**Experimental Justification for Obtaining Oil from Fruits of Sea Buckthorn (Hippophae Rhamnoides L.) Zarafshan River Basin**

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**Abstract.** The optimal method for obtaining oil based on the extraction process using low-boiling non-polar solvents is substantiated. The chromatographic method was used to establish the authenticity of the isolated oil. The chromatographic analysis of methyl esters of fatty acids that we conducted showed that the main fatty acid components are oleic, linoleic and alpha-linoleic acids. The use of the chromatographic method made it possible to identify the vast majority of sea buckthorn oil components. The dynamics of the process of distilling oil from sea buckthorn cake using the fractional distillation method was studied. The data obtained indicate that a sufficiently complete isolation of sea buckthorn oil from cake under normal conditions (at atmospheric pressure and the absence of catalysts) takes 12 hours.

**Keywords:** Sea buckthorn (*Hippophae rhamnoides* L.), medicinal and prophylactic properties, fruit and seed oils, existing technology.

**INTRODUCTION**

Expanding the range of fruit and berry crops and introducing new, promising representatives of wild nature into human economic activity will help solve many of the problems associated with the prevention of human diseases.

Identification of wild plant species that can potentially be used to obtain essential nutrients and thus expand the range of fruit and berry plants is a pressing issue in production.

In Uzbekistan, scientific and production activities on the introduction of wild fruit plants into culture are still not carried out with sufficient efficiency.

Sea buckthorn (*Hippophae rhamnoides* L.) has found a fairly wide distribution in Uzbekistan. One of the most important areas of distribution of sea buckthorn in Uzbekistan is the area of the middle reaches of the Zarafshan River within the Samarkand region. Currently, the valley of the Zarafshan River is considered the largest area of natural growth of sea buckthorn in Uzbekistan.

Sea buckthorn is a multivitamin plant rich in biologically active substances. The results of many studies [1-4] have shown that the fruits contain carotenoids, flavonoids, coumarins, sterols, sugars, acids, leucoanthocyanoids, triterpenoids, various vitamins and etc. The substance that makes sea buckthorn very valuable is also carotenoids. Of particular importance in sea buckthorn fruits is fatty oil. It is contained in the pulp of the fruit and seeds. The most valuable is considered to be the oil of the fruit pulp, which is a natural concentrate of vitamins.

The uniqueness of sea buckthorn is that almost all its parts have medicinal and prophylactic properties. A whole range of unsaturated fatty acids and other active substances with antioxidant and anticancer properties were found in sea buckthorn leaves, these are substances such as: triterpene acids (ursolic, oleic), vitamins B1, B2, B6, C, PP, coumarin, inositol, folic acid, flavonoid compounds and this is not a complete list. And sea buckthorn bark contains such an interesting substance as serotonin, which is an important neurotransmitter in plants and animals.

The most important trend in solving the issue of complex waste-free processing in relation to sea buckthorn, a valuable multivitamin, medicinal and food plant, is the production of juices, fruit and seed oils, and vitamin preparations. The most valuable product of sea buckthorn processing is sea buckthorn oil, which is obtained in various ways.

According to the existing technology, sea buckthorn juice is squeezed out of the fruits of sea buckthorn in presses, and fatty oil is extracted from the pomace, using sunflower oil as a solvent. The yield of juice obtained by this technology is low, and the sea buckthorn oil is diluted with a significant amount of sunflower oil.

The aim of the work is to substantiate the possibility of complex and waste-free processing of sea buckthorn with maximum extraction of biologically active substances. To solve this problem, sea buckthorn fruits were used as objects of research.

**METHODS**

The fruits of sea buckthorn (Hippophae) were used as objects of study (rhamnoides L) Zarafshan River basin. Sea buckthorn raw material was the press cake of sea buckthorn fruits.

Definitions and identification of the components of the objects were carried out by preliminary methylation of fatty acids of sea buckthorn oil.

The oil was tested according to GOST 31663-2012, and the production of methyl esters of fatty acids was carried out according to GOST 31665-2012.

Gas Chromatograph (GC) Scion 456 – GC.

Chromatographic capillary column with a length of 100 m and an internal diameter of 0,25 mm.

