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Study of the Qualitative Characteristics of Rapeseed Oil Obtained by Cold Pressing

Natalia L Kleymenova, Inessa N Bolgova, Maxim V Kopylov, and Ekaterina Y Zheltoukhova

FSBEI HE "Voronezh State University of Engineering Technologies" (FSBEI HE "VSUET"), 19 Revolution Ave., Voronezh, 394036, Russia

ORCID:
Natalia L Kleymenova: http://orcid.org/0000-0002-1462-4055

Abstract

Oil from spring rape seeds obtained by cold pressing was selected as the object of this study. Oil samples were obtained under the following technological conditions: the annular gap was 0.7 mm in a grain chamber and the screw rotation speed was 160 rpm at a pressing temperature of 315 K. The oil composition was studied by gas-liquid chromatography on the Chromotech 5000 apparatus. Rapeseed oil characteristics were obtained with chromatograms. An increased content of linoleic acid 20% (ω6) and linolenic acid 12% (ω3) was revealed in the fatty acid composition of the sample. Fatty acids contribute to lipid metabolism regulation. They are of primary importance in the diet. The presence of 58.6% oleic acid (ω9) was identified. The resulting rapeseed oil had healing properties due to the presence of ω3, ω6 and ω9. Vitamin B, vitamin K, traces of vitamin A, and α, β + γ, δ-tocopherols were found. α, β + γ-tocopherols contribute to the oxidation process. According to these results, rapeseed oil can be confidently recommended for introduction into various food recipes.

Keywords: rapeseed oil, vitamins, fatty acid composition.

Corresponding Author:
Natalia L Kleymenova
klesha78@list.ru

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1. Introduction

Modern population consumes a large amount of refined foods, so there is a deficiency in various nutrients. A promising direction in food production is the creation of new functional foods from unconventional raw materials containing biologically active components (proteins, lipids, vitamins, etc.) necessary for humans [1].

Nowadays the use of rapeseed as an oilseed is relevant due to its high profitability. That is why there is an increased demand for them [2] now. According to this demand, rapeseeds occupy the second place in the Russian Federation. Rapeseed oil is used in the chemical, food and textile industries. Rapeseed oil has been used relatively recently for the food purposes. The reason for this is the use of modern clarification methods,

improving the quality of rapeseeds, breeding of hybrid varieties with a high content of linolenic acid and a low content of erucic acid.

With the introduction of innovations in the oil industry, it makes sense to process rapeseeds by cold pressing to produce the oil with biologically active substances, and to use the resulting oil for blending [3].

One of the advantages of rapeseed oil is its transparency and the absence of a change in taste during oxidation [4]. In rape seeds, the content of valuable fats and proteins reaches 31%. Compared to other types of oils, rapeseed oil contains the optimal amount of fatty acids [5]. However, there is a drawback - erucic acid and thioglysides, which negatively affect the body, are present in it. The amount of monounsaturated acids is about 65% [6, 7].

Rapeseed oil contains a large amount of vitamins: E up to 120% and K up to 60%. Vitamins play a special role in the nutrition and support of human health. With their insufficient consumption, life expectancy, ability to work, and resistance to diseases are reduced. The aim of the study is to determine the fatty acid and vitamin composition of rapeseed oil to further predict the optimal properties of future blends.

2. Methods and Equipment

2.1. Methods

The oil obtained from spring rapeseeds was studied in the work. According to literature data, it is known that fatty acids of the ω3, ω6, ω9 group are part of rapeseed oil. They are presented in Table 1.

An analysis of literature data showed that the composition of rapeseed oil is represented by saturated fatty acid - palmitic, therefore, the oil contains tripalmitin in the glyceride composition [10]. A significant content of polyunsaturated fatty acid - oleic - contributes to a decrease in storage stability.

Rapeseeds cold pressing was carried out in the experimental unit with an annular grain chamber gap of 0.7 mm, a screw rotation speed of 160 rpm, and a pressing temperature of 315 K.

The fatty acid composition of rapeseed oil was determined with gas-liquid chromatography according to GOST 31665-2012 “Vegetable oils and animal fats. Obtaining of fatty acids methyl esters”, GOST 31663 - 2012 “Vegetable oils and animal fats. Determination of the mass fraction of fatty acids methyl esters by gas chromatography.” The SP-2560 column, as well as the Chromotech 5000 gas chromatograph, were used in the work.

Table 1: The fatty acid content of rapeseed oil.

