INVESTIGATION OF THE QUALITY OF VEGETABLE OILS

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Abstract

Vegetable oils are essential providers of energy to a human body; they play important role as a foodstuff. During processing and storage of vegetable oils, they may undergo molecular changes adverse to the human organism affecting the quality of the oils.

The content of fatty acids of fresh rapseed, linseed and hemp oils and of the mixture of rapeseed (800 g kg^{-1}) and linseed (200 g kg^{-1}) oils was determined by the method of gas chromatography (GH).

α -, δ - and γ - tocopherols was analyzed in the vegetable oils by the methods of the highly effective liquid chromatography (HPLC).

The hemp oils contain the indispensable polyunsaturated fat acids: linoleic acid – 53.0%, and linolenic acid – 23.2%. Such proportion of the fatty acids (3:1) is considered optimal in the nutrition.

When using both hot and cold pressure technology for the obtaining of oil it is possible that the polycyclical aromatic hydrocarbon – Benzo[a]pyrene – may be created and influenc the quality of the oil.

The environment also affects the content of the lead in the oils.

The density of the various vegetable oils at the temperature of 20 °C proved to be within the limits of 0.917 and 0.942 kg dm^{-3}.

Keywords: vegetable oil, fatty acids, α -, δ - γ, tocopherol, benzo(a)pyrene, density, lead.

Introduction

Over the last few years, a lot of attention has been paid to the plants that are most suitable to the Latvia climate and has-been cultivated from the ancient times, yielding oil, like rape, hemp, and flax. The oil processed through the technology of cold press, not exceeding the temperature of +50 °C, without purifying is considered to be a natural vegetable oil.

The oil of linseed and hemp is a really valuable resource of the natural products. It used to be the first curative accessible to our grandparents for the treatment of various diseases.

Linoleic and linolenic acids are called the vitamin F which has rich reserves of the flax and hemp oils. Those compounds are called indispensable fatty acids; they are necessary to the organism, though they cannot be synthesized and must be taken in with the food. Nature holds just a few products like oils of blackcurrant and grape seeds which are particularly rich in this vitamin and which directly stimulate the work and renewal of cells and normal functioning of metabolism processes (Mustard, 2005).

Tocopherols (vitamin E) naturally save the polyunsaturated fatty acids from being oxidized by default. Particularly large amounts of vitamin E are to be found in the oils of sunflower seeds, flax seeds and sprouts of wheat. During the process of refinement, some part of vitamin E is being lost, and the oil contains some remaining 75% of this vitamin, which is enough to save this oil from oxidation for some time (Dutta et al., 2003; Kulas et al., 2002; Farag et al., 1989). Anti radical characteristics within the cell membranes are displayed by vitamin E. Oxidation inhibitor soluble in the lipids reacting with the ROO^{-} of the lipid - peroxiradically (Tang et al., 2005; Goffman et al., 2001).

One of the most important role in the quality of oils plays the Benzo[a]pyrene.This is a polycyclic aromatic hydrocarbon with the cancerous cell development characteristics. Benzo[a]pyrene may be included into the oil through the seeds if they have been dried and ignoring the technology.

When using the food containing lead, it is absorbed in the small intestines. The lead accumulates in the liver, the kidneys, the bones, the pancreas, sometimes in the spleen and the brain. It may lay inactive for many years, and the human being feels healthy. The period of saving of the lead in the bones is approximately 20 years, in the blood – 35 days. The knowledge about the processes of the discharge of lead out of the body is very scarce. With the lowering of the organism's immunity (due to an increased intake of alcohol or smoking) and as the result of infectious diseases, physical or psychic trauma, the lead may enter the blood vessels causing the poisoning. Entering the blood the lead links itself with hemoglobin and plasma proteins, which may lead to erythrocythemia and disorders of the cell oxidation. Therefore, control over the contents of lead is so important (Belitz et al., 2004).

Various oils have different densities inherent just to them. They depend upon the contents of oil fatty acids.

The task of the investigation is:

- to determine and compare the contents and density of the fatty acids, tocopherols, Benzo[a]pyrene and lead for the rapseed oil, linseed oil and hemp oil produced in Latvia;
- to create the mix of rapeseed oil and linseed oil, 80 % and 20 % correspondingly.