**Quantitative determination of carotenoids.** About 0,05 g (exactly weighed) of the preparation was placed in a 50 ml measuring flask, 20-30 ml of hexane was added, mixed, then the volume of the solution was brought up to the mark with the same solvent and mixed again (test solution).

We used a spectrophotometer to evaluate the optical density of the test solution at a wavelength of 450 nm in a cuvette that was 10 mm thick compared to the comparison solution. Hexane is the solution used for comparison.

The content of the sum of carotenoids in terms of β-carotene in 100 g of the preparation (X) was calculated using the formula:

,

where:

A - optical density of the test solution;

a - weight of the preparation, g;

– specific absorption index β of carotene in hexane at a wavelength of 450 nm, equal to 2592;

10 - content of βcarotene in 1 ml of 1% solution, mg.

To determine the most optimal method of obtaining oil, i.e., oil with the highest yield of biologically active substances, we used the following methods:

**Press method.** Oil was extracted from dry pulp, which was obtained after extracting juice using a drift juicer in laboratory conditions. The pulp separated from the juice was subjected to pressing.

**Diffusion method.** Initially, the sea buckthorn fruit pulp was dried after the juice was extracted, followed by diffusion extraction of oil from the dry pulp with vegetable oil. Sunflower oil was used as vegetable oil.

**Extraction method.** The extraction method was used to extract valuable substances from plant materials. Petroleum ether and n- hexa were used as extractants, which were then distilled. Extraction was carried out in a Soxhlet apparatus for 12 hours. Dry cake dried at a temperature of 600C was extracted.

Somochemical extraction method in order to intensify the process of isolating biologically significant substances, the somochemical extraction method was used.

Leaves of sea buckthorn were taken as the object of the study. buckthorn (Hippophae rhamnoides L.) in the Zarafshan River basin. Sea buckthorn fruit pulp, sea buckthorn leaves and their mixture are used as sea buckthorn raw materials.

**results and discussion**

Initially, an organoleptic analysis of fresh sea buckthorn fruits was carried out, which are oval-shaped fruits of yellow-orange color, with a sour taste and a characteristic pleasant smell, reminiscent of pineapple. The fruits were analyzed for moisture, oil content in terms of dry matter and taking into account the total moisture. The moisture content of whole fruits was 78,2 % of the mass with an oil content of 19,4 % in terms of dry matter. The chemical composition of the fruits is presented in Table 1.

**Table 1.** Chemical composition of sea buckthorn *Hippophae rhamnoides* L.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sample name** | **Squirrels** | **Fats, %** | **Carbohydrates, %** | **Tannins, %** | **Vitamin C, mg %** |
| *Hippophae rhamnoides* L. | traces | 7,9 | 6,8 | 2,3 | 132,2 ± 0,1 |

The quantitative and qualitative composition of sea buckthorn pulp oil is inconsistent and depends on the physiological and genetic characteristics of the sea buckthorn variety, the agroclimatic conditions of its cultivation, and the anatomical localization in the fruit [5-6]. This significantly complicates the production of sea buckthorn oil with a stable composition.

Sea buckthorn oil was obtained by several methods, including pressing, extraction with chemical solvents, diffusion and somochemical [7-10]. Table 2 shows the technological yield of oil depending on the methods of obtaining.

**Table 2.** Technological yield of oil depending on the methods of production.

|  |  |  |
| --- | --- | --- |
| **Methods of oil extraction** | **Exit, %** | **Literary data** |
| Extraction of sea buckthorn fruit pulp with petroleum ether | 12 | 10–15 |
| Extraction of sea buckthorn fruit pulp with n- hexane | 23 | - |
| Extraction of sea buckthorn fruit pulp with sunflower oil | 9 | 5–10 |
| Pressing at 200C | 8,5 | - |
| Somochemicalextraction method | 7,2 | - |

The highest oil yield was obtained with using the extraction method.

The analysis of the isolated sea buckthorn oil was carried out using standard organoleptic and physicochemical methods. In accordance with the requirements adopted for assessing their quality, the following indicators were determined during the study of the oil: appearance, color, smell, density, refractive index, acidity, saponification number, iodine number.

The studied samples, regardless of the method of production, are an oily liquid of orange-red color with a characteristic odor; practically insoluble in water, easily soluble in chloroform.

