determination of the density of oil samples was carried out using a hydrometer in accordance with GOST 3900. The essence of the method is to immerse the hydrometer in vegetable oil and take readings on the hydrometer scale.

Studies of the viscosity of oils were carried out in accordance with GOST 33-2000 (ISO 3104-94), the purpose of which is to measure with a calibrated glass viscometer the expiration time, in seconds, of a certain volume of the test liquid under the influence of gravity at a constant temperature. The kinematic viscosity is the product of the measured flow time and the constant viscometer.

To determine the acid number of test samples vegetable oils performed according to GOST P 52110-2003 «Vegetable oils. Methods for determining the acid number».

The infrared spectra of the products of the radiation-chemical modification were recorded at a temperature of 20 °C on an FTIR-8400S device from Shimadzu.

Results and discussion

The main characteristics of vegetable oil samples are presented in table 1.

Table 1 – Characteristics of raw materials

Description of characteristics	sunflower oil	olive oil	rapeseed oil
Density, kg / m^3	921	918	915
Viscosity, cSt at 40 °C	61,7	41,4	49,1
Acid number, mg KOH /g	0,44	0,57	0,48
Pour point, °C	-16	-3	-12

It is known that one of the important signs of the quality of sunflower oil is the acid number, which serves as an indicator of the content of free fatty acids in it and their accumulation. For the test samples of oil value of the acid number from 0.44 to 0,57 was observed, which classifies it as high-class.

The process of producing biodiesel based on vegetable oils can be considered as a reaction of their transesterification with methanol / ethanol with the formation of a mixture of esters of higher aliphatic acids. In this regard, of particular interest is the contents of faty acids in the original samples of vegetable oils, for determining which was drawn by IR spectroscopy.

Experimental IR spectra of oil samples are shown in Figures 1–3.

The IR spectrum of vegetable oil samples (Figure1–3), which differs in its raw material in the region of 700–3000 cm^{-1}, contains absorption bands at 2850–2900 cm^{-1}, characteristic of deformation vibrations of C-H bonds of methyl and methylene groups. The absorption bands in the range of 1460–1370 cm^{-1} are due to CH_2 and CH_3 groups of both long paraffin chains and alkyl substituents in the rings.

Intense absorption bands in the region 1000–1300 cm^{-1} characterize the presence of unbranched paraffin chains in hydrocarbons. The presence of a peak of rather high intensity in the region of 700 cm^{-1}, which is an analytical band of vegetable oil, is noted [5].

The presence of vibrations of carboxylic acid groups in the studied oils is associated with absorption bands caused by stretching vibrations of C – O bonds (frequency 1750 cm^{-1}) with bending vibrations of OH groups (frequencies 2950–2800 cm^{-1}), which indicates a high content of oils of fatty carboxylic acids.

