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Physico-Chemical Properties, Composition and Oxidative Stability of *Camelina sativa* Oil

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Summary

Camelina sativa is a cruciferous oilseed plant. With the aim of describing the general characteristics of the oil obtained from the seeds of plants grown in Slovenia and of comparing it to camelina oil from other countries we determined some physico-chemical properties, fatty acid composition, iodine and saponification value and followed its oxidative stability under different storage conditions. The density at 20 °C was (0.9207 ± 0.0001) g/cm^3 and the refractive index reached 1.4756 ± 0.0001 at 25 °C. The analysis of fatty acids showed 10.3 % of saturated and 55.8 % of polyunsaturated acids, with 16.9 % of linoleic (C18:2), 35.2 % of α-linolenic (C18:3ω3) and 1.6 % of erucic acid (C22:1). Determination of oxidative stability of this highly unsaturated oil revealed that the formation of primary oxidation products was affected by photooxidation. The peroxide value, *PV*, of fresh oil was (2.38 ± 0.01) meq O_2/kg, while after 1 month in daylight at room temperature *PV* reached (21.0 ± 0.1) meq O_2/kg. When stored in darkness *PV* was (8.12 ± 0.08) meq O_2/kg. In the fresh oil, the *p*-anisidine value, *AV*, was 6.2 ± 0.1, after 11 months at room temperature 10.4 ± 0.1, and after the same time at 8 °C in darkness 7.1 ± 0.1. Susceptibility to oxidation of camelina oil was measured by the Rancimat test and expressed as the induction period. In fresh camelina oil the induction period was 4.8 h.

Key words: Camelina sativa oil, fatty acids, omega-3 fatty acids, density, refractive index, oxidative stability

Introduction

Camelina sativa, with the popular names false flax or gold of pleasure, is a cruciferous oilseed plant (*1*). It used to be an important oil crop during the Bronze and Iron Ages and it is still not clear why it was gradually replaced in the Middle Ages and thereafter. Slovenia is one of the few countries where at some farms in the Koroška region the production of *Camelina sativa* is still carried on. Recently, interest in *Camelina sativa* has been renewed (*2–4*) due to the fact that the crop does not require high inputs of nutrients and pesticides, it grows well in semiarid regions, and in the soil with low fertility (*1*).

The main product of *Camelina sativa* is the oil produced by crushing and pressing the seeds, which contain about 30 to 40 % of oil on a dry matter basis (*5*). Camelina oils are high (about 50 %) in polyunsaturated fatty acids. Their composition varies with the agrotechnical measures used in their production but primarily linoleic (18:2) and α-linolenic acid (18:3ω3) are found in the oil. This makes camelina oil a rich source of essential fatty acids (*6*) and a very good source of omega-3 fatty acids. These compounds may have favourable nutritional implications and beneficial physiological effects (*4,7*). Camelina oil can reduce serum triglycerides and choles-

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terol significantly (*6*), and some researchers think that it deserves greater attention (*2,8*).

Camelina oil with its unique fatty acid composition may be regarded as special oil suitable for direct consumption. The oil can be used in salads or for cooking, for the preparation of omega-3 fatty acid-enriched margarine, in the formulation of salad dressings, mayonnaise, ice cream, *etc*. (*1*). Because of its possible nutriceutical effects, the oil may attract considerable attention for use in the production of health promoting foods.

The development of oxidative rancidity has been recognized as the predominant cause of oil deterioration during storage. The main parameters that determine the stability of oils toward oxidation are the triglyceride composition and the presence of antioxidant compounds. Due to high content of unsaturated fatty acids in camelina oil its oxidative stability should be an important factor. To date only few investigations on the oxidative stability of oil from camelina plant seeds and the storage stability of a camelina oil-based spread have been carried out (*3,9*). In these studies camelina oil was found to be more stable towards oxidation than highly unsaturated linseed oil but less stable than rapeseed, olive, corn, sesame and sunflower oils.