**Density.** From0.915 to 0.998 g/sm3.

**Refractive index.** From 1,464 to 1,639.

**Acid number.** Not more than 6,9.

**Saponification number**. From 115 to 248, mg/g

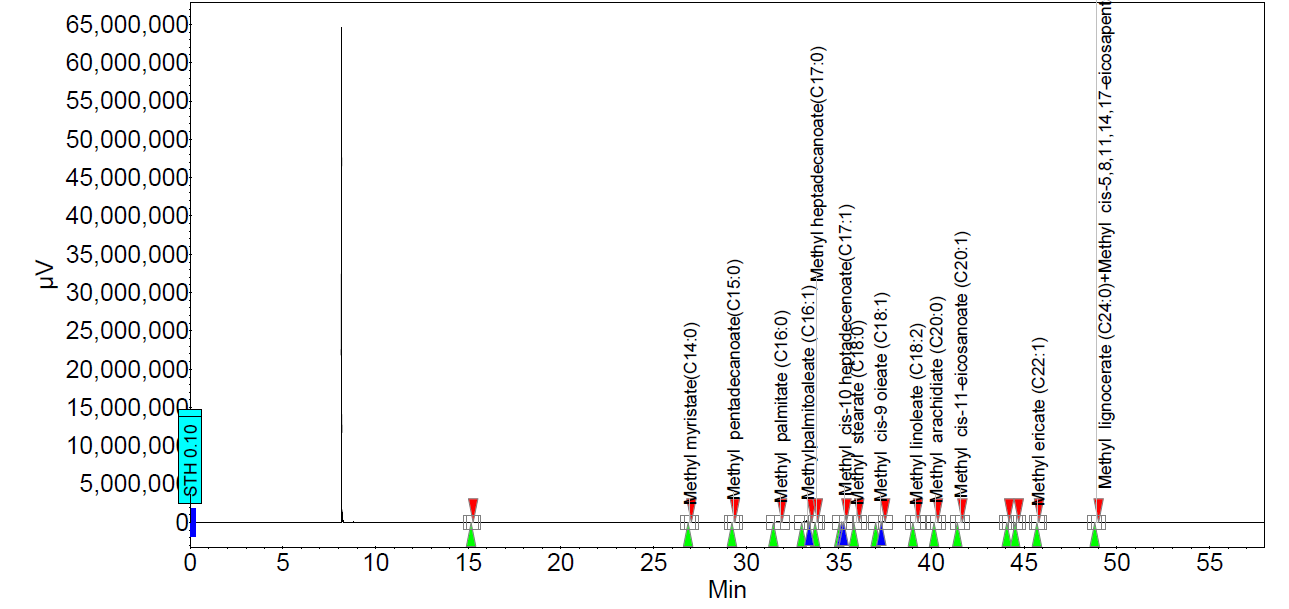
**Iodine number**. Not less than 30, mg/g. The results obtained are presented in Table 3.

**Table 3.** Physicochemical properties of oil

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Methods of oil extraction** | **Density,  g /sm3** | **Saponification number, mg/g** | **Ester value, mg/g** | **Iodine number, mg/g** | **Indicator Refractions** | **Acid number, ml/g** |
| Extraction of sea buckthorn fruit pulp with petroleum ether | 0,919 | 245 | 241 | 33 | 1,464 | 3,6 |
| Extraction of sea buckthorn fruit pulp with n- hexane | 0,920 | 248 | 246 | 34 | 1,467 | 4,2 |
| Extraction of sea buckthorn fruit pulp with sunflower oil | 0,976 | 88 | 84 | 53 | 1,639 | 6,9 |
| Pressing at 200C | 0,998 | 115 | 113 | 71 | 1,472 | 2,4 |

Thus, all samples of isolated sea buckthorn oil have the characteristics typical of this product.

To establish the authenticity of the extracted oils, a chromatographic method was used. The resulting chromatograms allowed us to obtain information about the composition of the oils and the distribution of all components of the essential oil (Figure 1, Table 4).

