KRMIVA

QUALITY OF OILS FROM MARKET

KAKVOĆA ULJA NA TRŽIŠTU

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SUMMARY

The aim of this study was to evaluate the quality of selected oils from the market in the Czech Republic by monitoring the fatty acids content during storage. The work was focused on oils widely used in animal nutrition as well as dietary supplements. Chosen oils: rapeseed, soybean, linseed and milk thistle were purchased in a health food store, salmon oil derived from a feed store. The fatty acids content in oils and changes in the composition during storage under various conditions were monitored. Fatty acids were detected in oils by gas chromatography with flame ionization detector (GC-FID). Individual fatty acids were divided into groups: saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA). SFA were most frequently found in salmon oil, most of PUFA was found in linseed oil and rapeseed oil contained the most of MUFA (15.4-16.6%, 77.3-77.5%, 64.5-64.8%, respectively). Oils stored in various conditions and storage periods did not show significant changes in the fatty acids composition. Mentioned oils are characterized and known by some fatty acids, although results show that they do not always have to be included in the expected quantities.

Key words: Fatty acid, Rapeseed, Soybean, Linseed, Milk Thistle, Salmon

INTRODUCTION

Oil is a typical component of a diet for animals raised for food production and can have a beneficial effect on the product – meat (Gallardo et al. 2012; Jankowski et al. 2012) and eggs. It is increasingly recommended to include non-traditional oils in the nutrition of small domestic animals and horses. For example, oils such as linseed oil, salmon oil and milk thistle oil (obtained from seeds of *Silybum marianum*) are recommended for their positive dietetic effect and the polyunsaturated fatty acids content. A wide range of oils of different origin is available on the market. Small-scale breeders turn to feedstuff and foodstuff markets in order to obtain guaranteed high quality. They can select particular oil on the basis of the price, place of purchase or other parameters. However, these parameters may not always be proportional to the quality of oil. It is hardly possible to choose an oil according to the distribution of fatty acids (FAs) because this information is usually missing. Quality can be compromised by the improper storage of oils at the place of consumption. Recommendations provided on the package label are not usually observed. Selected oils were investigated for their properties and composition by many researchers (Kardash et Tur'yan 2005; Khan et al. 2007; Hasanloo et al. 2008; Wu et Bechtel 2008; Malekzadeh et al. 2011; Endes et al. 2012; Roman et al. 2013.). Our study attempted to compare the levels of FAs in the above-mentioned oils including rapeseed and soybean oils as these are most frequently used in nutrition and their composition has long been investigated (Mohamed et Rangappa 1992.). The study concentrates on the composition

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of different oils and on the effect of different technological treatments such as fluorescence light, heating, frying, microwave-assisted heating, and deep freezing on the composition, quality and stability of oils (Stewart et al. 2001; Tan et al. 2001; Bangash et Khattak 2006; Sulieman et al. 2006; Allouche et al. 2007; Hidayatullah et al. 2007; Bangash et al. 2008; Bauxa et al. 2008; Silva et al. 2010; Marinova et al. 2012.). However, there is a lack of studies investigating the various types and duration of storage and their effect on the composition of oils. The only exception is a paper published by Lee et Cho (2012.) who investigated the effect of storage on soya.

The main objective of our study was to simulate different types of consumer behavior with regards to the storage of oil to find out whether the composition of oils (i.e. the fatty acid profile) was affected. Attempts were also made to provide an overview of the composition of different kinds of oils used in animal nutrition and assess the quality of oils.

MATERIALS AND METHODS

Oils generally available in the trading network in the Czech Republic and intended for human and animal nutrition were subjected to analysis. Rapeseed, soybean, linseed and milk thistle oils were selected as representatives of oils bought in a health food shop whereas salmon oil as the only animal oil was obtained from a feed store. All oils were 100% oils, fat extraction was not therefore necessary. Samples were analyzed for the fatty acids content and its variation due to the type and duration of storage. Selected oils were analyzed immediately after opening in June and then in one-month intervals for a period of four months (July-October). Oils were stored in different conditions: I. Dark – 5 °C; II. Variable conditions in a household (variable room temperature - daylight/dark); III. Dark – 30 °C. The fatty acids content was determined after opening and then in regular intervals, using gas chromatography the Shimadzu GC–2010 analyzer with a flame-ionization detector (FID), after converting fatty acids into their methyl esters. The results are expressed as the percentage of the total fatty acids content detected in 100 g of oil. Oil quality was evaluated on the basis of the results and the effect of the type and duration of storage on oil quality was evaluated statistically, using the programme Unistat CZ, version 5.6 for Excel (2005).

