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SHORT COMMUNICATION

Gas chromatographic analysis of the fatty acid composition of mustard oil obtained by cold pressing (method)

Alexander Nikolaevich Ostrikov, Natalya Leonidovna Kleymenova, Inessa Nikolaevna Bolgova, Maxim Vasilyevich Kopylov*

Voronezh State University of Engineering Technologies, 19, Revolution Av., Voronezh, 394036, Russian Federation

ABSTRACT

Nowadays there is such a type of product as mustard oil, which is a stockpot of valuable fatty acids and vitamins. Mustard oil is used in various fields of industry. It has a characteristic smell and taste, yellow-brown color. Mustard grows mostly in the southern regions. It is resistant to various diseases and pests. There is evidence from scientific research that proves the beneficial properties of this oilseed. Mustard oil was obtained by cold pressing under the following conditions: annular gap of the grain chamber of the oil press was 0.6 mm; screw rotation speed was 166 rpm; pressing temperature was 345 K. The study of the component composition of mustard oil was carried out by gas-liquid chromatography. The qualitative composition of the test sample was determined in the work. It contains the following acids - palmitic (4%), stearic (3%), polyunsaturated acids - linoleic (32%), linolenic (8%) and eicosenic (2%), monounsaturated acid - oleic (47%). The data obtained correlate with literary data. It was proved that unsaturated acids can act as essential nutrients. The presence of other fatty acids, the amount of which is within acceptable limits, is also identified in the work. Mustard oil vitamin composition studies were carried out according to standard methods. Vitamins A, E, K, β-carotene and α, β + γ, δ tocopherols were found in the original sample. Vitamins A, E, K increase immunity and strengthen the walls of blood vessels, as well as are anti-inflammatory substances. The presence of tocopherols benefits the skin. The results of studies of mustard oil allow us to conclude that the components identification is necessary for the development of balanced blends with a reduced amount of saturated acids and a high amount of semi-saturated acids.

Keywords: Mustard oil; Vitamins; Fatty acid composition

INTRODUCTION

Oils of various oilseeds are used for preventive nutrition. A promising direction is the use of oils with biologically valuable properties and the presence of vitamins and tocopherols in them (Dhanik et al., 2018). Nowadays it can be predicted that the use of mustard oil will be relevant in the coming decades. It is known that there is no reference oil containing the optimal amount of fatty acids and having their rational ratio (Hossain et al., 2018). Therefore, an important aspect is the study of fatty acid and vitamin components composition of any of the oils, including mustard oil, to create balanced blends.

Such a culture as white mustard is especially widespread. It has a yellow-brown color and an unpleasant bitterness smell, which can cause lacrimation. This oilseed is grown in the southern regions. It is resistant to a number of common diseases and pests (Sawicka et al., 2020). Mustard seeds are large, reproducible, contain a small amount of erucic acid (Wendlinger et al., 2014, Kok et al., 2018). According to sources, mustard seeds have about 50% fatty oil, about 2% essential oil, up to 90% of kernels and up to 10% of husk. They also contain proteins (Rusakova et al., 2014). Mustard oil is used in food, chemical and engineering industries (Swati et al., 2015).

Fig. 1 presents an analysis of literature data on the quantitative characteristics of mustard oil fatty acids. An analysis of the literature presented in Fig. 1 showed that the amount of linoleic acid ranges from 9-34.54%, linolenic acid - 13-33.2%, oleic acid - 17-49.3%, eruca acid - 0.1-8.5%, eicosenic acid - 0.2-10-10%. The wide variation in the indicators for the presence of fatty acids is explained by different varieties of mustard and different methods of production. One of the factors for the stability of vegetable

***Corresponding author:**
Maxim Vasilyevich Kopylov, Voronezh State University of Engineering Technologies, 19, Revolution Av, Voronezh, 394036, Russian Federation. **Email:** kopylov-maks@yandex.ru