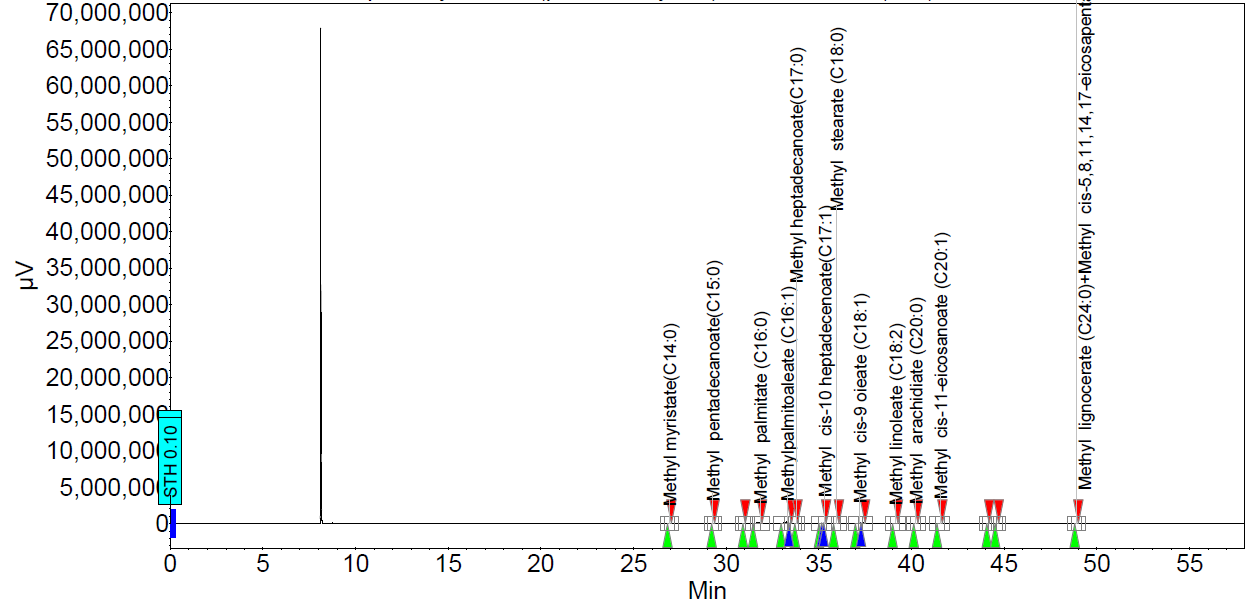


**FIGURE 1.** Chromatogram of methylated fatty acids of sea buckthorn oil during extraction with hexane.

**TABLE 4.** Content of the main methylated acids of sea buckthorn oil during extraction with hexane.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Index** | **Name** | **Time, min** | **Quantity, %** | **Height, μV** | **Area, μV/min** | **Area,**  **%** |
| 0 | Methyl butyrate (C4:0) | 9,26 | - | - | - | - |
| 0 | Methyl hexanoate (C6:0) | 10,76 | - | - | - | - |
| 0 | Methyl octanoate (C8:0) | 13,48 | - | - | - | - |
| 1 | Unknown | 15,20 | 0,03 | 473,8 | 27,3 | 0,028 |
| 0 | Methyl decanoate (C10:0) | 17,50 | - | - | - | - |
| 0 | Methyl undecanoate (C11:0) | 19,84 | - | - | - | - |
| 0 | Methyl laurate (C12:0) | 22,26 | - | - | - | - |
| 0 | Methyl tridecanoate (C13:0) | 24,70 | - | - | - | - |
| 2 | Methyl myristate (C14:0) | 26,96 | 0,54 | 8485,3 | 523,4 | 0,540 |
| 0 | Methyl myristoleate (C14:1) | 29,01 | - | - | - | - |
| 3 | Methyl pentadecanoate (C15:0) | 29,30 | 0,06 | 805,8 | 53,6 | 0,055 |
| 0 | Methyl cis-10 pentadeconate (C15:1) | 31,31 | - | - | - | - |
| 4 | Methyl palmitate (C16:0) | 31,86 | 35,70 | 181296,5 | 34569,7 | 35,699 |
| 5 | Methylpalmitoaleate (C16:1) | 33,30 | 38,29 | 272287,1 | 37076,0 | 38,287 |
| 6 | Unknown | 33,45 | 0,17 | 3049,6 | 160,1 | 0,165 |
| 7 | Methyl heptadecanoate (C17:0) | 33,78 | 0,05 | 697,0 | 45,7 | 0,047 |
| 8 | Unknown | 35,10 | 0,07 | 1057,4 | 66,7 | 0,069 |
| 9 | Unknown | 35,20 | 0,04 | 600,3 | 36,6 | 0,038 |
| 10 | Methyl cis-10 heptadecanoate (C17:1) | 35,33 | 0,05 | 807,9 | 51,2 | 0,053 |
| 11 | Methyl stearate (C18:0) | 35,98 | 0,85 | 8452,3 | 826,4 | 0,853 |
| 0 | Methyl trans-9 eladiate (C18:1) | 35,90 | - | - | - | - |
| 12 | Methyl cis-9 oleate (C18:1) | 37,23 | 11,61 | 91375,8 | 11237,9 | 11,605 |
| 13 | Unknown | 37,40 | 5,65 | 69737,9 | 5468,6 | 5,647 |