With the aim of describing general characteristics of the oil obtained from the seeds of C*amelina sativa* plants grown in Slovenia and to compare it to camelina oil from other countries, we determined some physico-chemical properties, fatty acid composition, iodine and saponification value and followed its oxidative stability under different storage conditions.

Materials and Methods

Materials

The camelina oil used in this study was produced from seeds of *Camelina sativa* plants grown in 2002 near Prevalje in the Koroška region, Slovenia. The camelina oil was obtained by the following procedure. Dried seeds were milled and mixed with water. The mixture obtained was roasted at temperatures ranging from 60 to 90 °C. After pressing, the oil thus obtained was filtered. According to the local oil producers, roasting of the seeds is necessary, as the oil cannot be obtained from non-roasted milled seeds. Before the investigation the oil was held in darkness at 8 °C for 3 weeks. This oil was »fresh oil« and had an attractive yellow colour and distinctive mustard like odour.

All other chemicals and solvents were of analytical grade.

Determination of physical characteristics

Density was determined picnometrically according to AOAC Official Method 9201.212 (*10*) at temperatures ranging from 20.0 to 50.0 °C. The accuracy of density determination was about $1 \cdot 10^{-4}$ g/cm^3.

Refractivity index was determined according to AOAC Official Method 921.08 (*10*) at (25 ± 0.05) °C with a Carl Zeiss Abbé refractometer (32-G 110e) with the precision of $1 \cdot 10^{-4}$ at 589 nm. The measurement was repeated ten times.

Determination of chemical characteristics

Free fatty acid content, iodine value and saponification value were determined according to AOAC Official Methods 940.28, 920.185 and 920.160 (*10*). These determinations were carried out in triplicate.

Determination of fatty acid composition

Fatty acids were determined as methyl esters after transesterification according to AOAC Official Method 969.33 (*10*) by gas chromatography on HP 5890 Hewlett-Packard gas chromatograph, series II instrument (Hewlett Packard Corp., Palo Alto, USA), equipped with a fused silica capillary column – Supelco, SP 2380 (60 m × 0.25 mm and film thickness 0.20 μm). The stationary phase was polysiloxane (90 % biscyanopropyl / 10 % cyanopropylphenyl). The carrier gas was helium at flow rate 1 cm^3/min. The internal standard was heptadecanoic acid. The column temperature was programmed to 210 °C. Injector and flame-ionization detector temperatures were set at 250 and 260 °C. The analysis was carried out in triplicate. The results are given as the weight percentage of total fatty acids. Values of the standard deviation were between 0.01 and 0.25 %.

Determination of oxidative stability

Storage conditions

Oil samples were transferred to transparent glass bottles (400 mL of 12 cm in diameter). The bottles were closed and subjected to different storage conditions: (*i*) at room temperature with exposure to daylight, (*ii*) at room temperature in darkness, and (*iii*) at 8 °C in darkness.

Periodically a suitable volume of oil was withdrawn from each bottle and subjected to the Rancimat test and to the determination of peroxide and *p*-anisidine value.

In the summer months (June, July and August) the room temperature varied between 25 and 30 °C, while in the rest of the year the temperature was between 20 and 25 °C. The oil samples exposed to daylight were placed approximately 1.5 m from the window and were not exposed to direct sunlight. The intensity of light in the room depended on the weather conditions. These are shown in Table 1 for each month of the experiment as hours of bright sunshine duration in Ljubljana. Table 1 also presents the number of hours per day the samples were exposed to light, expressed as the mean monthly length of the day. The data were taken from http:// www.arso.gov.si.

Peroxide value and p-anisidine value

Oxidation rate was followed by periodic determinations of peroxide and *p*-anisidine value. *PV* was determined according to AOAC Official Method 965.33 (*10*) and *AV* according to IUPAC method 2.504 (*11*). Both determinations were carried out in duplicate. *PV* was expressed as meq O_2/kg of oil. Standard deviation for each *PV* determination was less than 2 % and *AV* determination was less than 0.1.

