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Research of physical and chemical parameters of the oil obtained from organic and conversion hemp seeds varieties "Hliana"

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Abstract

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Introduction. The aim of the research is to confirm the literature data on the ratio of Omega-3 and Omega-6 unsaturated fatty acids in hemp oil – 1:3 ideal for human body absorption, recommended by the experts of the World Health Organization.

Materials and methods. The object of the study is the oil of conversion and organic seeds of industrial hemp variety "Hliana" of the crop of 2017. The content of tetrahydrocannabinol in this grade is zero. The fatty acid composition was studied using a chromatographic method, sensory characteristics, acidity and iodine number of hemp oil were also determined.

Results and discussion. The basic sensory characteristics of the experimental oil samples corresponded to the requirements of normative documentation. The acidity and iodine number of hemp oil from organic seeds of industrial hemp was 1.13% and 152 g/100 g respectively; with conversion seeds – 1.23% and 154 g/100 g respectively. According to chromatogram data the percentage content of acids in hemp oil was determined. Hemp seed variety "Hliana" contains approximately 55% of linoleic (Omega-6) acids, 16% oleic acid (Omega-9), 15% alpha-linolenic (Omega-3) and 2% gamma-linolenic (Omega-6) acid. The ratio of omega-3 and omega-6 fatty acids in hemp oil of the samples studied was approximately 1: 3.6. It is known that the human body needs about 2-3 grams of omega-3 and 4 grams of omega-6 each day. This amount of unsaturated fatty acids can provide 1 tablespoon of hemp oil per day.

Conclusions. For the first time the fatty acid composition of oil from hemp seeds of the variety "Hliana" was studied. It was confirmed that in hemp oil the ratio of essential fatty acids Omega-3 and Omega-6 is 1:3.6. The parameters of composition and quality of oil from organic and conversion seeds of hemp are almost identical.

Introduction

Health improvement of the population is an actual problem of power, doctors and food technologists of many countries of the world. It is proved that the prevention of an overwhelming number of diseases is a healthy lifestyle: a balanced diet and physical activity. Perspective are food products that have not only nutritional but also biological properties. To create such in different countries of the world hemp seeds are used [1].

Hemp seed is one of the best sources of easily digestible vegetable protein; phytonutrients, supporting the normal state of tissues, blood vessels, skin cells and internal organs; polyunsaturated fatty acids; vitamins A, D and E and group B, calcium, sodium, iron and dietary fiber [2].

According to the research of Canadian scientists, the content of lipids in hemp seeds is 26.9 – 30.6%, and of proteins 23.8 – 28.0%. Oil from hemp seeds mainly consists of unsaturated fatty acids, dominant is linoleic acid (Omega-6) – 59.7% and α -linoleic (Omega-3) – 17.0%. [3], their ratio makes it unique [4]. Especially valuable in hemp oil is the content of more than 2% of gamma-linolenic acid contained in human milk and is rarely found in nature [2, 5, 6]. Scientists of the world are studying the fatty acid composition of hemp seed varieties zoned in their country [4, 7, 8, 9, 10, 11, 12, 13, 14]. At present there is no information on the fatty acid composition of hemp varieties of Ukrainian breeding.

Recently the extraction of oil from non-traditional raw materials such as wheat germ, hemp seeds, flax seeds, pomegranate seeds, grapes, cherries, tomatoes, coffee beans, amaranth and many others has gained wide popularity [15].

It is known that the word "hemp" causes an ordinary citizen to associate with drugs. But hemp is a plant, and cannabinoids (marijuana) are a narcotic substance that is derived from cannabis. There are three main types of cannabis:

- Cannabis sativa – crop hemp;
- Cannabis indica – Indian hemp;
- Cannabis ruderalis – hemp garbage.

In sufficient quantities to obtain a drug (30% or more) cannabinoids are contained only in Indian hemp. Crop hemp and garbage hemp contain an extremely small amount of psychoactive substances which, it should be noted, are contained only in pollen, leaves, cones of an adult hemp plant. In seeds of hemp, there are no narcotic substances in principle.