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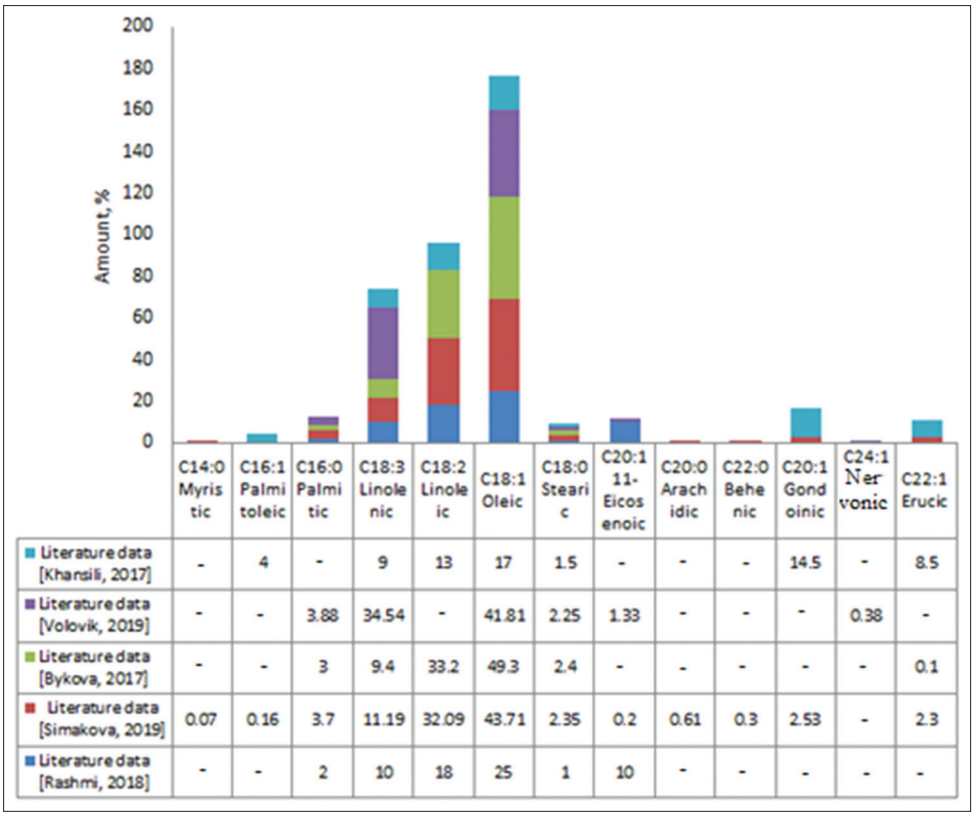


	C14:0 Myristic	C16:1 Palmitoleic	C16:0 Palmitic	C18:3 Linolenic	C18:2 Linoleic	C18:1 Oleic	C18:0 Stearic	C20:1 11-Eicosenoic	C20:0 Arachidic	C22:0 Behenic	C20:1 Gondoinic	C24:1 Nervonic	C22:1 Erucic
Literature data [Khansili, 2017]	-	4	-	9	13	17	1.5	-	-	-	14.5	-	8.5
Literature data [Volovik, 2019]	-	-	3.88	34.54	-	41.81	2.25	1.33	-	-	-	0.38	-
Literature data [Bykova, 2017]	-	-	3	9.4	33.2	49.3	2.4	-	-	-	-	-	0.1
Literature data [Simakova, 2019]	0.07	0.16	3.7	11.19	32.09	43.71	2.35	0.2	0.61	0.3	2.53	-	2.3
Literature data [Rashmi, 2018]	-	-	2	10	18	25	1	10	-	-	-	-	-

Fig 1. The content of saturated and unsaturated acids of mustard oil.

oils is the presence of fatty acids. Oils with high content of unsaturated acids oxidize faster.

Therefore, it should be noted that mustard oil is of particular interest as it contains useful fatty acids necessary for eating Jeet, 2018. The aim of the study is to establish the content of fatty acid and vitamin composition of mustard oil.

MATERIALS AND METHODS

Mustard oil was chosen as the object of study

Mustard oil obtained by cold pressing was used for analysis. The tests were carried out at the FSBEI HE "VSUET" (Voronezh) it the device under the following conditions: the annular gap of the grain chamber was 0.6 mm, the screw speed was 166 rpm and the pressing temperature was 345 K (Fig. 2).