Name of fatty acids	Literature data,% of total fatty acids [8]	Literature data,% of total fatty acids [9]	Literature data,% of total fatty acids [10]	Literature data,% of total fatty acids [11]
C12:0 Lauric	-	0.02	-	
C14:0 Myristinic	-	0.09	-	
C15:0 Pentadecanoic	-	0.02	-	
C15:1 Pentadecenic	-	0.01	-	
C16:0 Palmitic	-	4.52	4.0	2.7-3.7
C16:1 Hexadecenoic	-	0.06	-	
C16:1, 9-cis Palmitoleic	-	0.29	-	
C16:2 Hexadecadienoic	-	0.02	-	
C17:0 Margaric	-	0.04	-	
C17:1 Heptadecenoic	-	0.03	-	
C18:0 Stearic	12.4	1.73	50	0.9-2.3
C18:1, 9-cis Oleic	0.54	57.24	5	75.1-82.3
C18:1, 11-trans Vaccenic	-	3.02	-	
C18:2 Linoleic	72.84	20.58	-	6.9-12.7
C18:3 Linolenic	0.22	-	-	2.3-6.5
C20:0 Arachic	-	0.49	-	
C20:1 Gondoinic	3.37	1.21	-	
C20:2 Eicosadienoic	-	0.16	-	
C20:3 Eicosatrienoic	-	0.06	-	
C22:0 Behenic	1.74	0.20	-	
C22:1 Erucic	1.06	0.61	1	up to 0.1
C22:2 Docosadienoic	-	0.03	-	
C22:3 Docosatrienoic	-	0.11	-	
C23:0 Tricosanoic	0.86	-	-	
C24:0 Lignoceric	0.42	0.06	-	

The main objective was to study the fatty acid and vitamin composition of rapeseed oil by gas-liquid chromatography to further evaluation of the safety and prospects of its use in food.

Table 2: Rapeseed oil components calculation results.

Component	Time, min	Area, mV · s	Area, %	Response factor	Concentration, %
C4:0 Oleic	8.958	2.953	0.014	1.428	0.020
C6:0 Caproic	9.496	1.281	0.006	1.237	0.007
C8:0 Caprylic	10.520	1.193	0.006	1.114	0.006
C10:0 Capric	12.375	4.972	0.023	1.041	0.024
C12:0 Lauric	15.441	8.612	0.041	1.061	0.041
C14:0 Myristic	19.856	30.532	0.144	0.997	0.141
C15:0 Pentadecanoic	22.492	5.592	0.026	1.007	0.026
C16:0 Palmitic	25.371	961.683	4.525	1.000	4.453
C16:1 Palmitoleic	27.241	47.545	0.224	0.997	0.219
C17:0 Margaric	28.322	9.857	0.046	1.009	0.046
C18:0 Stearic	31.667	387.497	1.823	1.005	1.803
C18:1n9c Oleic	33.972	12696.692	59.738	0.997	58.612
C18:2n6c Linoleic	37.282	4201.546	19.768	1.011	19.668
C20:0 Arachic	39.771	130.353	0.613	0.981	0.592
C18:3c9 α- Linolenic Alfa-Linolenic	41.879	2171.534	10.217	1.149	11.553
C20:1 Eicosenic	42.553	330.488	1.555	0.991	1.516
C21:1 Uncosanoic	44.605	3.075	0.014	1.023	0.015
C20:2 Eicosadienoic	46.365	19.501	0.092	1.091	0.099
C22:0 Behenic	48.489	74.547	0.351	0.986	0.340
C20:3n11c Eicosatrienoic	49.945	4.004	0.019	1.074	0.020
C22:1 Erucic	50.372	76.662	0.361	1.122	0.398
C20:5 Eicosapentaenoic	53.587	11.303	0.053	1.114	0.058
C24:0 Lignoceric	54.703	32.987	0.155	1.030	0.157
C24:1 Selacholeic (Nervonic)	56.454	39.403	0.185	1.015	0.185

3. Results

Peaks for the chromatogram of the oil sample tested were determined with the normalization method. The qualitative characteristics of its components were determined by area. The results of the qualitative characteristics of the test sample in the fatty acids composition are presented in Table 2.

As we can see from Table 2 and Figure 1, not all the results obtained correlate with literature data. The composition of rapeseed oil obtained by cold pressing, practically does not contain erucic acid. The presence of oleic acid in rapeseed oil is 58.6%, which allows it to be attributed to high-quality edible oils.