Migal M. and Shulga I. studied the dynamics of accumulation of cannabinoids in vegetative and generative organs of hemp and established by thin-layer chromatography method that there are no cannabinoid cannabis seeds in the shell and embryo of the seeds [17].

Seeds of hemp practically one-third comprise of useful fats which can be used in cooking, and hemp oil in quality is not inferior to whale fat [18].

Hemp oil is a rich and balanced source of linoleic (Omega-6), alpha-linolenic (Omega-3) fatty acids. Impact on human health of these two polyunsaturated fatty acids consists in anti-inflammatory, anti-thrombotic, antiarrhythmic and hypolipidemic properties. Hemp oil also contains a significant number of tocopherols that exhibit antioxidant activity [19].

According to the literary data the fatty acid composition of hemp oil is as follows: Omega-6 (linoleic acid) – 40–60%, Omega-3 (alpha-linolenic acid) – 15–25%, Omega-9 (oleic acid) – 11% palmitic acid – 6%, stearic acid – 3% [2].

In addition to food, hemp oil is used in the manufacture of paints, shampoos, soaps, cosmetics, body care products, etc. [14].

The purpose of the research is to determine the physico-chemical parameters and fatty acid composition of organic and conversion seeds of hemp variety "Hliana", confirmation of the literature data on the ideal ratio of Omega-3 and Omega-6 unsaturated fatty acids – 1 :3 recommended by the experts of the World Health Organization. The quality of the seeds (including the content of unsaturated fatty acids) depends on the method and conditions for the hemp growing.

Materials and methods

Materials

The object of the study is conversion oil (3 years conversion) and organic seed of industrial hemp "Hliana" of the 2017 crop grown by the agro-industrial group "Arnika" (Poltava region, Ukraine). This variety is selected at the Institute of bast crops and is universal in use (for the production of fiber and seeds), the content of tetrahydrocannabinol in it is zero. Organic hemp seed meets the requirements of the EU certificate [20]. The organic olive oil of hemp was 33.45% and the conversion value was 33.60%.

Methods

Determination of sensory indicators of oil quality

Determination of the sensory characteristics such as taste, smell, color and transparency was carried out at 20 °C.

To determine the color of 50 cm³, the oils were poured into a chemical glass and looked in the light that passed and reflected on a white background. In the presence of chlorophylls the color should be greenish.

To determine the transparency the oil was poured into a measuring cylinder per 100 cm³ and left at rest for 24 hours at temperature of 20 °C. In the settled oil in the light that passed and reflected on a white background the transparency was determined. The oil was considered transparent in the absence of weighed flakes as well as mesh (the net is due to the presence of tiny waxy substances in the oil that add turbidity). After defending the oil the presence of damp was determined in it.

The smell was determined in oil which was applied to a glass plate with a thin layer. For the most distinctive recognition of the smell the oil was heated in the water bath to 50 °C.

Taste specific, inherent in hemp oil was determined sensorially in the oral cavity.

Determination of acidity and iodine number of hemp oil

The acidity was determined according to ISO 729:1988 – "Seed oil – Determination of oil acidity".

We took a dry and clean flask with an oil sample of 5 g and dissolved it in 50 cm³ neutral mixture of diethyl ether with ethyl alcohol, shake until dissolved. To the solution an indicator (5 drops of a 1% alcohol solution of phenolphthalein) was added. After that the solution was titrated with stirring with 0.1 mol / dm³ alcoholic solution of potassium hydroxide until the indicator changed its color to bright pink. Carried out two definitions in parallel.

Oil acidity (%) was calculated by the formula 1.

$$X_1 = (V \cdot C \cdot M) / 10 \cdot m, \quad (1)$$

where C is the exact concentration of the standard solution of potassium hydroxide, mol/dm³;

V is the volume of the standard solution of potassium hydroxide expended on titration, cm³;

M is the molar mass of acids taken to express the analysis results, for coconut oil and palm kernel oil – 200 g / mol, for all other oils – 282 g / mol;

m is the weight of the sample.

For the result of determining the acidity the arithmetic mean of two parallel measurements was taken which is rounded to decimal.

The iodine number was determined according to ISO 3961:2013 – “Animal and vegetable fats and oils – Determination of iodine value”.