| 0 | Methyl linolelaidate (C18:2) | 38,37 | - | - | - | - |
| 14 | Methyl linoleate (C18:2) | 39,15 | 3,65 | 44849,5 | 3530,6 | 3,646 |
| 15 | Methyl arachidiate (C20:0) | 40,24 | 0,33 | 4305,9 | 315,8 | 0,326 |
| 0 | Methyl-gamma-linoleanate (C18:3) | 40,91 | - | - | - | - |
| 16 | Methyl cis-11-eicosanoate (C20:1) | 41,58 | 2,61 | 33405,7 | 2525,6 | 2,608 |
| 0 | Methyl linoleate (C18:3) | 41,77 | - | - | - | - |
| 0 | Methyl heneicosanoate (C21:0) | 42,68 | - | - | - | - |
| 0 | Methyl cis-11,14-eicosanoate (C20:2) | 43,70 | - | - | - | - |
| 17 | Unknown | 44,12 | 0,03 | 496,5 | 31,5 | 0,033 |
| 18 | Unknown | 44,61 | 0,14 | 1922,7 | 136,4 | 0,141 |
| 0 | Methyl behenate (C22:0) | 44,87 | - | - | - |  |
| **Index** | **Name** | **Time, min** | **Quantity, %** | **Height, μV** | **Area, μV/min** | **Area,**  **%** |
| 0 | Methyl cis-8,11,14-eicosatrienoate (C20:3) | 45,16 | - | - | - |  |
| 19 | Methyl ericate (C22:1) | 45,74 | 0,02 | 353,0 | 21,3 | 0,022 |
| 0 | Methyl cis-11,14,17-eicosatrienoate (C20:3) | 46,28 | - | - | - | - |
| 0 | Methyl tricosanoate (C23:0) | 46,94 | - | - | - | - |
| 0 | Methyl cis-5,8,11,14-eicosatetraenoate (C20:4) | 47,87 | - | - | - | - |
| 0 | Methyl cis-13,16-docosatetraenoate (C22:2) | 48,80 | - | - | - | - |
| 20 | Methyl lignocerate (C24:0) +  Methyl cis-5,8,11,14,17-eicosapentaenoate (C20:5) | 48,92 | 0,14 | 1607,5 | 132,0 | 0,136 |
| 0 | Methyl nervonate (C24:1) | 50,46 | - | - | - | - |
| 0 | Methyl cis-4,7,10,13,16,19-docosahexaenoate (C22:6) | 55,59 | - | - | - | - |
|  | **Total:** |  | **100,00** | **726067,4** | **96836,2** | **100,00** |

Figure 2 and Table 5 shows the chromatogram and the content of the main methylated acids of sea buckthorn oil during extraction with petroleum ether.

 **FIGURE 2.** The chromatogram and the content of the main methylated acids of sea buckthorn oil during extraction with petroleum ether.