Table 1 The most common fatty acids in oils (g per 100 g of oil) under 3 storage conditions

Tablica 1. Najčešće masne kiseline u uljima (g/100 g ulja) u tri uvjeta skladištenja

Oil - Ulje	Conditions – Uvjeti	C16:0	C18:0	C18:1	C18:2	C18:3	C20:5	C22:6
RSO	I.	4.41	1.58	59.36	19.20	7.08	-	-
	II.	4.54	1.63	61.33	19.77	7.26	-	-
	III.	4.50	1.60	60.32	19.47	7.14	-	-
SBO	I.	10.12	3.61	23.03	55.82	7.41	-	-
	II.	9.99	3.57	22.02	54.95	7.21	-	-
	III.	9.84	3.47	21.53	53.93	7.09	-	-
LSO	I.	5.57	3.39	13.07	75.15	2.01	-	-
	II.	5.52	3.40	13.08	74.93	2.00	-	-
	III.	5.60	3.43	13.23	75.93	2.03	-	-
MTO	I.	6.32	3.81	20.36	60.83	0.26	-	-
	II.	6.13	3.70	19.56	58.42	0.25	-	-
	III.	6.20	3.74	19.79	58.72	0.24	-	-
SLO	I.	8.61	2.28	37.09	12.76	4.96	3.10	5.54
	II.	8.68	2.05	37.16	12.67	4.91	3.05	4.74
	III.	8.57	2.24	36.79	12.50	4.84	3.01	5.35

RSO – rapeseed oil – repičino ulje, SBO – soybean oil – sojino ulje, LSO – linseed oil – laneno ulje, MTO – milk thistle oil – ulje mliječne koprive, SLO – salmon oil – lososovo ulje, SFA – saturated fatty acids, MUFA – monounsaturated fatty acids, PUFA – polyunsaturated fatty acids, C16:0 – palmitic acid, C18:0 – stearic acid, C18:1 – oleic acid, C18:2 – linoleic, C18:3 α-linolenic, C20:5 – EPA, C22:6 – DHA, I.,II., III. – storage conditions - uvjeti skladištenja (I. Dark - tama – 5 °C; II. Variable conditions in a household – varijabilni uvjeti u skladištu; III. Dark - tama – 30 °C)

RESULTS AND DISCUSSION

It follows from the statistical processing that the composition of fatty acids remained unaffected at different conditions of storage, the difference was non-significant (NS). The amount of oleic and linoleic acids was shown to vary with the duration of storage after opening as is shown in Table 2. However, these changes were not found statistically significant (NS). Table 1 and Table 2 give an overview of the most common fatty acids detected in oils. Table 1 shows the most common fatty acids under 3 storage conditions and Table 2 shows changes in fatty acids composition after opening in June and after during 4 months storage. No statistically significant difference with regards to different conditions and duration of storage was found for these fatty acids.

Table 1 and Table 2 provide an overview of FAs detected in individual oils at highest levels (g per 100 of oil). Four major FAs detected at highest levels (in percent) are listed for each oil. In the case of salmon oil, the levels of PUFA n-3 fatty acids EPA (C20:5n3) and DHA (C22:6n3) are also provided since these are characteristic of salmon oil although they do not occur at the highest level.

In Table 3, fatty acids are evaluated in groups as saturated (SFA) and unsaturated, namely monounsaturated (MUFA) and polyunsaturated (PUFA). The results are expressed in percentage of all analyzed fatty acids. The highest levels of SFA were found in salmon oil as the only oil originating from animals analyzed in this study. Rapeseed oil contained the highest levels of MUFA whereas the highest levels of PUFA were detected in linseed oil. Rapeseed and salmon oils had similar ratios of individual groups of FAs in percentage (SFA:MUFA:PUFA). Even closer ratios were found for soybean and milk thistle oils.

Table 2 The most common fatty acids in oils (g per 100 g of oil) in 5 months of storage

Tablica 2. Najčešče masne kiseline u uljima (g/100 g ulja) u 5 mjeseci skladištenja