0.1 g oil sample was placed in a flask and added 500 cm³ 20 cm³ solvent (a mixture of 50 cm³ of cyclohexane and 50 cm³ of anhydrous acetic acid) and 25 cm³ Viysa reagent with a pipette. The Viase reagent contained monohloride iodine in acetic acid (I / Cl ratio 1.1). The flask was closed with a stopper, the contents were stirred in circular motions and placed in a dark place for 2 hours. After completion of the reaction, 20 cm³ of potassium iodide and 150 cm³ of water were added. The contents of the flask were titrated with a standard solution of sodium thiosulfate (concentration 0.1 mole / dm³) until the yellow color disappeared. A few drops of starch were added and the titration continued until the blue color disappeared. To prepare the starch solution, 5 g of starch was added to 30 cm³ of water, added to 1 liter of boiling water and boiled for 3 minutes, cooled. In parallel, titration of the blank sample was carried out according to the above procedure only without the addition of oil.

Iodine number (g / 100 g) of oil was calculated by the formula 2.

$$W_1 = (12,69 \cdot C \cdot (V_1 - V_2)) / m, \quad (2)$$

where C is the concentration of sodium thiosulfate solution, mol / dm³;

V₁ is the volume of the solution of sodium thiosulfate which was used for idle determination, cm³;

V₂ is the volume of the solution of sodium thiosulfate which was used for titration, cm³;

m is the weight of the sample.

For the result of determining the iodine number, the arithmetic mean of two parallel measurements was taken which is rounded to decimal.

Determination of fatty acid composition of hemp oil by gas-liquid chromatography

In research process a method for determining the fatty acid composition of hemp oil, namely the gas-liquid chromatography method on a Shimadzu GC 2010 – Plus (Japan) chromatograph with a capillary Thermo TR – FAME column (Germany) has the characteristics given in Table 1.

Table 1

Characteristics of the Zebron capillary column

| № | Characteristic | Value |
|----------------------------|-----------------------|---|
| Column information: | | |
| 1 | Column Dimensions | Thermo TR - FAME 30 m L × 0,25 mm ID × 0.25 μm df |
| 2 | Liquid Phase | Proprietary |
| 3 | Temperature Limits | -20 to 260 °C (Isothermal) |
| 4 | Part Number | 260M142P |
| 5 | Column Serial Number | 1102181B20 |
| Test conditions: | | |
| 6 | Column Temperature | 140 °C / 5,0 min → 4,0 °C / min to 220 °C Hold 10 min |
| 7 | Instrument | Shimadzu GC 2010 – Plus |
| 8 | Injection Temperature | 240 °C |
| 9 | Injection Mode | Split @ 1:60 |
| 10 | Carrier Gas | H ₂ UHP |
| 11 | Detector | F.I.D @ 240 °C |
| 12 | Test Sample | 0,75 μl of FAME-37 |

The analysis was carried out at a given temperature of 140 - 250 ° C (2 ° C / min). The injector temperature was 240 °C, the detector temperature was 240 °C.

Results and discussion

Sensory quality indicators

A sensory analysis of hemp oil samples was carried out, the results of which are given in Table 2.

Table 2

Sensory indicators of quality of oil samples from organic and conversion hemp seeds

| № з/п | Indicator | Organic seed oil | Conversion seed oil |
|------------------|------------------|--|--|
| 1 | Transparency | Above the sediment is transparent | Above the sediment is transparent |
| 2 | Color | Light green | Light green |
| 3 | Smell and taste | Typical of hemp oil, without off-odors, tastes, and not bitter | Typical of hemp oil, without off-odors, tastes, and not bitter |

From the table we can conclude that the sensory quality of all samples is inherent in hemp oil.

Acidity and iodine number of hemp oil

In order to assess the quality of hemp oil samples the following physical and chemical parameters such as acidity and iodine number are determined. Comparative characteristics of physico-chemical parameters of hemp oil are given in Table. 3

Table 3
Comparative characteristics of acidity values and iodine number of hemp oil

| Indicator | Organic seeds oil | Conversion seeds oil | Control |
|-----------------------|-------------------|----------------------|---------------|
| Acidity, % | 1,13 | 1,23 | less than 1.5 |
| Iodine number, g/100g | 152 | 154 | less than 145 |

These tables confirm the presence of sufficient amount of fatty acids in oil from hemp seeds which is an important factor in the production and storage of hemp products.