Table 1. Bright sunshine duration and mean monthly length of day

Month	Bright sunshine duration / h	Mean monthly length of day / h
2002		
June	298	15.7
July	281	15.3
August	220	14.0
September	177	12.5
October	109	10.8
November	55	9.5
December	16	8.7
2003		
January	71	9.0
February	135	10.3
March	208	12.0
April	188	13.7
May	–	15.0
June	283	15.7

Rancimat test

Susceptibility of camelina oil to oxidation was also studied using the Rancimat test (*12,13*). The test was performed on a Rancimat apparatus 679 (Methrom, Herisau, Switzerland) by measuring the induction period at 110 °C and an air flow rate of 20 dm^3/h. Determination of the induction period was based on the conductometric detection of volatile acids. The determination was carried out in duplicate. The induction time measurements were reproducible to within ±2 %.

Results and Discussion

Physical and chemical characteristics

In Table 2 some physical and chemical characteristics of camelina oil are presented. The oil contains 2.35 % of free fatty acids, which is quite a high value. Free fatty acids were probably formed by the hydrolytic activity of lipolytic enzymes during the preparation of seeds for oil production. This parameter actually assesses the treatment of the seeds before and during pressing. Unrefined oils can have up to 3.0 % of free fatty acids according to the Regulations (*14*) for such oils. It has to be stressed here again that our camelina oil was not refined, simply filtered after pressing.

The values of the density, ρ, of camelina oil at different temperatures are presented in Table 2. The density at 25 °C (0.9184 g/cm^3) obtained for this highly unsaturated camelina oil (about 56 % of polyunsaturated fatty acids) is slightly higher than those published for some other vegetable oils with small or even negligible quantities of polyunsaturated linolenic acid (ρ(corn oil) = 0.916 g/cm^3, ρ(cottonseed oil) = 0.914 g/cm^3, ρ(olive oil) = 0.909 g/cm^3, ρ(rapeseed oil) = 0.903–0.907 g/cm^3, ρ(sunflower oil) = 0.9178 g/cm^3, ρ(soybean oil) = 0.9148 g/cm^3) (*15,16*). Higher density is quite understandable bearing in mind that the density of oil increases as the degree of unsaturation increases (*17*).

The effect of temperature on the density of camelina oil presented in Fig. 1 is described by a polynomial relationship:

$$\rho = a + b \cdot t + c \cdot t^2 \qquad /1/$$

where t is the temperature in °C, while a, b and c are the regressional parameters. For the investigated oil sample the parameters were obtained by regression analysis and amounted to a = 0.92826, b = $-3.09 \cdot 10^{-4}$ and c = $-3.48 \cdot 10^{-6}$, R^2 = 0.99998.

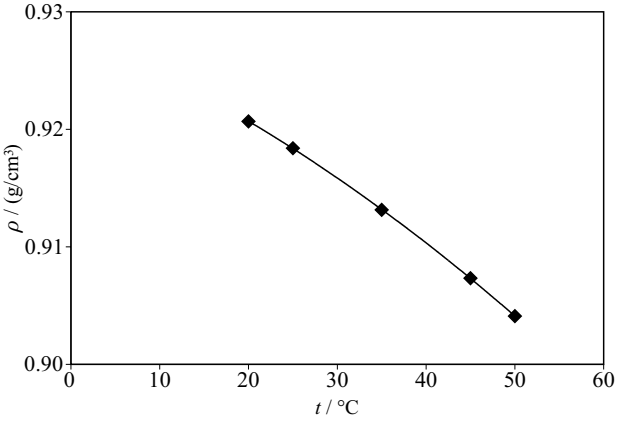

Fig. 1. Density of *Camelina sativa* oil as a function of temperature

The value for the refractive index of camelina oil at 25 °C was 1.4756. The observed value is higher than the values of refractive index for some other vegetable oils such as corn (1.4726), soybean (1.4728) or sunflower oil (1.4740) (*16*).

