The study of the fatty acid composition of camelina oil obtained by cold pressing

A N Ostrikov, N L Kleimenova, M V Kopylov and I N Bolgova

Voronezh State University of Engineering Technologies, 19 Revolution Ave., Voronezh, 394036, Russia

E-mail: klesha78@list.ru

Abstract. Non-traditional oilseeds include camelina seeds, which are widely known in the global production of oils and blends. The seeds of this plant are a source of polyunsaturated fatty acids, including linoleic and linolenic acids. A distinctive feature of the seeds of this culture is the oil content – 40% and crude protein – 30%. The object of the study was oil obtained by cold pressing and the seeds of camelina of the Penzyak variety. Samples were obtained in an experimental installation under the following conditions: a pressing chamber annular clearance was 0.3 mm; the screw rotational speed was 160 rpm at a temperature of 336 K. The fatty acid composition of the camelina oil sample was determined by gas-liquid chromatography on a Chromotech 5000. The presented results of camelina oil studies by fatty acid composition show that unsaturated fatty acids -9 prevail in the test oil. It was determined that fatty acids of groups 18 and 16, 20 predominate in camelina oil. At the next work stage, studies were carried out on the chemical composition of the sample, as a result of which it was found that camelina oil contains 4 vitamins (vitamins A, K, δ and γ-tocopherols) and traces of vitamin K, the purpose of which is to provide increased biological and nutritional value of the product.

1. Introduction

Currently, such an oilseed crop as camelina is very popular in oil production. It is widely used in the production of oils by cold pressing and the development of blends. Successful developments in the field of camelina selection as an oilseed crop are well known [1].

The relevance and prospects of the use of camelina seeds in oil production are determined by the unpretentiousness and high productivity of this crop. Its seeds contain about 40 - 45% of drying oil and about 30% of crude protein [2]. The fields of its application are different: medicine, dietary nutrition, paint and varnish industry, perfumery and cosmetic products [3, 4].

The main advantage of this choice of the study object is that camelina oil is a rich in polyunsaturated fatty acids: linolenic acid (ω-3) from 36 to 41%; linoleic acid (ω-6) from 16 to 20% [5, 6]. The ratio of ω-3: ω-6 is 2.5: 1. This ratio of camelina oil fatty acids is recommended for people who have high blood cholesterol. The composition of this oil contains natural antioxidants – tocopherols (60 – 109 mg%), and the amount of erucic acid is relatively low (1.5 – 4.2%).

Camelina is resistant to frost and drought. The camelina culture technique is easy and does not require economic costs [7]. Another feature of this culture is its early maturation, which is attributed to biological value [8, 9]. The camelina oil obtained by cold pressing of seeds has a high content of...
vitamin E and polyunsaturated fatty acids, it contains a natural complex of tocopherol, and carotene promotes less oxidation and prolongs the shelf life of the oil [10].

In a modern industrial society with a predominance of megacities, one of the main problems in human nutrition is vitamin deficiency [11]. In the basic human diet, the necessary balance of proteins, carbohydrates, vitamins and amino acids should be present [12]. Therefore, the aim of the study is to determine the fatty acid and vitamin composition of camelina oil [13, 14].

2. Materials and methods

The object of the study was the seeds of camelina winter varieties Penzyak. The main qualitative characteristic of camelina oil is the fatty acid composition. An analysis of the literature on the fatty acid composition of camelina oil is presented in table 1.

