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Chemical characterization of the lipid fractions of pumpkin seeds

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Abstract

Purpose – This paper aims to characterize the pumpkin (*Cucurbita sp*) seed oil from the varieties Nova Caravela, Mini Paulista, Menina Brasileira (*Cucurbita moschata*) and Moranga de Mesa (*Cucurbita maxima*) as to their physicochemical properties, vitamins and fatty acid and triacylglycerols profiles.

Design/methodology/approach – The oils were extracted from oilseeds by the Bligh and Dyer (1959) method, and chemical characterization was performed by using standard methods for oils and fats. The vitamin A and E content, fatty acid profile and triacylglycerols profile also were determined.

Findings – About the chemical properties, the oils showed values within the range for edible vegetable oils. The oil from variety Nova Caravela stood out for presenting better quality, as it showed lower values of free fatty acids, acidity and peroxides. However, it was found that the Moranga de Mesa oil was the most unsaturated, due to the high refractive and iodine index, and was also reported to have lower oxidative stability. Among the unsaturated fatty acids, ranging from 70 to 78 per cent of the total obtained, linoleic and oleic acids stood out, while among the saturated ones, palmitic and stearic did.

Practical implications – These seeds are rich in high-quality lipids; therefore, their use could help to reduce the amount of waste produced in the industries, and consequently reduce environmental contamination. This study showed that the seeds could be used as a raw material for oil extraction, and also could be used for developing functional foods instead of being discarded.

Originality/value – This study provides valuable information about the quality and fatty acid contents of pumpkin seed oils consumed in Brazil.

Keywords Fatty acids, Cucurbitaceae, Vegetable oils, Physicochemical properties

Paper type Research paper

Introduction

The sharp decrease in the volume of domestic exports of fresh fruit has led to increased amounts of processed fruits, especially in the candy industry (Basco and Guanziroli, 2009). As a result, large amounts of waste such as peels, seeds and marcs, which are prone to microbial degradation, are generated, restricting future exploration. Moreover, the costs of drying, storage and transportation of these products are also economically limiting factors (Schieber *et al.*, 2001).

Even so, the use of waste is important, especially the use of seeds. It is known that 75 per cent of edible vegetable oils are extracted from the seed's endosperm. However, to be considered suitable for commercial oil extraction, the seeds must have an excellent fatty acid composition and must present more than 25 per cent of oil (Salas *et al.*, 2000). In addition, there are several factors that influence the quality of oil obtained from these

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seeds, considering that they may have poor formation and different maturation stages. Therefore, it is advised that we wait longer before opening the fruits and removing the seeds, because, after the harvest, they continue to develop inside the fruit. Thus, during the storage period, they reach their physiological maturity, when the quality is better (Fadavi *et al.*, 2006).

Cucurbitaceae occupies a distinct place as one of the most important families in the food field. This family is divided into several genera, such as *Cucurbita spp*, which was domesticated in the New World and planted long ago by the Amerindians. Despite the current marginalization of some species, they have been an essential component of the diet of rural and urban communities from America and from other parts of the world. *Cucurbita spp* fruits are rich in carotenoids, precursors of vitamin A or antioxidant properties, such as β -carotene and lutein, and they have considerable amounts of nutrients. Its seeds are consumed in several countries, and they are rich in lipids, proteins, fibers, thiamin, niacin and micronutrients (Rubatzky and Yamaguchi, 1999).

The extraction of oil is an alternative to the use of these seeds, because they are sources of environmental contamination. Studies show that oil seeds of *Cucurbita pepo*, cultivated in Serbia, have high content of squalene, phytosterols and monounsaturated fatty acids, and recommend the use of this type of the oil for nutritional and medical purposes (Rabrenovic *et al.*, 2014). Moreover, the oil can be used for salads, for its aroma and taste, because it is extracted by cold press, so the particular properties are retained (Fruhworth *et al.*, 2003). However, few studies characterize and analyze fatty acid profiles of seed oils from fruits belonging to the family *Cucurbitaceae*. Given these facts, the purpose of this work is to characterize the oil extracted from pumpkin seeds (*Cucurbita sp*) cultivated in Brazil through physicochemical properties and fatty acid profiles, to evaluate the potential of these seeds as special oil sources.