Fatty acid composition

According to the content of omega-3 and omega-6 – polyunsaturated fatty acids which are recommended for the prevention and treatment of diseases of the cardiovascular and nervous systems, obesity, hemp oil is the best (even for linen oil). Also hemp oil is rich in antioxidants, phytosterols, fat-soluble vitamins and minerals. Therefore it was important to study the content of saturated and unsaturated fats in hemp oil.

Determination of the fatty acid content of hemp oil was carried out by chromatographic method by analyzing the methyl esters of fatty acids contained therein based on the testing laboratory of “Cotecnа Ukraine Limited” Ltd. The chromatogram results are shown in Fig. 1 and 2.

According to chromatogram data the percentage content of acids in hemp oil which is given in Table 4 was determined. Hemp oil contains the maximum amount of unsaturated fatty acids in comparison with known vegetable oils. Scientists have long confirmed the need for humans in polyunsaturated fatty acids Omega-3 and Omega-6, but the primary importance is not only the content of these acids in the product but the right combination [2]. According to literary data in hemp oil the ratio of essential fatty acids (EFA) is close to the ideal: Omega-3 and Omega-6 are 1:3, while in linseed oil is 4:1, in rape is 1:2, in soya is 1:7 [4].

As can be seen from the data given, the content of basic acids in hemp oil from seed variety “Hliana” corresponds to the data of literary sources of information. It was confirmed that the ratio of Omega-3 and Omega-6 in hemp oil is 1: 3.6 which is approximately ideal for human digestion, and the content of gamma-linolenic acid (Omega-6) is about 2%.

It is known that the human body needs about 2-3 grams of omega-3 and 4 grams of omega-6 each day. This amount of unsaturated fatty acids can provide 1 tablespoon of hemp oil per day.

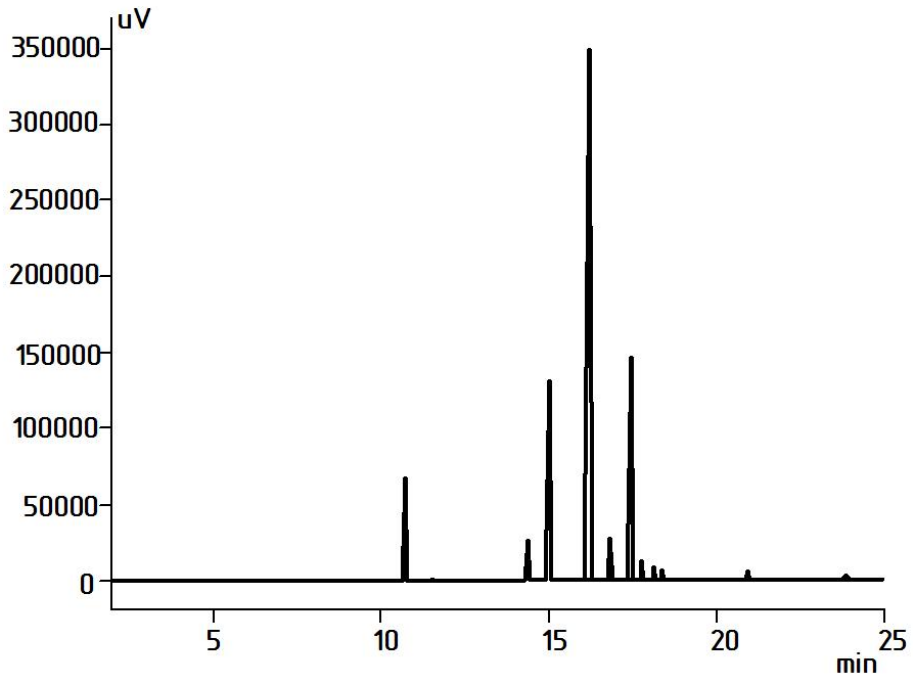


Figure 1. Chromatogram of oil fatty acids from organic seed of industrial hemp variety "Hliana"