Oil - Ulje	Month - Mjesec	C16:0	C18:0	C18:1	C18:2	C18:3	C20:5	C22:6
RSO	VI	4.21	1.45	55.32	17.92	6.59	-	-
	VII	4.66	1.69	62.25	20.18	7.44	-	-
	VIII	4.59	1.63	61.85	20.00	7.35	-	-
	IX	4.51	1.64	61.65	19.80	7.27	-	-
	X	4.46	1.61	60.60	19.48	7.13	-	-
SBO	VI	9.32	3.15	19.71	49.40	6.45	-	-
	VII	10.05	3.63	23.55	55.83	7.45	-	-
	VIII	10.38	3.67	22.79	57.03	7.50	-	-
	IX	10.23	3.71	22.84	57.05	7.52	-	-
	X	9.93	3.58	22.10	55.20	7.25	-	-
LSO	VI	5.28	3.13	12.15	69.94	1.86	-	-
	VII	5.59	3.46	13.32	76.41	2.05	-	-
	VIII	5.83	3.61	13.89	79.89	2.13	-	-
	IX	5.55	3.39	13.03	74.68	2.00	-	-
	X	5.57	3.45	13.25	75.75	2.03	-	-
MTO	VI	3.60	2.13	11.36	34.15	0.14	-	-
	VII	7.03	4.25	22.47	67.16	0.29	-	-
	VIII	7.05	4.26	22.68	67.83	0.28	-	-
	IX	6.70	4.06	21.48	63.79	0.27	-	-
	X	6.71	4.06	21.53	63.68	0.26	-	-
SLO	VI	8.41	2.20	35.36	12.11	4.73	2.92	2.40
	VII	8.76	2.35	36.97	12.90	5.01	3.11	5.20
	VIII	9.03	1.96	39.23	13.32	5.15	3.23	5.72
	IX	8.40	2.21	36.47	12.37	4.79	3.01	6.38
	X	8.50	2.23	37.01	12.52	4.82	3.00	6.36

RSO – rapeseed oil –repičino ulje, SBO – soybean oil – sojino ulje, LSO – linseed oi – laneno uljel, MTO – milk thistle oil – ulje mliječne koprive, SLO – salmon oil –lososovo ulje, SFA – saturated fatty acids, MUFA – monounsaturated fatty acids, PUFA – polyunsaturated fatty acids, C16:0 – palmitic acid, C18:0 – stearic acid, C18:1 – oleic acid, C18:2 – linoleic, C18:3 α-linolenic, C20:5 – EPA, C22:6 – DHA, VI, VII, VIII, IX, X - month of storage – mjesec skladištenja

Table 3 Groups of fatty acids in oils during months and under the storage conditions, (%)

Tablica 3 Skupine masnih kiselina u mjesecima i raznim uvjetima skladištenja

Oil - Ulje	%	VI	VII	VIII	IX	X	I.	II.	III.
RSO	SFA	7.4	7.5	7.4	7.4	7.4	7.4	7.4	7.4
	MUFA	64.6	64.5	64.6	64.8	64.7	64.6	64.7	64.6
	PUFA	28.0	28.0	28.0	27.9	27.9	28.0	27.9	27.9
SBO	SFA	15.0	14.3	14.7	14.6	14.6	14.5	14.7	14.6
	MUFA	22.4	23.4	22.5	22.5	22.5	23.0	22.5	22.4
	PUFA	62.7	62.3	62.8	62.9	62.9	62.5	62.8	62.9
LSO	SFA	9.4	9.3	9.3	9.3	9.3	9.3	9.3	9.3
	MUFA	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
	PUFA	77.4	77.5	77.4	77.3	77.4	77.4	77.4	77.4
MTO	SFA	13.5	13.5	13.4	13.6	13.6	13.4	13.5	13.6
	MUFA	21.9	22.0	22.1	22.1	22.1	22.0	22.0	22.1
	PUFA	64.6	64.5	64.5	64.3	64.3	64.5	64.5	64.3
SLO	SFA	16.6	16.2	15.4	15.7	15.7	15.8	15.8	16.1
	MUFA	52.1	49.8	51.0	50.1	50.3	50.5	51.1	50.4
	PUFA	31.3	34.1	33.6	34.2	34.0	33.7	33.0	33.6

RSO – rapeseed oil – repičino ulje, SBO – soybean oil –sojino ulje, LSO – linseed oil – laneno ulje, MTO – milk thistle oil – ulje mliječne koprive, SLO – salmon oil – lososovo ulje, SFA – saturated fatty acids, MUFA – monounsaturated fatty acids, PUFA – polyunsaturated fatty acids, VI, VII, VIII, IX, X - month of storage mjesec skladištenja

Linseed oil is characterized by the highest PUFA content. However, the comparison of oils with regards to the particular levels of individual FAs (Table 1 and Table 2) does not comply with this comparison.

n-6 PUFA and n-3 PUFA ratios in soybean oil (55% and 7%) are in good agreement with the finding reported by Jankowski et al. (2012), in contrast to the ratios determined in rapeseed oil (20% and 8%) and linseed oil (75% and 2%). Mohamed and Rangappa (1992) found a slightly higher amount of some FAs (palmitic acid, oleic acid, linoleic acid) in soybean oil, as compared to our study. The amounts of linoleic and linolenic acids are in a good agreement with the values determined in our study. Surprisingly, linseed oil contained a very low amount of α-linolenic acid as results show. This amount differs from the value found by Endes et al. (2012) but the SFA:MUFA:PUFA ratio reported by the authors in linseed oil is similar to our findings. Malekzadeh et al. (2011.) studied the composition of milk thistle oil. The measured levels of linoleic, linolenic, and oleic acids are in relatively good agreement with our results. Similarly, the distribution of FAs measured by Hasanloo et al. (2008.) and Khan et al. (2007.) also come into line with our data.