Table 1. Fatty acid composition of camelina oil

| Acid                        | Literature data, % of total fatty acid content | Literature data, % of total fatty acid content | Literature data, % of total fatty acid content |
|-----------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| C 16:0 Hexadecanoic (palmitic) | 4.3                                           | 5.3                                           | -                                             |
| C 16:1 Hexadecenoic (palmitoleic) | 0.07                                          | 0.1                                           | -                                             |
| C 18:0 Octadecanoic (stearic)    | 2.3                                           | 2.1                                           | 9.57                                          |
| C 18:1 Octadecenic (oleic)       | 12.73                                         | 14.8                                          | -                                             |
| C 20:0 Eicosanoic; (arachidic)   | 1.04                                          | 1.8                                           | -                                             |
| C 20:1 Eicosenoic (gondoinic)    | 11.19                                         | 12.8                                          | -                                             |
| C 22:0 Docosanoic (behenic)      | 0.31                                          | 0.3                                           | 2.18                                          |
| C 22:1 Docosenoic (erucic)       | 2.38                                          | 3.5                                           | -                                             |
| C 18:2 Octadecadienoic (linoleic) | 24.29                                         | 2.4                                           | 4.57                                          |
| C 18:3 Octadecatrienoic (linolenic) | 36.92                                         | 33.7                                          | 52.55                                         |

This oil is influenced by the cold pressing mode, which allows preserving the curative properties of camelina oil. Investigations of the cold pressing process of camelina seeds were carried out in an experimental installation in the following ranges of technological parameters: pressing chamber annular clearance – 0.3 mm, screw rotation speed – 160 rpm, pressing temperature - 336 K.

Based on the requirements of National Standard 31665-2012 “Vegetable oils and animal fats. Obtaining methyl esters of fatty acids” methyl esters of fatty acids and the fatty acid composition of camelina oil were defined. In this case, an SP-2560 column was used, as well as a Chromotech 5000 gas chromatograph.

The objective of the study was to identify the peaks of the obtained chromatograms for camelina oil. For this purpose, the area normalization method was used to determine the qualitative characteristics of the oil composition of interest.
3. Results

The study results on the composition of fatty acids of camelina oil are presented in Table 2.

| Acid component      | Time, min | Area, mV·s | Area, % | Response factor | Concentration, % |
|---------------------|-----------|------------|---------|-----------------|------------------|
| C4:0-Butyric        | 8.997     | 7.719      | 0.044   | 1.428           | 0.059            |
| C6:0- Caproic       | 9.529     | 4.298      | 0.024   | 1.237           | 0.029            |
| C8:0- Caprylic      | 10.537    | 3.197      | 0.018   | 1.114           | 0.019            |
| C10:0- Capric       | 12.374    | 7.606      | 0.043   | 1.041           | 0.043            |
| C12:0- Lauric       | 15.415    | 10.898     | 0.062   | 1.016           | 0.060            |
| C14:0- Myristic     | 19.801    | 41.160     | 0.235   | 0.997           | 0.221            |
| C14:1- Myristoleic  | 21.799    | 2.842      | 0.016   | 1.001           | 0.015            |
| C15:0- Pentadecanoic| 22.431    | 7.203      | 0.041   | 1.007           | 0.039            |
| C16:0- Palmitic     | 25.305    | 1004.049   | 5.722   | 1.000           | 5.411            |
| C16:1- Palmitoleic  | 27.170    | 20.826     | 0.119   | 0.997           | 0.112            |
| C17:0- Margaric     | 28.247    | 9.515      | 0.054   | 1.009           | 0.052            |
| C18:0- Stearic      | 31.567    | 465.766    | 2.654   | 1.005           | 2.523            |
| C18:1n9- Elaidic    | 33.213    | 5.215      | 0.030   | 1.029           | 0.029            |
| C18:1n9c- Oleic     | 33.707    | 3001.547   | 17.105  | 0.997           | 16.128           |
| C18:2n6c- Linoleic  | 37.149    | 3081.933   | 17.563  | 1.011           | 16.792           |
| C20:0- Arachic      | 39.756    | 238.904    | 1.361   | 0.981           | 1.263            |
| C18:3c9- alpha-linolenic | 41.896 | 6029.709  | 34.361  | 1.149           | 37.338           |
| C20:1- Eicosenoic   | 42.617    | 2510.713   | 14.308  | 0.991           | 13.409           |
| C20:2- Eicosadienoic| 46.321    | 327.686    | 1.867   | 1.091           | 1.927            |
| C22:0- Behenic      | 48.445    | 50.304     | 0.287   | 0.986           | 0.267            |
| C20:3n11c- Eicosatrienoic | 49.909 | 243.026   | 1.385   | 1.074           | 1.407            |
| C22:1- Erucic       | 50.363    | 444.907    | 2.535   | 1.122           | 2.690            |
| C22:2- Docosadienoic| 53.028    | 18.809     | 0.107   | 1.040           | 0.105            |
| C20:5-Eicosapentaenoic | 53.399   | 10.148     | 0.058   | 1.114           | 0.061            |