**TABLE 5.** Content of the main methylated acids of sea buckthorn oil during extraction with petroleum ether.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Index | Name | Time, min | Quantity, % | Height, μV | Area, μV/min | Area, % |
| 0 | Methyl butyrate (C4:0) | 9,26 | - | - | - | - |
| 0 | Methyl hexanoate (C6:0) | 10,76 | - | - | - | - |
| 0 | Methyl octanoate (C8:0) | 13,48 | - | - | - | - |
| 0 | Methyl decanoate (C10:0) | 17,50 | - | - | - | - |
| 0 | Methyl undecanoate (C11:0) | 19,84 | - | - | - | - |
| 0 | Methyl laurate (C12:0) | 22,26 | - | - | - | - |
| 0 | Methyl tridecanoate (C13:0) | 24,70 | - | - | - | - |
| 1 | Methyl myristate (C14:0) | 26,94 | 0,54 | 8472,9 | 536,7 | 0,538 |
| 0 | Methyl myristoleate (C14:1) | 29,01 | - | - | - | - |
| 2 | Methyl pentadecanoate (C15:0) | 29,29 | 0,06 | 791,5 | 57,5 | 0,058 |
| 3 | Unknown | 30,97 | 0,03 | 570,5 | 33,7 | 0,034 |
| 0 | Methyl cis-10 pentadeconate (C15:1) | 31,31 | - | - | - | - |
| 4 | Methyl palmitate (C16:0) | 31,84 | 34,95 | 186359,7 | 34860,8 | 34,948 |
| Index | Name | Time, min | Quantity, % | Height, μV | Area, μV/min | Area, % |
| 5 | Methylpalmitoaleate (C16:1) | 33,28 | 37,47 | 273870,1 | 37374,5 | 37,468 |
| 6 | Unknown | 33,44 | 0,17 | 3165,3 | 170,1 | 0,171 |
| 7 | Methyl heptadecanoate (C17:0) | 33,77 | 0,04 | 646,6 | 44,4 | 0,044 |
| 8 | Unknown | 35,09 | 0,07 | 1074,4 | 69,0 | 0,069 |
| 9 | Unknown | 35,20 | 0,04 | 649,1 | 39,7 | 0,040 |
| 10 | Methyl cis-10 heptadecanoate (C17:1) | 35,32 | 0,05 | 798,3 | 52,1 | 0,052 |
| 11 | Methyl stearate (C18:0) | 35,96 | 0,89 | 8642,4 | 884,5 | 0,887 |
| 0 | Methyl trans-9 eladiate (C18:1) | 36,90 | - | - | - | - |
| 12 | Methyl cis-9 oleate (C18:1) | 37,22 | 11,70 | 92625,7 | 11667,5 | 11,697 |
| 13 | Unknown | 37,39 | 5,53 | 69796,8 | 5620,1 | 5,534 |
| 0 | Methyl linolelaidate (C18:2) | 38,37 | - | - | - | - |
| 14 | Methyl linoleate (C18:2) | 39,15 | 4,58 | 55787,8 | 4566,3 | 4,578 |
| 15 | Methyl arachidiate (C20:0) | 40,23 | 0,32 | 4395,9 | 323,5 | 0,324 |
| 0 | Methyl-gamma-linoleanate (C18:3) | 40,91 | - | - | - | - |
| 16 | Methyl cis-11-eicosanoate (C20:1) | 41,57 | 3,26 | 42245,7 | 3251,6 | 3,260 |
| 0 | Methyl linoleate (C18:3) | 41,77 | - | - | - | - |
| 0 | Methyl heneicosanoate (C21:0) | 42,68 | - | - | - | - |
| 0 | Methyl cis-11,14-eicosanoate (C20:2) | 43,70 | - | - | - | - |
| 17 | Unknown | 44,12 | 0,03 | 464,2 | 29,3 | 0,029 |
| 18 | Unknown | 44,60 | 0,14 | 1958,5 | 141,1 | 0,141 |
| 0 | Methyl behenate (C22:0) | 44,87 | - | - | - | - |
| 0 | Methyl cis-8,11,14-eicosatrienoate (C20:3) | 45,16 | - | - | - | - |
| 0 | Methyl ericate (C22:1) | 45,97 | - | - | - | - |
| 0 | Methyl cis-11,14,17-eicosatrienoate (C20:3) | 46,28 | - | - | - | - |
| 0 | Methyl tricosanoate (C23:0) | 46,94 | - | - | - | - |
| 0 | Methyl cis-5,8,11,14-eicosatetraenoate (C20:4) | 47,87 | - | - | - | - |
| 0 | Methyl cis-13,16-docosadienoate (C22:2) | 48,80 | - | - | - | - |
| 19 | Methyl lignocerate (C24:0) + Methyl cis-5,8,11,14,17-eicosapentaenoate (C20:5) | 48,90 | 0,13 | 1562,2 | 126,7 | 0,127 |
| 0 | Methyl nervonate (C24:1) | 50,46 | - | - | - | - |
| 0 | Methyl cis-4,7,10,13,16,19-docosahexaenoate (C22:6) | 55,59 | - | - | - | - |
|  |  |  |  |  |  |  |
|  | **Total:** |  | **100,00** | **753877,6** | **99749,2** | **100,00** |