Fatty acid composition

Fatty acid composition of the investigated camelina oil is presented in Table 3. The amount of the most abundant fatty acid, *i.e.* α-linolenic acid found in the oil was 35.2 %. Common vegetable oils such as olive, corn and sunflower oils have less than 1 % of α-linolenic acid, rapeseed or soybean oil have about 8 %, and linseed oil with up to 60 % is the richest source of α-lino-

Table 2. Physical and chemical characteristics of Slovene *Camelina sativa* oil

Free fatty acid content*/%	Iodine value* (g I_2 / 100 g oil)	Saponification number* (mg KOH / g oil)	Density / (g/cm^3) 20 °C	25 °C	35 °C	45 °C	50 °C	Refractive index at 25 °C
2.35 ± 0.002	104.7 ± 0.3	187.8 ± 0.1	0.9207	0.9184	0.9132	0.9073	0.9041	1.4756

* average of three replicates ± standard deviation

Table 3. Content of fatty acids in *Camelina sativa* oil

Fatty acid	Content of fatty acid / %			
	This study*	Budin *et al.* (*2*)	Eidhin *et al.* (*3*)	Zubr *et al.* (*8*)
palmitic acid (16:0)	6.43 ± 0.01	5.7 – 8.4	5.5	5.3 – 5.6
stearic acid (18:0)	2.57 ± 0.01	1.4 – 3.5	2.3	2.3 – 2.7
oleic acid (18:1)	17.40 ± 0.30	14.2 – 19.4	14.9	14.0 – 16.9
linoleic acid (18:2)	16.90 ± 0.10	19.0 – 24.0	15.8	13.5 – 16.5
α-linolenic acid (18:3)	35.20 ± 0.40	27.1 – 34.7	38.9	34.9 – 39.7
arachidic acid (20:0)	1.24 ± 0.05	**	0.4	1.2 – 1.5
gondoic acid (20:1)	14.90 ± 0.20	12.3 – 14.7	16.2	15.1 – 15.8
eicosadienoic acid (20:2)	2.12 ± 0.02	**	2.1	1.7 – 2.0
eicosatrienoic acid (20:3)	1.61 ± 0.03	**	1.3	1.3 – 1.7
erucic acid (22:1)	1.62 ± 0.03	0.0 – 4.0	2.4	2.6 – 3.0

* average of three replicates ± standard deviation
** all others: 2.0 – 8.1 %

lenic acid (*16*). Camelina oil contains gondoic acid (20:1), which in the investigated oil amounted to 14.9 %, but is not present in most common vegetable oils (*2,16*).

In Table 3 the results of fatty acid analysis are compared with those of Budin *et al.* (*2*), Eidhin *et al.* (*3*) and Zubr *et al.* (*8*). The fatty acid composition of Slovene camelina oil was similar, but not the same as that reported for oils from seeds of camelina cultivars grown in the USA, Central and Northern Europe (*2,3,8*). Budin *et al.* in their investigation (*2*) carried out on oils from Minnesota, USA, found lower contents of α-linolenic and gondoic acid, but a higher amount of linoleic acid than in our study. For 5 cultivars grown in Central and Northern Europe Zubr *et al.* (*8*) report values for α-linolenic acid from 34.9 to 39.7 %, oleic acid from 14.0 to 16.9 %, linoleic acid 13.5 to 16.5 % and gondoic acid from 15.1 to 15.8 %. The differences in the composition can be ascribed not only to different cultivars but also to different regions and different growing conditions. In camelina oil 1.6 % of erucic acid (22:1) was also found. This acid is considered as a limiting factor in vegetable oil because it determines the oil's applicability for human consumption. The content of erucic acid in our camelina oil was well below the permitted value of 5 % (*14,18*) and also significantly lower than the values (2.6–3.0 %) reported by Eidhin *et al.* (*3*) and by Zubr *et al.* (*8*).

Determination of oxidative stability

The effect of storage conditions on the formation of primary oxidation products, expressed as *PV*, versus time of storage is shown in Fig. 2. At the beginning of the experiment a peroxide value of 2.38 meq O_2/kg for camelina oil was determined. The value falls in the range considered as satisfactory according to the Regulations on Edible Oils (*14*). Although the peroxide value is applicable for monitoring peroxide formation in the early stages of oxidation, it is nevertheless highly empirical and its accuracy questionable (*19*). Still, *PV* determinations are widely reported.