Analysis of the data obtained from Table 2 and Figure 1 showed that fatty acids of groups 18 and 16, 20 predominate in camelina oil. The sum of the concentrations of all other components is considered to be 100%. Thus, the main profile in the chromatogram in the test sample is saturated acids - palmitic; unsaturated acids - linoleic and oleic; polyunsaturated acids - eicosenoic and linolenic.
It should be noted that the data obtained on the fatty acid composition of the analyzed camelina oil sample correlate well with the literature data presented in Table 1, which indicates a high accuracy of the studies.

Figure 2 demonstrates the results of the analysis of the fatty acid composition of camelina oil in comparison with standard values [18, 19].

![Figure 2](image_url)

**Figure 2.** The results of the fatty acid composition of camelina oil

The values obtained are within normal limits. The content of erucic acid, which is not removed from the oil, is 2.69%, therefore, camelina oil is recommended to be used as a nutritionally complete food product, since the content of erucic acid meets the requirements of the standards (no more than 5%).

Linoleic acid is also present in camelina oil, which helps to reduce the risk of malignant diseases. ω-6 acids are well digested.

The vitamin composition of camelina oil was determined in accordance with the requirements of National Standard 30417-96 “Vegetable oils. Methods for determining the mass fractions of vitamins A and E”. As a result of the studies, it was determined that in the composition of camelina oil includes 4 vitamins and minor traces of vitamin K (Table 3).

The analysis showed that camelina oil contains vitamin E and α, β+γ and δ-tocopherols, the presence of which helps to maintain the ability to oxidize during storage. However, camelina oil has a specific smell; therefore, in order to satisfy consumers, it is better to recommend it for the development of functional blends as part of preventive nutrition. The analyzed chemical composition of the studied oil corresponds to the values of international and interstate standards [18].
Table 3. The chemical composition of the test sample

| No. | Measured values | Unit/samples | Camelina oil |
|-----|-----------------|--------------|--------------|
| 1   | Vitamin A       | mg%          | 0.02±0.005   |
| 2   | Vitamin B1      | mg %         | –            |
| 3   | Vitamin B4      | mg %         | –            |
| 4   | Vitamin B6      | mg %         | –            |
| 5   | Vitamin D       | mg %         | –            |
| 6   | Vitamin E       | mg %         | 0.72±0.005   |
| 7   | α-tocopherol    | mg %         | 0.3±0.005    |
| 8   | β+γ-tocopherol  | mg %         | –            |
| 9   | δ-tocopherol    | mg %         | 0.21±0.005   |
| 10  | β-carotene      | mg %         | –            |
| 11  | Vitamin K       | mg %         | traces       |

4. Conclusion
An analysis of the research results showed that camelina oil obtained by cold pressing has a valuable fatty acid composition, is characterized by a low amount of saturated fatty acids (primarily myristic, stearic, arachic and behenic) and a high content of unsaturated acids (oleic, lenoleic, erucic). The content of erucic acid in camelina oil is 2.69%, that is, almost 2 times lower than in National Standard 31665-2012, National Standard 30417-96 (no more than 5%) [18]. Given there is specific smell of camelina oil, it is advisable to continue the development of blends of various oils.

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