Our chromatographic analysis of fatty acid methyl esters showed that the main. The fatty acid components are oleic, linoleic and alpha -linoleic acids. The use of the chromatographic method made it possible to identify the vast majority of sea buckthorn oil components. The results obtained correspond to the quality of sea buckthorn oil.

The dynamics of the process of oil distillation from sea buckthorn pulp was studied using the fractional distillation method - by measuring its volume released over certain time intervals. Along with recording the oil yield during the experiments, their values were calculated, normalized by the maximum yield in each specific experiment. Normalization allows us to exclude the influence of the loading volume on the yield and compare the results with different masses of raw materials used in the experiment.

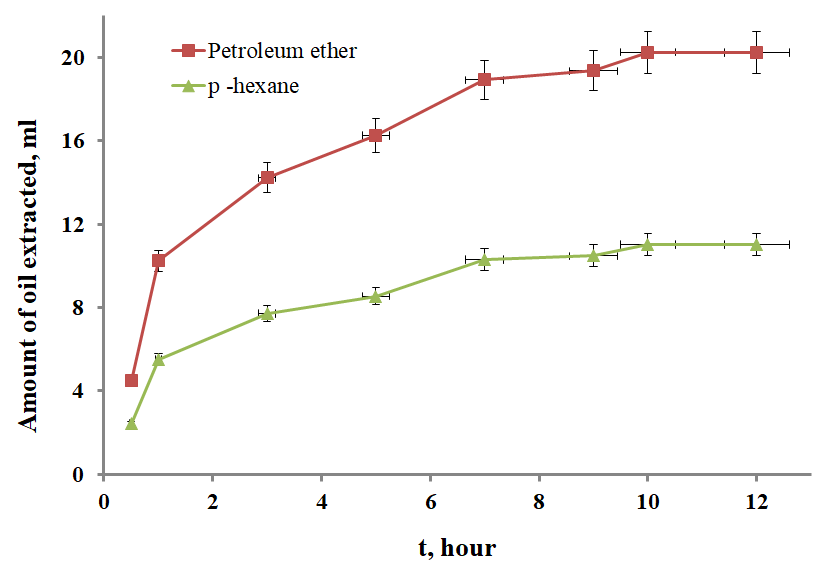
The distillation was carried out from samples of dry cake dried at a temperature of 600C. The oil yield was measured after 0,5; 1,0; 3,0; 5,0; 7,0; 9,0; 10,0; 12,0 hours after the appearance of the first drop. To reduce experimental error, the experiments were carried out in triplicate.

The obtained data are presented in Table 6 and in the Figure 3.

**TABLE 6.** Dynamics of essential oil release for different lemon varieties.

|  |  |  |
| --- | --- | --- |
| Distillation time, hour | Amount of oil extracted, ml | |
| Extraction agent  Petroleum ether | Extraction agent  p -hexane |
| 0,5 | 4,51±0,03 | 2,43±0,02 |
| 1,0 | 10,23±0,01 | 5,50±0,03 |
| 3,0 | 14,22±0,003 | 7,72±0,02 |
| 5,0 | 16,24±0,02 | 8,55±0,01 |
| 7,0 | 18,91±0,03 | 10,29±0,04 |
| 9,0 | 19,35±0,02 | 10,48±0,02 |
| 10,0 | 20,24±0,01 | 11,02±0,03 |
| 12 | 20,23±0,04 | 11,02±0,02 |