Fig. 2 illustrates that in camelina oil exposed to daylight for 1 month at ambient temperature *PV* rose sharply to 21.0 meq O_2/kg, and that after 10 months it reached 50.6 meq O_2/kg. Higher rate of increase in the *PV* of this sample during the first month, but not later, can be at least partially attributed to higher temperature and longer days in June and July (Table 1) when the experiment was started. *PV* of the oil stored in darkness (Fig. 2) did not show such a sharp increase after the first month of storage. During this month *PV* increased from 2.38 to 8.12 meq O_2/kg, and in the next 10 months it reached 32.2 meq O_2/kg. These findings show that the oxidation process in the first period of storage was more affected by light than by temperature. We believe that faster oxidation occurred due to greater exposure to light (*20,21*). In an investigation by Eidhin (*3*) performed on camelina oil the same trend has been observed. But in his study *PV* increased more progressively than in

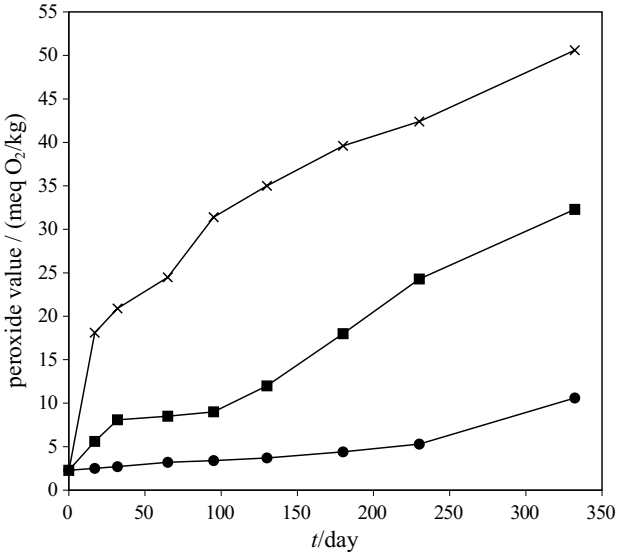

Fig. 2. Effect of light and temperature on the peroxide value of *Camelina sativa* oil during storage (× – daylight, room temperature; ■ – darkness, room temperature; ● – darkness, temperature 8 °C). Values are means of two replicates with standard deviation of determination 0.02 – 0.8 meq O_2 / kg

Table 4. Peroxide value after three months in different oils and storage conditions

Oil	Storage conditions	Duration of storage / month	*PV* / (meq O_2/kg)
Slovene camelina oil	daylight, room temp.	3	31.4
	darkness, room temp.	3	9.0
Eidhin *et al.* (*3*)	daylight, room temp.	3	130
	darkness, room temp.	3	90
Matthäus (*9*)	dark glass bottles, room temp.	3	20
Crude sunflower oil (*9*)	dark glass bottles, room temp.	3	20
Crude rapeseed oil (*9*)	dark glass bottles, room temp.	3	9.0

ours. We compared the results of our study (Table 4) to those already published for the same type of oil and for 2 other edible oils. Table 4 shows storage conditions, duration of storage and *PV* value. It can be concluded from the data in Table 4 that our camelina oil is quite stable in comparison with common edible oils and other camelina oils.

PV of 20 meq O_2/kg, the upper limit for unrefined oils (*14*), was attained in 1 month in oil exposed to daylight at ambient temperature. In darkness the same value was attained in 6.5 months. As can be seen in Fig. 2, the oil after the storage for 11 months at 8 °C in darkness had a peroxide value of 10.6 meq O_2/kg so the upper limit of *PV* was not reached. Thus oxidation is retarded even in highly unsaturated camelina oil if proper storage conditions are chosen and as long as antioxidants are present.