The fatty acid composition was evaluated by gas chromatography on a Chromotech 5000 chromatograph with an SP-2560 column using a standard procedure (Fig. 3) (GOST 31665-2012, CXS 210-1999).

The vitamin composition of mustard oil was determined in accordance with the requirements of GOST 30417-96 "Vegetable oils. Methods for determining the mass fractions of vitamins A and E" (GOST 30417-96).

Fig 2. Device for cold pressing MPL-1.

A sample of mustard oil is shown in Fig. 4.

The objective of our study was to determine the percentage composition of fatty acids in mustard oil using a chromatogram.

RESULTS AND DISCUSSION

Results for mustard oil components identification are presented in Table 1.

Table 1: Calculation results for mustard oil components

Component	Time, min	Area, mV·s	Area, %	Response factor	Concentration, %
C4:0 – Oleic	8.962	3.529	0.019	1.428	0.027
C6:0 – Caproic	9.501	1.754	0.010	1.237	0.012
C8:0 – Caprylic	10.521	1.790	0.010	1.114	0.011
C10:0 – Capric	12.380	7.058	0.039	1.041	0.040
C12:0 – Lauric	15.445	12.376	0.068	1.016	0.068
C 14:0 – Myristinic	19.860	41.486	0.228	0.997	0.224
C 14:1 – Tetradecanoic	21.856	2.149	0.012	1.001	0.012
C 15:0 – Pentadecanoic	22.499	7.448	0.041	1.007	0.041
C 16:0 – Palmitic	25.373	802.192	4.404	1.000	4.343
C 16:1 – Palmitoleic	27.244	39.201	0.215	0.997	0.212
C 17:0 – Margaric	28.333	8.866	0.049	1.009	0.048
C 18:0 – StearіC	31.669	581.168	3.191	1.005	3.162
C 18:1n9c – Oleic	33.925	8738.059	47.973	0.997	47.166
C 18:2n6c – Linoleic	37.319	5890.680	32.340	1.011	32.243
C 20:0 – Arachic	39.769	117.875	0.647	0.981	0.626
C 18:3C 9 – α–Linolenic	41.853	1342.663	7.371	1.149	8.352
C 20:1 – Eicosadienoic	42.564	329.359	1.808	0.991	1.767
C 20:2 – Eicosatrienoic	46.374	28.529	0.157	1.091	0.169
C 22:0 – Behenic	48.495	52.522	0.288	0.986	0.280
C 20:3n11c - Eicosatrienoic	49.951	5.045	0.028	1.074	0.029
C 22:1 – Erucic	50.381	99.999	0.549	1.122	0.607
C 22:2 - Docosadienoic	53.079	2.040	0.011	1.040	0.011
C 20:5 – Eicosapentaenoic	53.447	3.479	0.019	1.114	0.021
C 24:0 – Lignoceric	54.721	56.261	0.309	1.030	0.314
C 24:1 – Selacholeic (Nervonic)	56.462	39.070	0.214	1.015	0.215

Fig 3. Chromatograph "Chromatek 5000".

Fig 4. Test sample of mustard oil.

25 fatty acids were found as a result of mustard oil gas chromatographic analysis (Fig. 5), with the largest part of them being saturated acids - palmitic (4%), stearic (3%), polyunsaturated acids - linoleic (32%), linolenic (8%) and eicosenoic (2%), monounsaturated acid - oleic (47%). The results obtained correlate properly with data obtained from literary sources. An increased content of oleic and linoleic acid, which are the main representatives of ω9, is observed in our studies (Chowdhury, 2007). Unsaturated acids are known to be essential nutrients (Melo et al., 2019), so foods containing them in high quantities can be considered to be promising in the food market.

A number of studies have shown (Khansili et al., 2017, Volovik et al., 2019), that erucic acid is toxic to the heart muscle and accumulates in the tissues of the body, can slow the growth and puberty of the body, can increase the risk of diseases of the cardiovascular system, cirrhosis.

According to GOST 8807-94, the mass fraction of erucic acid should be no more than 5-5.1% (GOST 8807-94).