Marinova et al. (2012.) found a decrease in the C18:2/C16:0 ratio in vegetable oils exposed to heat; we found the opposite trend in our study. Allouche et al. (2007.) did not find any significant changes in the level of oleic acid in olive oil upon heating. Sulieman et al. (2006.) observed that the level of linoleic acid in vegetable oils decreased during frying whereas the levels of palmitic, stearic and oleic acids increased. In our study, the levels of the most common FAs increased, investigated after the opening of oils (all oils). Some of oils increase the most common FAs in warm storage (RSO, LSO) and most of them decrease the level of the most common FAs or keep it similar in warm storage (SBO, MTO, SLO). Roman et al. (2012.) have confirmed that the degree of oil unsaturation is the major parameter that affects the rate of oil oxidation, rapeseed oil is not oxidized at such an extent like sunflower oil, sunflower oil with the highest level of oleic acid appears to be the most stable. In our study salmon oil and rapeseed oil contain the highest level of SFA and MUFA and seem to be the most stable. It can be concluded that variations in the levels of fatty acids in salmon and rapeseed oil are only very small. Stewart et al. (2003.) have reported that the degradation of fatty acids depends on the temperature and duration of heat treatment and that degradation proceeds faster at higher temperatures. It cannot be clearly confirmed by our study. Wu et Bechtel found higher levels of EPA and DHA in salmon oil, as compared to our findings, and failed to show any change in the composition of FAs upon short-term storage, which can be confirmed by our study. Lee et Cho (2012.),

who studied changes during the storage of soybean at room temperature for two years did not find statistically significant changes. They only observed a slight increase in the level of oleic acid whereas the levels of remaining FAs decreased. Even our experiment did not indicate any statistically significant changes in the profile of FAs.

CONCLUSION

It follows from our results that SFA, MUFA and PUFA groups may distort the composition of FAs in the oil. Oils that are commonly available in the trading network do not usually have the required quality or their quality does not correspond to their price. Information on package labels is ambiguous or misleading. The oils investigated in our study are known for the certain fatty acids content although our results have shown that respective fatty acids may not always be present in anticipated amounts. The package label may contain a statement that a particular oil contains n-3 fatty acids or the data concerns the division of FAs into groups SFA, MUFA, PUFA, which may not reflect reality. As documented in our study, the composition of fatty acids is not statistically affected by storage. This could be solved by imposing a duty to the manufacturer who should provide the exact composition of fatty acids on the package label, at complying with the prescribed storage conditions. It can be concluded that the short-term storage at real conditions (even if the proper conditions are not met) will not have a profound effect on the composition of fatty acids. As documented in our study, higher prices or purchase in specialized shops do not necessarily guarantee the quality of oil.

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SAŽETAK

Cilj ovog rada bio je ocijeniti kakvoću odabranih ulja na tržištu Češke Republike kontroliranjem sadržaja masnih kiselina za vrijeme uskladištenja. Rad je bio usredotočen na najviše upotrebljavana ulja u hranidbi životinja kao i ulja korištena kao dodatak hrani. Odabrana ulja repice, soje, lana i mliječne koprive kupljena su u trgovini zdrave hrane a lososovo ulje u trgovini hrane. Kontroliran je sadržaj masnih kiselina u uljima, te promjene sastava za vrijeme skladištenja u raznim uvjetima. Masne kiseline su određene u uljima plinskom kromatografijom s detektorom ionizacije pomoću plamena (GC-FID). Pojedine masne kiseline podijeljene su u skupine:zasićene (SFA), mononezasićene (MUFA) i polinezasićene (PUFA). SFA su najčešće nađene u ulju lososa, većina PUFA bila je u lanenom ulju, a repičino ulje sadržavalo je većinom MUFA (15,4-16,6%,77,3-77,5%,64,5-64,8%). Ulje uskladišteno u raznim uvjetima i trajanju skladištenja ne pokazuju značajne promjene u sastavu masnih kiselina. Spomenuta ulja karakteriziraju i poznata su po nekim masnim kiselinama, iako rezultati pokazuju da ona ne moraju uvijek biti u očekivanim količinama.

Ključne riječi: masna kiselina, repica, soja, lan, mliječna kopriva, losos