Among other bioactive compounds phenolics are considered as possible antioxidants in oils. Many authors (*22–24*) have confirmed a close correlation between total phenolic content and oil stability towards oxidation. In a preliminary experiment we determined approximately 400 mg of total phenolics per kg of fresh oil (unpublished results). The determination of total phenolics was performed spectrophotometrically at 765 nm with Folin-Ciocalteau reagent using chlorogenic acid for the preparation of a standard curve. According to the literature data camelina oil also contains an appreciable amount of tocopherols (up to 800 mg/kg) with γ-tocopherol predominating (*8*). We believe that tocopherols and other bioactive compounds are able to postpone the oxidation process, depending on storage conditions, until these antioxidants are oxidized and lose their antioxidant potential (*25*).

The same effect was also noticed in other studies with unrefined oils stored under the same conditions. It has been reported (*24)* that during storage of virgin olive oil under diffused light at temperatures between 6 and 18 °C a 90 % decrease in tocopherol concentration and an almost 60 % decrease in total phenolic concentration occurred after 6 months, indicating their rapid degradation. At the same time *PV* rose from 7.2 to 34 meq O_2/kg. In the same study but during the storage in darkness, after 12 months a slower rate of reduction was observed (a decrease of 60 % for tocopherol and of 50 % for total phenolics) with an increase of *PV* to 26 meq O_2/kg. Similar results were found for virgin olive oils after the storage in darkness for 7 months at room temperature (*26*).

It has been already shown (*27*) that unrefined oils are more oxidatively stable than their refined counterparts. Again, the observation could be attributed to a higher content of tocopherols and other antioxidative components present in unrefined oils. We believe that the differences found in Table 4 could be due to different levels of the antioxidants present. Therefore a more detailed analysis of phenolics and other antioxidants in our oil should be performed.

The formation of secondary oxidation products under different storage conditions as determined by the *p*-anisidine value is presented in Fig. 3. The value for fresh oil was 6.2 and after 1 month the values for *AV*, regardless of storage conditions did not differ significantly from this value. As *p*-anisidine value is mainly a measure of 2-alkenals and 2,4-dienals, this result could mean that such products were not formed. After 10 months, regardless of the storage conditions, *AV* increased. In oil stored in darkness at 8 °C formation of secondary oxidation products was significantly retarded compared to the oil exposed to daylight at room temperature (Fig. 3). The same finding could be seen in a study of Eidhin *et al.* (*3*) on the oxidative stability of camelina oil from Ireland stored under similar conditions. Compared to our investigation the values in the Irish study were much higher. In an investigation performed on crude sunflower oil (*28*) *AV* in the earlier stages of storage in open flasks in the darkness at 30 °C remained constant, but then after 3 months rose from 0.96 to 10.

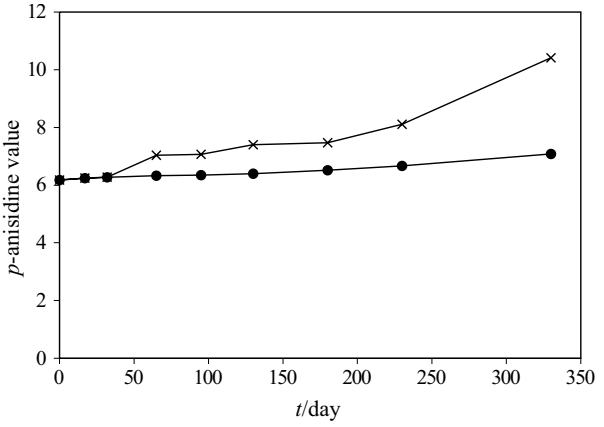

Fig. 3. Effects of light and temperature on the *p*-anisidine value of *Camelina sativa* oil during storage (× – daylight, room temperature; ● – darkness, temperature 8 °C). Values are means of two replicates with standard deviation of determination less than 0.1

Total oxidation value, the so-called Totox value, calculated from twice the peroxide value plus the *p*-anisidine value, is another useful indicator of measuring the onset of progressive deterioration in oil and provides information regarding progression of the formation of primary and secondary oxidation products (*29*). In Fig. 4 the increase of Totox value for camelina oil during storage in daylight at room temperature and in darkness at 8 °C is presented. Similarly to changes in *PV* and *AV*, the oil stored in darkness at 8 °C had consistently lower Totox values than oil stored in daylight at room temperature.