Materials and Methods

Materials

Fresh, cold pressed and unrefined vegetable oil (rapseed, linseed and hemp oils), as well as the mix of rapseed and linseed (80% and 20% correspondingly) from 'Naukšēni' Ltd and 'Iecavnieks' Ltd were determined.

Methods

The content of vegetable oils was determined using the gas chromatography (GH). The content of fatty acids was analyzed with the Shimadzu GC 2010 (detector – flame ionization, column – AT-Wax length 50 m, internal diameter – 0.25 mm, thickness of immobile phase – 0.2 μm) (LVS EN ISO 5508:1995, LVS EN ISO 661:2005, LVS EN ISO 5509:2001).

Huge resolution of the highly effective liquid chromatography (HPLC) methods allows separating the classes of the matter of a wide range; it is used as the method for separation of the hardly evanescent or thermally unstable compounds.

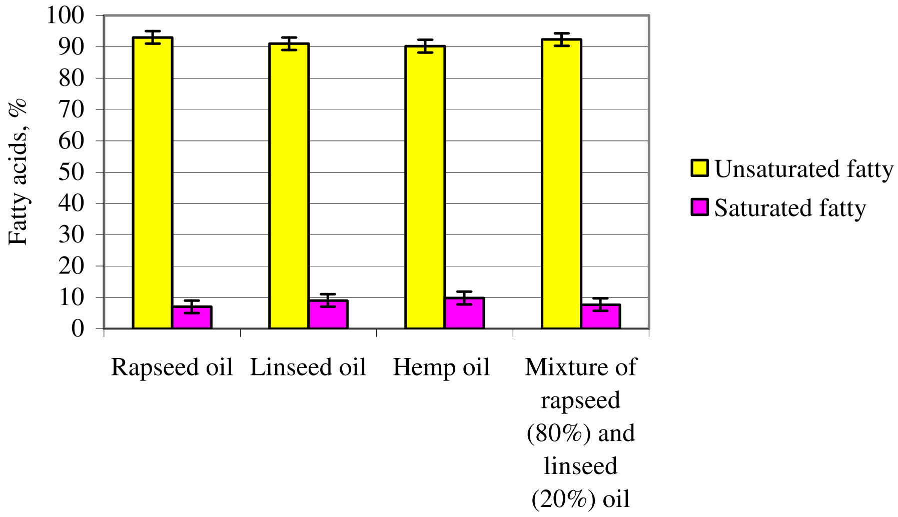
The content of tocopherols in the vegetable oils was established with the HP HPLC 1110 (ELSD detector, column – Pronto SIL C 30 5μm, length – 250 mm x 4.6 mm, mobile phase 96% of methanol : 4% of water, thermostat temperature – 25 °C, 0.9 mL min) (LVS EN ISO 9936:2001).

The content of Benzo[a]pyrene was set by the HP HPLC 1110 (ELSD detector, column: C 18, 5 μm, length 250mm x 4,6mm, mobile phase: 40% acetonitrile: 60% water, thermostat temperature – 25 °C, 1.0 mL min) (LVS EN ISO 15302:2001).

Table 1

The Content of fatty acids in the oils of linseed, rapseed and hemp

Fatty acids	**Rapseed oil, % ±2.0**	**Linseed oil, % ±2.0**	**Hemp oil, % ±2.0**	**The mix of the rapseed and linseed oil, % ±2.0**
14:0	0.1	0.1	0.1	0.1
16:0	4.1	4.9	5.8	4.4
16:1	0.2	0.2	0.1	0.2
17:0	0.1	0.1	0.1	0.1
17:1	0.1	-	-	-
18:0	1.7	3.4	2.4	2.3
18:1 cis 9	58.0	19.3	10.5	48.0
18:1 cis 11	3.0	0.8	0.9	2.8
18:2	19.5	14.7	53.0	17.0
18:3 gamma	**-**	**-**	**4.3**	**-**
18:3 alpha	10.3	55.8	18.9	22.9
18:4	-	-	1.5	-
20:0	0.6	0.2	0.9	0.5
20:1	1.4	0.2	0.5	1.2
20:2	0.1	-	0.1	-
22:0	0.3	0.2	0.4	0.2
22:1	0.2	-	0.3	0.1
24:0	0.1	0.1	0.1	0.1
24:1	0.2	-	0.1	0.1



Figu e 1. The content of satu ated and unsatu ated fatty acids in the vegetable oils.