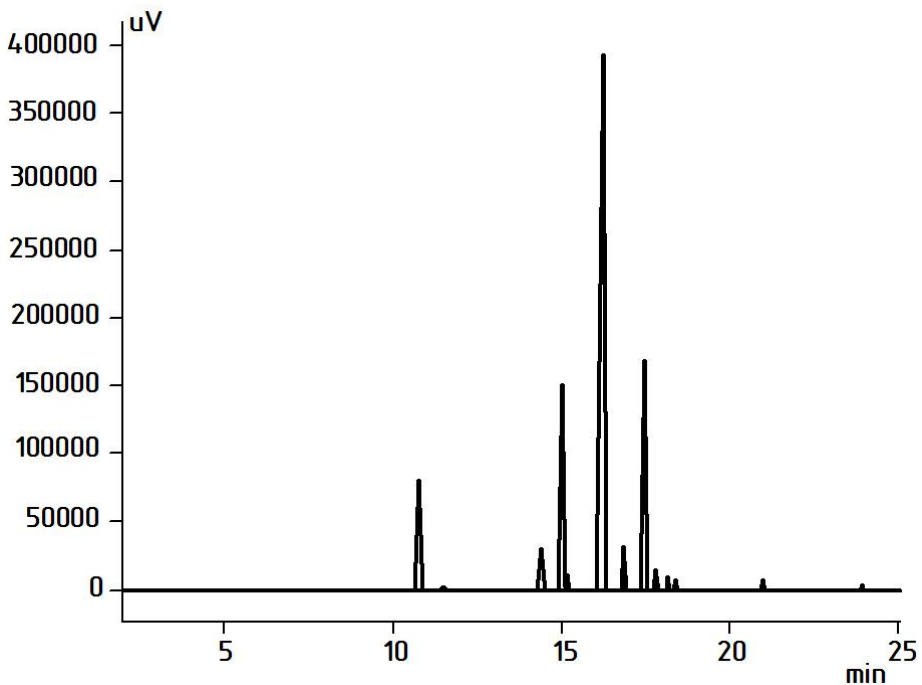


Figure 2. Chromatogram of oil fatty acids from conversion seed of industrial hemp variety "Hliana"

Table 4.
Comparative characteristics of the fatty acid composition of the test samples of hemp oil

| Name of the acid | The content of acid % relative to total acids | |
|--------------------------------|---|---------------------|
| | Organic seed oil | Conversion seed oil |
| C 16:0 Palmitic | 6,007 | 5,994 |
| C 16:1 Palmitoleic | 0,098 | 0,104 |
| C 18:0 Stearic | 3,033 | 3,070 |
| C 18:1n9c Oleic | 16,155 | 16,154 |
| C 18:2n6c Linoleic | 54,803 | 54,989 |
| C 18:3n6 gamma-Linolenic | 2,269 | 2,260 |
| C 18:3n3 Linolenic | 14,821 | 14,654 |
| C 20:0 Arachidic | 1,019 | 1,012 |
| C 20:1 cis-11-Eicosenic | 0,695 | 0,684 |
| C 20:2 cis-11,14-Eicosadienoic | 0,461 | 0,446 |
| C 22:0 Behenic | 0,443 | 0,434 |
| C 24:0 Lignoceric | 0,197 | 0,198 |

Conclusion

During the researches of physical and chemical indices of hemp oil from organic and conversion seeds it was established:

- the acidity of the test specimens of the hemp oil is within the range of 1.13 – 1.23%;
- the iodine number of prototype hemp oils is in the range of 152 – 154 g / 100 g;
- hemp seed variety “Hliana” contains approximately 55% of linoleic (Omega-6) acids, 16% oleic acid (Omega-9), 15% alpha-linolenic (Omega-3) and 2% gamma-linolenic (Omega-6) acid. It is confirmed that the ratio of Omega-3 and Omega-6 in hemp oil is 1 : 3.6 which is close to the ideal for human assimilation;
- indicators of composition and quality of oil from organic and conversion seeds of hemp are not nearly identical.

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