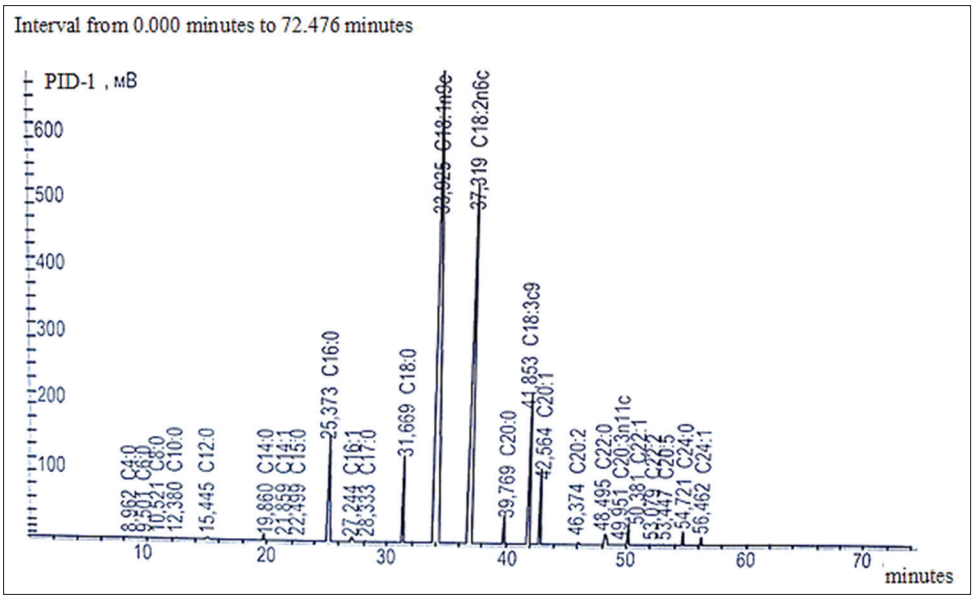


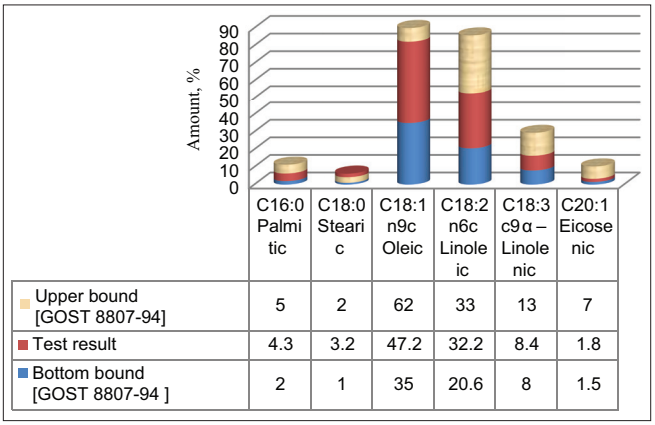
Fig 5. Chromatogram of methyl esters mixture for mustard oil.

In the test oil, erucic acid is 0.607%, which is significantly lower than the standard. In the future, we consider it possible to further reduce its content.

According to the chromatogram data obtained, one can note 5 main peaks characterizing the presence of such fatty acids as oleic, linoleic, alpha-linoleic, palmitic, stearic and a slight presence of eicosenic in ascending order. The presence of other fatty acids, the amount of which is within the regulatory range, was identified in the work as well. It was previously found that the detected acids stimulate the fat metabolism in the human body, and linoleic acid has an anti-inflammatory effect (Konuskan et al., 2019).

The results of mustard oil fatty acid composition compared to standard values were obtained in the work (Fig. 6).

The results of the fatty acid composition of mustard oil obtained during the study were compared with standard values. From the data obtained it can be seen that the amount of stearic acid lies outside the normative values of the oil studied. Such an amount of stearic acid proves that mustard oil can help restore lipid metabolism and protect human skin. The study also found that the ratio of ω9: ω6: ω3 is 1.5: 1: 0.25 in mustard oil. However, it should be noted that the amount of essential acids is recommended in the ratio of ω3: ω6 - 3: 1 for a proper diet. New varieties of mustard with erucic acid low content have been developed over the years of research (Kok et al., 2018). This explains its insignificant presence in the oil studied. The presence of oleic and linoleic acid indicates mustard oil high stability. The presence of acids detected characterizes the unique property of the oil - the ability to long-term storage without its taste and properties changing.