The content of lead in the vegetable oils was established by the x–ray fluorescence method with the Oxford Instruments EDXRF spectrophotometer Lab-X 3500.

The density of vegetable oils was established by means of the Anton Paar digital density measurer (DMA 48) (LVS EN ISO 3656:2003). The densities of vegetable oils was established electronically by measuring the oscillation of the vibration of the U–tube.

Each measuring was carried out several times and then the simple average was calculated.

The data were analyzed statistically by using SPSS for Windows, MS Excel.

Results and Discussion

The content of linseed, rapseed and hemp oils was determined using the gas chromatography method (Table 1).

It should be emphasized that the content of γ-linolenic within the hemp oil constitutes 4.3%. The physiological characteristics of this acid has been examined just recently. However, it plays an important role in the prevention of the immunological disturbances. The author may mention the few oils containing the γ-linolenic, for example, the black currant and grape seed oil (Belitz et al., 2004).

By the use of the chromatography data, a comparison between the contents of saturated and unsaturated fats in the oils of rapseed, linseed and hemp was made (Figure 1).

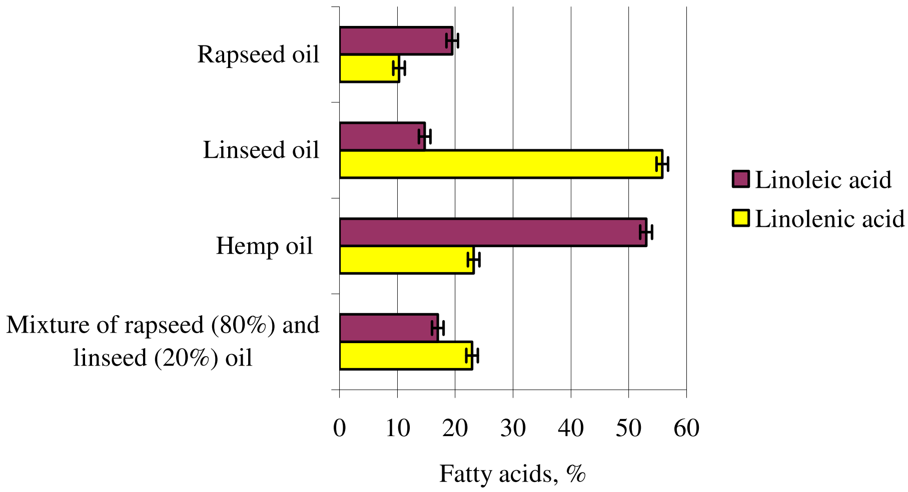
The common content of unsaturated fatty acids in rapseed oil was 93.0%, in linseed oil – 91.0% and in hemp oil – 90.2%, but the content of polyunsaturated fatty acids in rapseed oil was 29.8%, in linseed oil – 70.5% and in hemp oil – 77.7%. In the mixture of rapseed and linseed oils, the content of unsaturated fatty acids was 92.3% and of polyunsaturated fatty acids – 39.9%.

Due to the influence of the indispensable fatty acids ω-6 and ω-3, that is, linoleic and linolenic, the level of the triglycerides and the low density lipoproteins lowers, and the level of the high density lipoproteins increases, which helps protect against the heart diseases, cancer and atherosclerosis, and slightly increases the blood vessels. Therefore the author investigated the fatty acids content in linseed, hemp and rapseed oils (Figure 2). The hemp oil contains indispensable polyunsaturated fat acids: linoleic – 53.0%, and linolenic – 23.2 %. Such proportion of the fatty acids, 3:1, is considered to be the optimal in the human nutrition thereby hemp oil is considered to be unique among the other vegetable oils under the research.

Linseed oil is rich in linolenic acid (55.8%) which is an essential fatty acid for the human being. The unsaturated fatty acids are very important for our immune system and help us regulate our blood pressure.