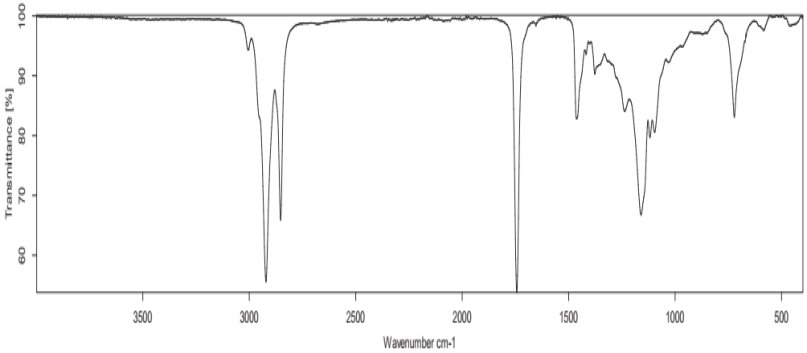

Figure 1 – IR - spectra of a sample of sunflower oil

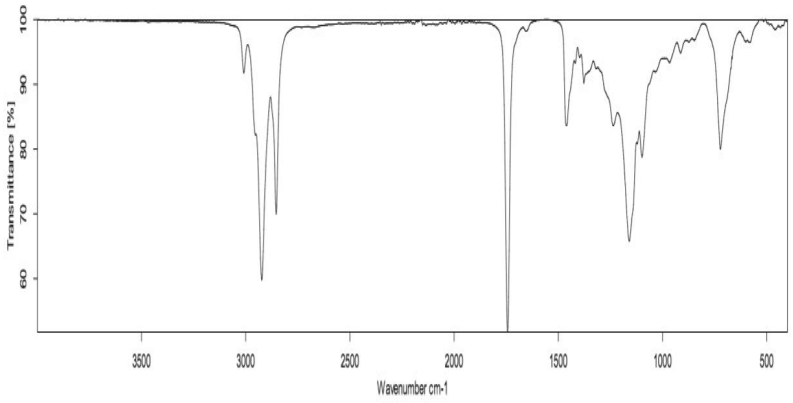

Figure 2 – IR - spectra of a sample of olive oil

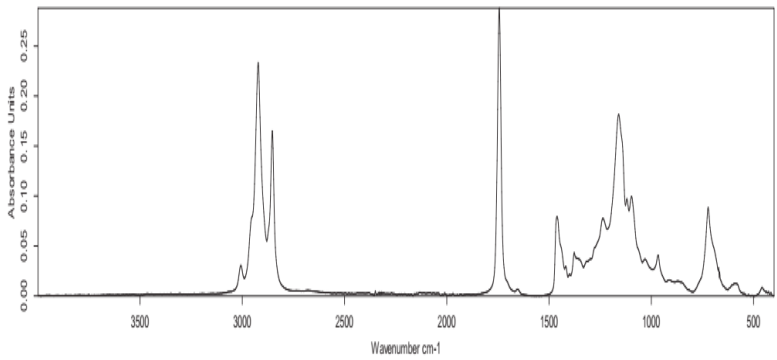

Figure 3 – IR – spectra of a sample of rapeseed oil

In the paper [6] in an analytical bands in the IR spectra is proposed to use oil absorption band at 900 cm^{-1}, which is formed by the stretching vibration of C-C bonds between carbon CH_2 – groups and carbon atoms belonging to the unsaturated bonds. It is known that the spectral composition of vegetable oils is determined by the presence of lipid molecules containing fatty acids. In this connection, they are in second analytical absorption band range can be considered 3000 cm^{-1}, characteristic stretching vibrations of CH-unsaturated fatty acid portions of chains. A change in the degree of unsaturation of these chains is naturally reflected in the intensity of these bands, which makes it possible to use them to estimate the relative content of unsaturated acids in vegetable oils.

The results of evaluating the refractive index (nD) and iodine number (ID), which summarize the unsaturation of fatty acids and fat-soluble compounds in the oil are presented in the graph (Figure 4).

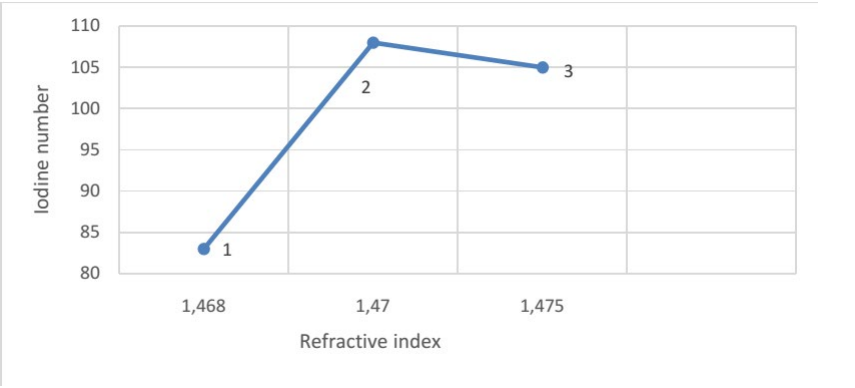

Figure 4 – Results of refractometric analysis of an experimental series of vegetable oils: 1 – olive oil; 2 – sunflower oil, 3 – rapeseed oil

The observed noticeable differences in the ratio of the refractive index and iodine number of vegetable oil samples demonstrate rather high refractive indices and iodine numbers for sunflower and rapeseed oils, which makes it possible to adequately assess the increase in the content of C = C bonds in the composition of triglyceride fatty acids with an increase in their unsaturation.

Conclusions

Thus, the chemical composition, physical and physicochemical indicators of the original and used sunflower vegetable oil have been investigated and high prospects have been revealed for their use with affordable and cheap raw materials for the production of fatty esters and alcohols. It is known in Kazakhstan the greatest demand is for sunflower and rapeseed oil, while in the world - palm and soybean, which implies the development of the topic of obtaining biodiesel directly from palm and soybean oils. Based on the results obtained, the article reveals that sunflower and rapeseed oils are not inferior to the rest in terms of their physical and chemical characteristics and composition, and they can be used as raw materials for the production of biodiesel fuel.

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Өсімдік майлары – биодизель өндіруг е арналған шикізат

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Растительные масла – сырье для получения биодизеля

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Бұл жұмыста өсімдік майы үлгілерінің (күнбағыс, рапс, зәйтүн) физика-химиялық қасиеттерін зерттеу нәтижелері келтірілген, сонымен қатар олардың негізінде биодизель отынын алу мүмкіндігі көрсетілген.

Кілтті сөздер: биодизель, өсімдік майлары, күнбағыс майы, рапс майы, зәйтүн майы, ИҚ- спектрі, йод саны.

В данной работе представлены результаты исследования физико-химических свойств образцов растительных масел (подсолнечное, рапсовое, оливковое), а также показана возможность получения биодизельных топлив на их основе.

Ключевые слова: биодизельное топливо, растительные масла, подсолнечное масло, рапсовое масло, оливковое масло, ИК- спектр, йодное число.

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