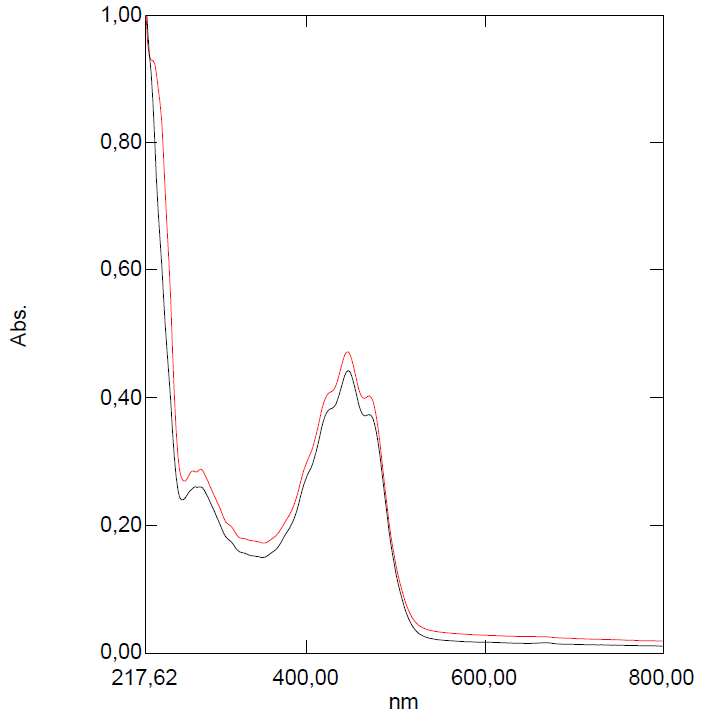
The results showed that the amount of initial raw material does not influence the pattern of oil extraction. Around 20% of the oil is extracted within the first 30 minutes. The extraction process is most intensive during the first 12 hours, after which the rate slows considerably. These findings suggest that, under standard conditions (atmospheric pressure and without the use of catalysts), the extraction of sea buckthorn oil from the cake is largely complete within 12 hours.



**FIGURE 3.** Dynamics of sea buckthorn oil.

Determination of carotenoid content in sea buckthorn oil is an important analytical process that allows assessing the quality and biological value of the product. Determination of carotenoid content in samples was carried out by spectrophotometric method.

Obtained dependences of optical density of carotenoids in oil during extraction from sea buckthorn fruits from the wavelength are shown in Figure 4.



**FIGURE 4.** Dependence of the optical density of carotenoids in oil obtained from sea buckthorn fruits during extraction with hexane and petroleum ether on the wavelength.

As a result of the analysis, it was established that the content of carotenoids in sea buckthorn oil is 534 mg/100 g and does not depend on the extraction method. This indicator corresponds to the values indicated in the literature, which indicates a high concentration of biologically active substances.

Overall, the results obtained demonstrate the high quality of sea buckthorn oil in terms of carotenoid content, which confirms its value as a source of natural antioxidants.

The antioxidant activity of sea buckthorn oil is a characteristic important for assessing the biological value and quality of the oil, as well as its potential health benefits.

The oxidation-reduction titration approach, namely the iodometric method, was employed to ascertain the antioxidant activity of the examined extracts, relying on the reaction between hydrogen peroxide and potassium iodide in an acidic environment.

The results obtained are presented in Table 7.

**TABLE 7.** Results of determination of antioxidant activity.

|  |  |  |  |
| --- | --- | --- | --- |
| № | Volume of Na2S2O3  (without adding extract), ml | Volume of Na2S2O3​​  (with addition of extract), ml | Antioxidant activity, % |
| 1 | 20 | 6,2 | 69,0 |
| 2 | 20 | 6,0 | 70,0 |
| 3 | 20 | 6,3 | 68,5 |

Thus, sea buckthorn oil has high antioxidant activity. This confirms its potential as a natural source of antioxidants.

**Conclusion**

Sea buckthorn oil, extracted from the fruits of the sea buckthorn (Hippophae rhamnoides), is a natural product that has a high content of vitamins, minerals and antioxidants.

Processing sea buckthorn using modern technologies (for example, the use of ultrasonic or supersonic processing, nanotechnology) opens up new opportunities for increasing the yield of valuable components and expanding the range of products.

The physicochemical properties of sea buckthorn oil make it a unique and valuable natural product. Due to the high concentration of saturated and unsaturated fatty acids, as well as the richness of carotenoids, vitamins and antioxidants, it has pronounced biological and therapeutic properties.

The study of the physicochemical properties of sea buckthorn oil confirms its high quality, richness of active components and potential for use in various fields due to its unique characteristics. These data are the basis for product standardization, assessment of its safety and effectiveness.

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