With the HPLC method of the liquid in determining the tocopherol content it was found that the predominant ingredient in the linseed, hemp and rapseed oils was the α-tocopherol. The highest content of tocopherols was found in the hemp oil (Figure 3).

The content of α-tocopherols in rapseed oil was 95.8 mg kg^{-1}, in linseed oil – 25.3 mg kg^{-1},



Figu e 2. The atio between linolenic acids and linoleic acids in the vegetable oils.

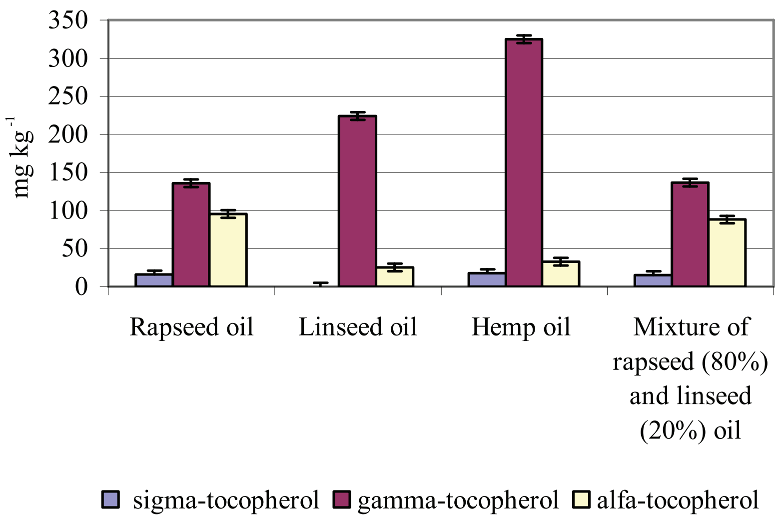
and in hemp oil – 32.4 mg kg^{-1}. In the mixture of rapseed and linseed oils, the content of α-tocopherols was 88.1 mg kg^{-1}.

It is well known that the α-tocopherols take an active part in the work of ductless glands and fat metabolism, as well as participates in the process of transforming the carotene into vitamin A. Its work is associated with the processes of fat metabolism.

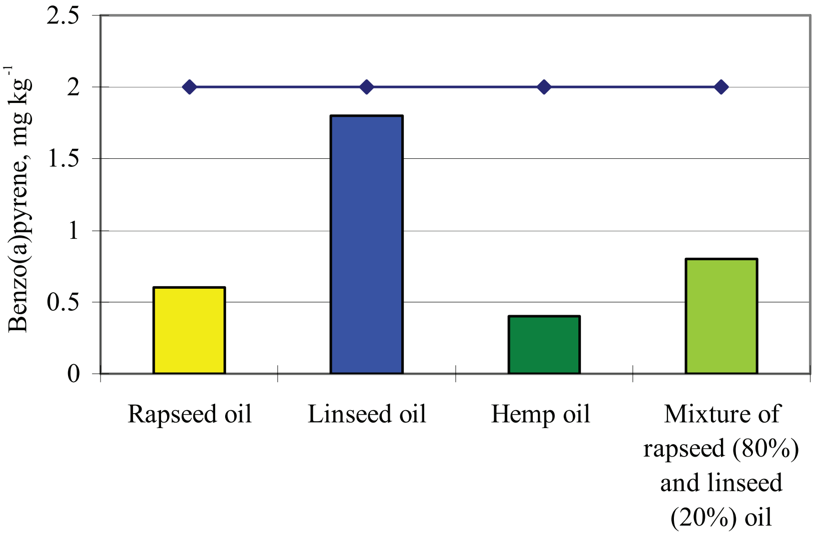
The content of Benzo[a]pyrene was established using the highly effective liquid chromatography (Figure 4). In the oils under the research, the content of Benzo[a] pyrene did not exceed the permissible level of 2 μg kg^{-1}. Benzo[a] pyrene, having carcinogenic qualities, may serve both as quality and quantity indicator in relation to the multiring aromatic hydrocarbon content within the product (Commission Regulation 2005/208/EC).

The results of obtained vegetable oils density are shown in Figure 5. The results show that density of the various oils differs in a wide range. The volume of the density was observed depending the type of the oils, and this also affects the changes in those oils.