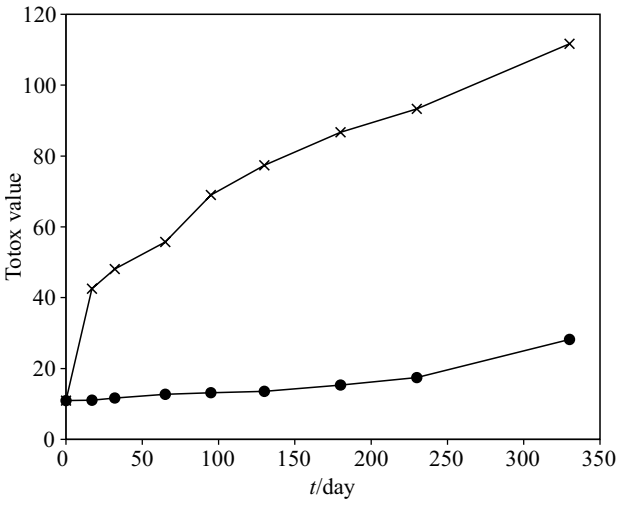

Fig. 4. Effects of light and temperature on the Totox value of *Camelina sativa* oil during storage (× – daylight, room temperature; ● – darkness, temperature 8 °C)

The susceptibility of camelina oil to oxidation measured by the Rancimat test and expressed by the induction period is shown in Table 5. The induction period represents the time needed for decomposition of hydroperoxides produced by oil oxidation (*12*). In our fresh camelina oil the induction period was 4.8 h. We managed to find only one report in the literature (*9*) about the Rancimat test performed on camelina oil. In that study (*9*) the induction period (at 110 °C) was 3 h. It has been shown (*30,31*) that an increased degree of unsaturation negatively affects the oxidative stability of oil determined by the Rancimat test. In safflower oil with 20 % of oleic, 59 % of linoleic and 10 % of linolenic acid and a tocopherol content of 490 mg/kg, sunflower oil with 20 % of oleic, 66 % of linoleic and a tocopherol content of 630 mg/kg, rapeseed oil with 59 % of oleic, 21 % of linoleic, 10 % of linolenic acid and a tocopherol content of 710 mg/kg, the induction periods (at 120 °C) were determined to be 2.4, 2.6 and 3.7 h, respectively (*30*). In our case, the Rancimat test was performed at 110 °C and according to (*13*) an increase in temperature of 10 °C lowers the induction time by a factor of two. This means that if the Rancimat tests were performed at 120 °C, we would get the induction time of about 2.4 h.

Table 5. Dependence of induction period (Rancimat test) for *Camelina sativa* oil on storage time

Storage time / day	65	155	280
	Induction period / h		
daylight, room temp.	3.7	2.7	2.1
darkness, room temp.	3.8	2.9	2.4
darkness, 8 °C	4.1	nd	3.6

nd – not determined

In Table 5 it can also be seen that the induction period decreases with time of storage. This can be explained in two ways. Firstly, as already mentioned, the antioxidative components originally present in our camelina oil degraded with time, thus losing their antioxidant properties, and secondly, the oxidation products increase with time of storage as shown in Fig. 2. In a study on virgin olive oil (*22*), after 12 months of storage in darkness at ambient temperature, a decrease in total phenolic content and 100 % loss of tocopherol was established, while the induction period (by Rancimat test at 120 °C) was about 50 % of the initial (10 h) value.

In Table 5 it can also be seen that the susceptibility to oxidation is affected by the storage conditions. A higher temperature and the presence of light reduce the induction period. Our camelina oil still had a 3.6 h induction period after more than 280 days of storage in darkness at 8 °C. A critical concentration of degradable volatile products under the Rancimat test conditions and the deterioration of the oil were reached faster in oil stored in daylight at room temperature after the same period of storage. Because of this a shorter induction period (2.1 h) was measured.