Materials and methods

Raw material

Seeds of the pumpkin varieties Nova Caravela, Mini Paulista, Menina Brasileira (*Cucurbita moschata*) and Moranga de Mesa (*Cucurbita maxima*) were used, for being the most appreciated ones by Brazilian consumers. Approximately 2 kg of seeds of each pumpkin variety, from the 2009 and 2010 harvests in São Paulo State, were acquired. Variety Nova Caravela was obtained courtesy of the Silvana Doces Company, located in Engenheiro Schmidt District, and the other ones were found in the local market. After being extracted from the fruits, the seeds were selected, and only the ones that were completely and totally formed were used. Then, they were dried in a dark place at room temperature. At the time of oil extraction, seeds were crushed in a knife grinder (Marconi brand, model MA340).

Lipid fraction extraction

For the extraction of lipid fraction from pumpkin seeds, the method of Bligh and Dyer (1959) was used. It is effective for total lipids extraction, in which polar and apolar classes are extracted, because chloroform is a solvent for any organic lipid class and methanol has the function of breaking the connections. Ten grams of seeds were weighed; 25 ml of chloroform, 50 ml of methanol and 10 ml of distilled water were added; and the mixture was stirred in a shaker for 30 min. Then, 25 ml of chloroform and 25 ml of 1.5 per cent sodium sulfate solution were added. Again, the mixture was stirred in a

shaker for 2 min and transferred into a separating funnel. After the separation phase, the lower phase was filtered through a flat-bottomed flask using a filter paper containing anhydrous sodium sulfate. The solvent was recovered in a rotary evaporator at 40°C. The oil was placed in an amber glass, filled with inert gaseous nitrogen, and stored at -18°C until the time of analysis.

Chemical characterization

Acid values, peroxide value, refractive index, iodine test, saponification and unsaponifiable matter were determined using the [AOCS \(2009\)](#) official method for the oils.

The oxidative stability index was determined by the method proposed by [AOCS \(2009\)](#) using the Rancimat[®] equipment model 743 (Metrohm brand) under the following conditions: 3.0 g of oil, air flow of 20 L/h, temperature 100°C and 60 ml water distilled in flasks containing electrodes, which is based on the determination of the electrical conductivity of the degraded volatile products. By this method, a curve is automatically recorded during the course of the reaction and test, and the oxidative stabilities are determined in hours.

Vitamins

Vitamin A content was calculated according to the ratio of provitamin A carotenoids established by the Institute of Medicine, Food and Nutrition Board, where 1 retinol activity equivalent (RAE) = 1 µg retinol = 12 µg β-carotene ([IOM, 2001](#)). While vitamin E content was calculated according to the method described by [Mclaughlin and Weihrauch \(1979\)](#), represented as α-tocopherol equivalents (α-TEs), and α-TEs were defined as α-tocopherol, mg × 1.00; β-tocopherol, mg × 0.40; γ-tocopherol, mg × 0.1; and δ-tocopherol, mg × 0.01.