	C16:0 Palmitic	C18:0 Stearic	C18:1 n9c Oleic	C18:2 n6c Linoleic	C18:3 c9 α – Linolenic	C20:1 Eicosenic
Upper bound [GOST 8807-94]	5	2	62	33	13	7
Test result	4.3	3.2	47.2	32.2	8.4	1.8
Bottom bound [GOST 8807-94]	2	1	35	20.6	8	1.5

Fig 6. The results of mustard oil fatty acid composition.

Mustard oil vitamin composition studies were carried out according to standard methods (GOST 30417-96). The results are given in Fig. 7.

The presence of vitamins A, E, K, β-carotene and tocopherols is the advantage of the oil studied. Vitamins stimulate metabolism and support the immune system, improve human skin and hair, strengthen nails, promote rapid wounds healing as well as have a beneficial effect on vision. With such a composition of valuable substances, people are treated with mustard oil for various diseases. It is also recommended to use it for massages and in diabetes curing (Sarkar et al., 2016). The results of mustard oil research allow us to conclude that the identification of components is necessary for the development of a balanced composition with a reduced amount of saturated acids and a high amount of semi-saturated acids.

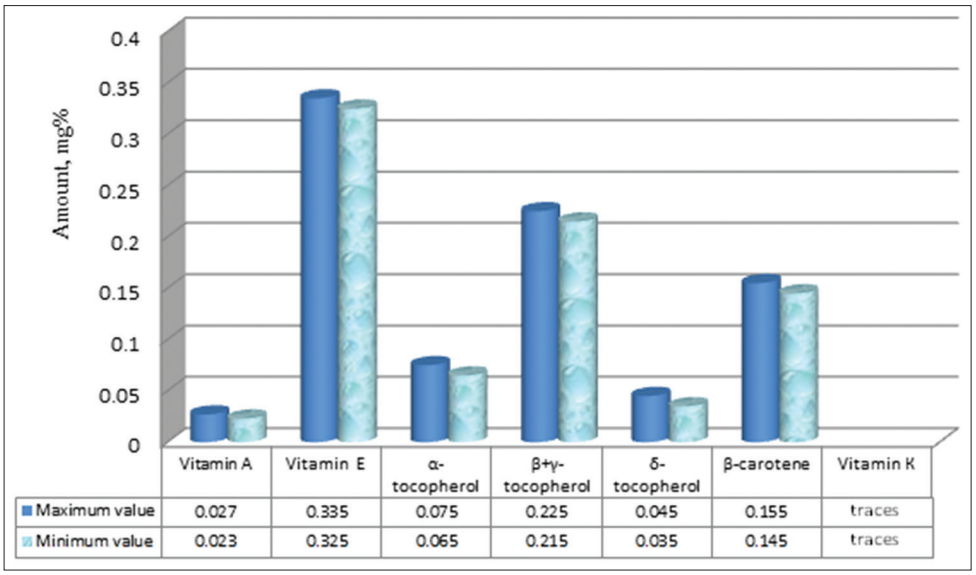


Fig. 7. The results of mustard oil chemical composition.

CONCLUSION

The unique composition of fatty acids in mustard oil was determined in the following quantity: palmitic - 4%, stearic - 3%, eicosenic - 2%, linoleic - 32%, linolenic - 8%, oleic - 47%. It was found that mustard oil contains 47% oleic acid, which gives it a specific smell and taste. The resulting vitamins and tocopherols have indispensable properties resisting various diseases with the correct use of mustard oil. Vitamins A, E, K, β-carotene and α, β + γ, δ tocopherols were found in the initial sample. Vitamins A, E, K increase immunity and strengthen blood vessels walls. They are anti-inflammatory substances as well. The presence of tocopherols benefits the skin. Mustard oil is an important product of proper and balanced nutrition, as it stimulates certain biological functions in the human body.

Contributions of authors

Alexander Nikolaevich Ostrikov and Natalya Leonidovna Kleymenova performed analyzed the results and prepared the manuscript. Inessa Nikolaevna Bolgova and Maxim Vasilyevich Kopylov analyzed the results and contributed for preparing the manuscript.

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