Conclusions

In conclusion, the camelina oil used in this study was produced from seeds of *Camelina sativa* plants grown in the Koroška region, Slovenia. We determined some physical parameters not previously known and its chemical characteristics. The characterisation enabled the comparison of the Slovene camelina oil with camelina oils from different areas and with some other edible oils.

The density and the refractive index obtained are slightly higher than those published for some other vegetable oils, with small or even negligible quantities of polyunsaturated linolenic acid. The effect of temperature on the density of camelina oil was determined and described by a polynomial relationship. The oil is a rich source of α-linolenic acid (35.2 %), only linseed oil has more (up to 60 %). Camelina oil contains 14.9 % of gondoic acid (20:1), which is absent in the most common vegetable oils and 1.6 % of erucic acid (22:1), which determines the applicability of oil for human consumption, but in our oil it was well below the permitted value of 5 % and also significantly lower than the values reported by others. The fatty acid composition of the Slovene camelina oil was similar, but not the same as that reported for oils from seeds of camelina cultivars grown in the USA, Central and Northern Europe. The differences in the composition can be ascribed not only to different cultivars but also to different regions and different growing conditions.

The effect of storage conditions on oxidation expressed as *PV*, *AV* and the Totox value versus time of storage was also followed. We compared the results of our study to those already published for the same type of oil and some other vegetable oils. It can be concluded from the data that our camelina oil is quite stable in comparison with common unrefined edible and other camelina oils. The susceptibility of the camelina oil used in this study to oxidation measured by the Rancimat test showed that it was more stable than the one for which we could find the data of the test in the literature. It is obvious that this oil must contain an appreciable amount of antioxidants. In a preliminary experiment approximately 400 mg of total phenolics per kg of fresh oil were determined and we are planning to identify them and other antioxidants in the future.

Acknowledgements

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Fizičko-kemijska svojstva, sastav i oksidacijska stabilnost ulja od uljarice *Camelina sativa*

Sažetak

Camelina sativa je biljka-uljarica iz porodice krstašica (*Cruciferae*). Da bi se opisale opće karakteristike ulja, dobivenog od sjemena biljke koja raste u Sloveniji, i da bi se usporedile s uljem od kameline iz drugih zemalja, određena su neka fizičko-kemijska svojstva, sastav masnih kiselina, jodni i saponifikacijski broj, te praćena njihova oksidacijska stabilnost pod različitim uvjetima skladištenja. Gustoća pri 20 °C bila je (0,9207 ± 0,0001) g/cm^3, a indeks loma dostigao je vrijednost 1,4756 ± 0,0001 pri 25 °C. Analizom masnih kiselina utvrđeno je 10,3 % zasićenih i 55,8 % višestruko nezasićenih kiselina, sa 16,9 % linolne (C18:2), 35,2 % α-linolenske (C18:3ω3) i 1,6 % eruka kiseline (C22:1). Određivanje oksidacijske stabilnosti ovog jako nezasićenog ulja otkrilo je da je fotooksidacija štetno djelovala na stvaranje produkata primarne oksidacije. Peroksidni broj svježeg ulja iznosio je (2,38 ± 0,01) meq/kg, dok je nakon 1 mjeseca na dnevnom svjetlu i pri sobnoj temperaturi dostigao vrijednost (21,0 ± 0,1) meq/kg. Pri skladištenju u mraku iznosio je (8.12 ± 0.08) meq/kg. U svježem ulju, *p*-anisidinski broj iznosio je 6,2 ± 0,1, a nakon 11 mjeseci na sobnoj temperaturi 10,4 ± 0,1, te nakon istoga vremena pri 8 °C u mraku 7,1 ± 0,1. Osjetljivost na oksidaciju ulja od kameline bila je mjerena Rancimat-testom i izražena kao indukcijsko vrijeme. U svježem ulju od kameline indukcijsko je vrijeme iznosilo 4,8 h.