Fatty acid and triacylglycerols profiles

Lipid fractions of pumpkin seeds (50 mg) were transesterified to methyl esters using potassium hydroxide in methanol and n-hexane, according to the [AOCS method Ce 2-66 \(2009\)](#). Fatty acid methyl esters (FAMES) were analyzed using a GC 3900 gas chromatograph (Variant GC 3900, Varian Associates, Inc., Walnut Creek, CA), equipped with a flame-ionization detector (GC-FID), injector split and automatic sampler. FAMES were separated by using a CP-Sil 88 fused-silica capillary column (60 m × 0.25 mm i.d., 0.25 µm film thickness; Chrompack, Varian Inc., Walnut Creek, CA). The column oven temperature was initially held at 90°C (10 min), heated at 10°C/min at 195°C and maintained at 195°C/16 min. The injector and detector temperatures were 230 and 250°C, respectively. Samples (1 µL) were injected adopting a split ratio of 1:30. The carrier gas was hydrogen with a flow rate of 30 ml/min. FAMES were identified by comparing their retention times with those of pure FAME standards (Supelco, Bellefonte, USA) under the same operating conditions. The integration software computed the peak areas, and percentages of FAMES were obtained as weight percentage by direct internal normalization. The molar ratio of triacylglycerols (TAGs) percentage was calculated using the concentration of fatty acids by the method described by [Antoniosi Filho et al. \(1995\)](#).

Statistical analysis

The obtained results from analytical determinations, in triplicate, were subjected to analysis of variance, and differences between means were tested at 5 per cent probability by Tukey test, using the ESTAT program (Statistical Analyses System), version 2.0 (UNESP, Jaboticabal, São Paulo, Brazil).

Results and discussion

Chemical characterization and vitamins of lipid fraction pumpkin seeds

The results of the oil content of the seeds, chemical characterization and vitamins of lipid fraction of pumpkin seeds are shown in Table I. All varieties showed high percentages of oil contents, and the pumpkin oil from Moranga de Mesa stood out, with 42.3 per cent. These seeds proved to be a good raw material for the oil extraction.

The percentage of free fatty acids and acid value are related to the development of hydrolytic reactions in the oil. It is observed, among the samples, that the amount of free fatty acids ranged from 0.16 to 2.83 per cent, and acid value ranged from 0.32 to 5.64 mg NaOH/g oil. The lipid fraction of the seeds of Moranga de Mesa pumpkin variety showed the highest rate of acid value, similar to the value of the pumpkin seed oil of same variety that originated in Korea which was found to be 5.57 mg NaOH/g oil by Mitra *et al.* (2009). Moreover, Ardabili *et al.* (2010), evaluating the acid value of crude oil from *C. pepo* seeds and of its mixture with canola oil, obtained lower values, compared to the ones in this study. Only Moranga de Mesa pumpkin seed oil showed acid value in disagreement with the Codex Alimentarius Commission (2009), which permits a maximum of 4 mg KOH/g of acidity for most crude vegetable oils. The lower free fatty acid and acid value of lipid fraction of pumpkin seeds showed that they are edible and could have a long shelf life

Properties	Nova Caravela*	Mini Paulista*	Menina Brasileira*	Moranga de Mesa*
Oil content	40.6 ± 0.2 ^b	33.5 ± 0.1 ^c	30.7 ± 0.0 ^d	42.3 ± 0.1 ^a
Parameter				
Free fatty acids (oleic acid %)	0.16 ± 0.05 ^d	1.40 ± 0.00 ^c	1.71 ± 0.03 ^b	2.83 ± 0.06 ^a
Acid value (mg NaOH/g oil)	0.32 ± 0.09 ^d	2.79 ± 0.00 ^c	3.40 ± 0.06 ^b	5.64 ± 0.13 ^a
Peroxide value (meq O ₂ /kg oil)	3.13 ± 0.27 ^c	3.09 ± 0.13 ^c	3.85 ± 0.16 ^b	5.17 ± 0.06 ^a
Index of refraction	1.462 ± 0.000 ^b	1.461 ± 0.000 ^c	1.461 ± 0.000 ^c	1.464 ± 0.000 ^a
Iodine (g I ₂ /100 g)	104 ± 0 ^b	104 ± 0 ^c	95.5 ± 0.1 ^d	109 ± 0 ^a
Saponification (mg KOH/g oil)	218 ± 2 ^c	233 ± 1 ^b	241 ± 1 ^a	191 ± 2 ^d
Unsaponifiable matter (%)	1.35 ± 0.08 ^c	2.27 ± 0.11 ^b	6.22 ± 0.22 ^a	1.56 ± 0.07 ^c
Oxidative stability (hours)	47.8 ± 0.3 ^b	47.1 ± 0.4 ^b	66.8 ± 0.0 ^a	41.8 ± 0.0 ^c
Vitamins				
Vitamin A (µg retinol/100 g)	63.7 ± 9.6 ^b	223 ± 7 ^a	217 ± 14 ^a	75.9 ± 5.6 ^b
Vitamin E (α-TE)	32.5 ± 0.4 ^b	14.6 ± 0.2 ^d	60.2 ± 0.2 ^a	19.4 ± 0.1 ^c