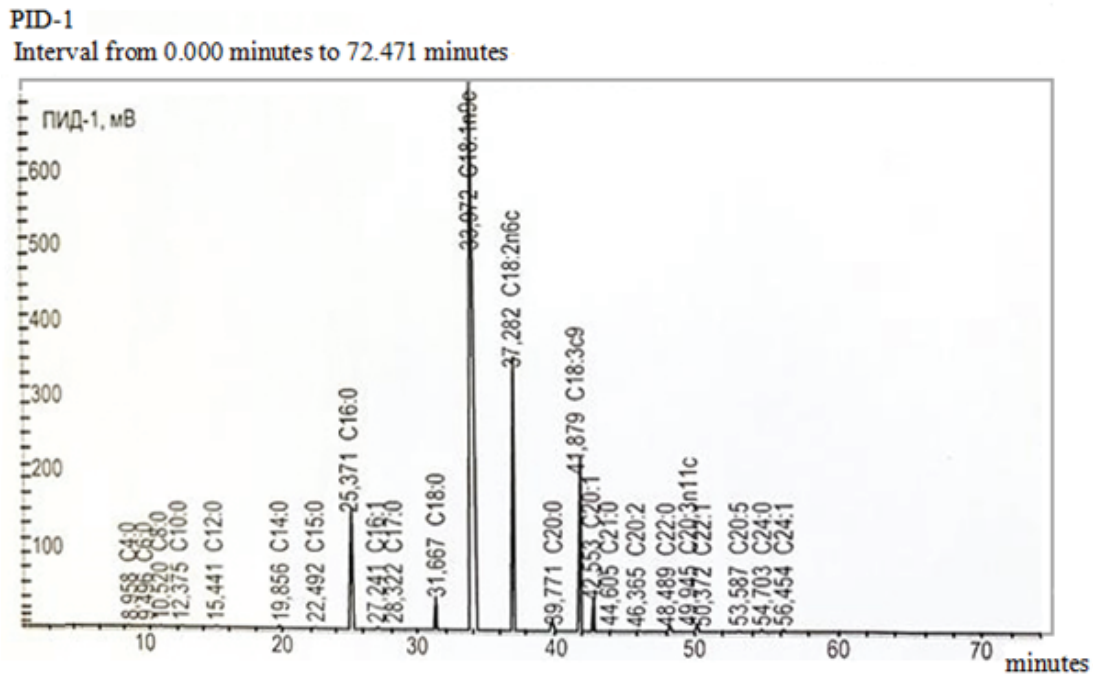


Figure 1: Chromatogram of rapeseed oil fatty acids content.

A comparative analysis of the fatty acid composition of rapeseed oil with standard values is presented in Figure 2 a, b [12, 13].

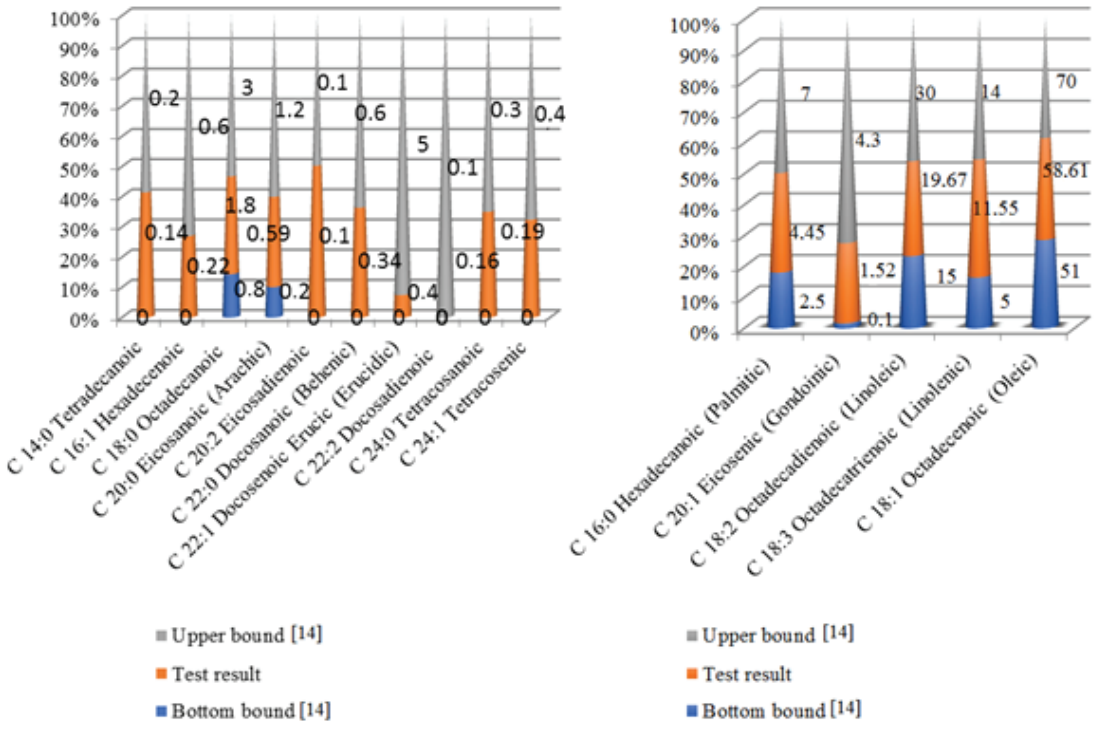
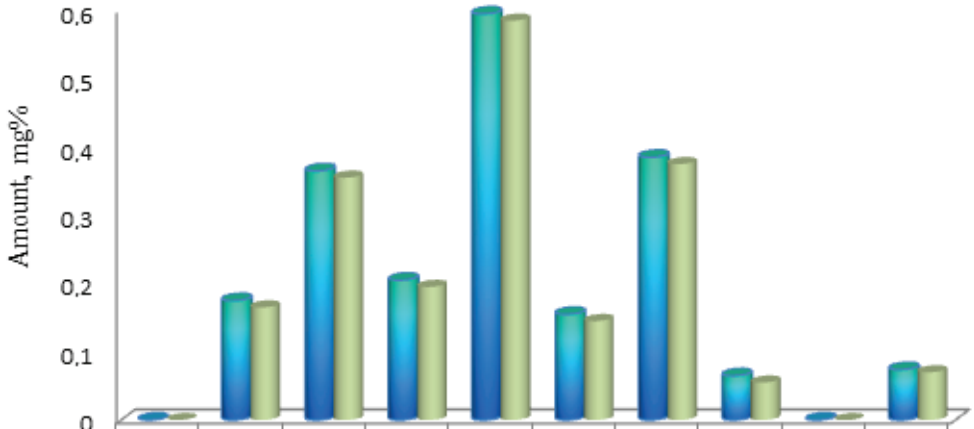