With the use of the x–ray fluorescence spectrometer, the content of lead was established in various vegetable oils. An increased lead



Figu e 3. Tocophe ols content in the vegetable oils, mg kg^{-1}.



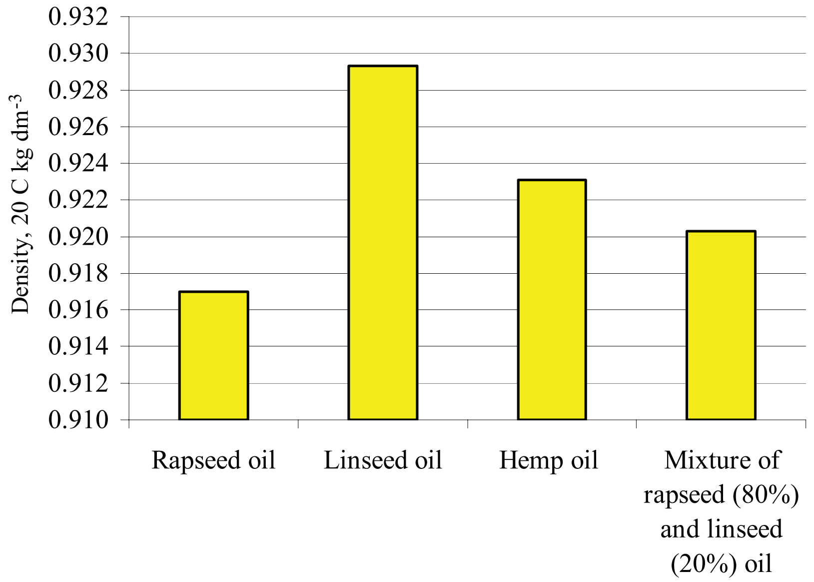
Figu e 4. Benzo[a]py ene content in f esh vegetable oils, μg kg^{-1}.

intake through foods and vegetable oils may cause illnesses of various origin, as well as disorders of the nervous system, therefore control of the lead content is so important (Commission Regulation 2005/78/EC).

The lead content in the vegetable oils was established in all the oils ranging from 0.02 to 0.05 mg L^{-1}. In accordance with the data from FAO, the human daily intake of lead may reach 0.2 – 0.3 mg L^{-1} (Codex STAN 33-1981).

Conclusions

- The content of fatty acids in the vegetable oils under the research was established as follows:
  - total content of unsaturated fats in linseed oil amounted to 91.0 %, including irreplaceable fat acids – 70.5%; in hemp oil – correspondingly 90.2% and 77.7%, and in rapseed oil – 93.0% and 29.8%;



Figu e 5. Density of the vegetable oils.

- in the mixture of rapseed and linseed oils, the content of unsaturated fatty acids was 92.3%, and that of polyunsaturated fatty acids – 39.9%;
- the hemp oil is the only oil under the research containing the flex acid γ-linolenic (4.3%). The ratio between linoleic and α-linolenic is 3:1 for the demands of the optimal human organism. Thus, hemp oil may be considered as unique among other vegetable oils under the research.

- While examining the contents of tocopherols it was established that linseed oil, hemp oil and rapseed oil predominantly contain α-tocopherols that are followed by α-tocopherols and smaller amount of α-tocopherols.The highest content of tocopherols was found in hemp oil. The content of α-tocopherols in rapseed oil was 95.8 mg kg^{-1}, in linseed oil – 25.3 mg kg^{-1}, and in hemp oil – 32.4 mg kg^{-1}. In the mixture of rapseed and linseed oils the content of α-tocopherols was 88.1 mg kg^{-1}.
- Benzo[a]pyrene was found in all of the oils under the research, and its content did not exceed 2 μg kg^{-1}.
- The density of vegetable oils at the temperature of 20 °C remained within the range of 0.917 – 0.942 kg dm^{-3}.
- As one of the indicators of the pollution, was determined the content of lead in the oils under the research. In all the oils the lead content was established 0.02 – 0.05 mg L^{-1}. The level of lead in the vegetable oils is not a reason for alarm, though it is necessary to take sustained measures to continue to decrease the average level of the lead content in the foodstuffs.

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