Figure 2: The results of studies of rapeseed oil fatty acid composition: with a fatty acid content limit of up to 3 (a); with an acid content limit of up to 70 (b).

GOST 30417-96 “Vegetable oils. Methods for determining the mass fractions of vitamins A and E” [14] was used to determine the vitamin composition of rapeseed oil. The results of the analysis are presented in Figure 3.



	Vitamin A	Vitamin B1	Vitamin B2	Vitamin B4	Vitamin E	α-tocopherol	β+γ-tocopherol	δ-tocopherol	β-carotene	Vitamin K
Maximum value	traces	0,175	0,365	0.205	0,595	0,155	0,385	0,065	traces	0,074
Minimum value	traces	0,165	0,355	0,195	0,585	0,145	0,375	0,055	traces	0,07

Figure 3: The results of chemical composition in the sample tested.

4. Discussion

According to the research results, the fatty acid composition of the rapeseed oil sample contains an increased content of linoleic acid of 20% (ω6) and linolenic acid of 12% (ω3). However, according to the literature data it was revealed that for oil from spring rape the amount of ω6 is 5-5.5% and ω3 is 4.5-6%, respectively [15]. Analysis of rapeseed oil composition proved that it contains saturated fatty acid (palmitic) in an amount of 4.4%, as well as monounsaturated fatty acid ω9 and polyunsaturated fatty acids of the ω6 and ω3 series. Oleic acid (ω9) is necessary for lipid metabolism, and it is also an antioxidant [16, 17]. Thus, the results obtained are in the range not exceeding the normative values of GOST 31759-2012 «Rapeseed oil. Technical conditions” [18].

The amount of erucic acid in the test oil is 0.4%. The increased content of polyunsaturated fatty acids in the sample confirms the studies of scientists [19] that these acids participate in the construction of cell membranes, help to synthesize hormones, regulate metabolism in cells and remove cholesterol, and reduce diseases of the cardiovascular and nervous system. Analysis of the fatty acid composition of rapeseed oil complies with international standards [20].

The analysis of Figure 3 showed that the test sample contains a rational ratio of saturated and polyunsaturated acids. The discovered B vitamins help to strengthen the nervous system. The present vitamin E has antioxidant properties and is recommended for daily use with food. The rational content of α-tocopherol helps to slow down or prevent oxidation. The presence of β + γ-tocopherols in rapeseed oil will ensure oxidation stability, and β + γ-tocopherols will also act as antioxidants.

Rapeseed oil has a grassy odor that does not satisfy consumers, so itis necessary to carry out some studies to select the taste and aroma of rapeseed oil and to develop blends with various ingredients.

5. Conclusion

Thus, the test sample of rapeseed oil obtained with cold pressing contains about 59% of oleic acid, which is a valuable property and allows to use this oil for diabetic nutrition, to lower cholesterol, etc. Another identified advantage of rapeseed oil is the presence of the essential fatty acids ω3 and ω6. The biological value of vitamins found in oil opens up prospects for using it as an ingredient in functional foods. The α, β + γ-tocopherols discovered as a result of research contribute to the maintenance of the oxidation process. Analysis of the results allows us to conclude that rapeseed oil can be recommended for blending.

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Conflict of Interest

The authors have no conflict of interest to declare.

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