Table I. Chemical characterization and vitamins for the lipid fraction extracted from pumpkin seeds

Notes: * Average value of triplicate analyses (+SD); values not sharing same superscripts (a, b, c, d) are significantly different from each other within the row (Tukey's test, $p < 0.05$)

and indicates that they are almost free from hydrolytic rancidity brought almost by lipases.

Peroxide value is commonly used to assess the magnitude of primary oxidation products in oils. The samples presented peroxide value from 3.09 to 5.17 meq/kg oil, and the lipid fraction of pumpkin seeds from Moranga de Mesa is highlighted. These values are lower than those obtained by other researchers who analyzed the species *C. moschata*, *maxima* and *pepo* (Ardabili *et al.*, 2010; Fokou *et al.*, 2009). Moreover, these values are low when compared with the Codex Alimentarius Commission's (2009), which establishes 10 and 15 meq/kg for crude and refined oils, respectively. It was also verified, according to free fatty acids and peroxide value, that the oils studied present low oxidative and hydrolytic degradation.

The index of refraction is mainly related to the saturation degree and the double-bond *cis/trans* fatty acid ratio. For investigated lipid fractions, refractive indexes of 1.461 and 1.462 for the species *C. moschata* and of 1.464 for *C. maxima* were obtained. This value is similar to the one obtained by Mitra *et al.* (2009), who characterized the pumpkin seed oil from the species *C. maxima*, originated in Korea, and also similar to the one found by Jiao *et al.* (2014), who studied the pumpkin seed oil extracted with n-hexane in a Soxhlet extractor.

As the index of refraction, the iodine test indicates the degree of oil unsaturation. The lipid fractions that showed a lower unsaturation degree were the ones from the seeds of Menina Brasileira pumpkin variety, followed by Mini Paulista, Nova Caravela and Moranga de Mesa. These values are similar to those achieved by Fokou *et al.* (2009), who by studying the oil from *C. moschata* and *C. maxima* seeds, originated in Cameroon, found a variation from 66.6 to 104 g I₂/100 g and 81.5 to 114 g I₂/100 g, respectively. However, they are lower than the ones obtained by Ardabili *et al.* (2010), when evaluating the oil from *C. pepo* L. seeds. Moreover, they are in agreement within the range for edible vegetable oils, such as rapeseed (94-120 g I₂/100 g) and rice bran (90-115 g I₂/100 g) (Codex Alimentarius Commission, 2009). As for iodine, vegetable oils can be classified into siccative (greater than 130 g I₂/100 g), semi-siccative (115 to 130 g I₂/100 g) and non-siccative (less than 115 g I₂/100 g). In this study, they are all labeled as non-siccative, i.e. they present significant amounts of saturated fatty acids, which makes them not capable of forming films in contact with air (Van de Mark and Sandefur, 2009).

The saponification index indicates the average molecular weight of fatty acids esterified to glycerol in a TAG molecule, i.e. high saponification index implies fatty acids with low molecular weight. Among the lipid fractions described, the lowest saponification index was presented by lipid fraction of Moranga de Mesa seed (191 mg KOH/g oil) and the highest one by Menina Brasileira seed oil (241 mg KOH/g oil). It can be inferred that lipid fraction of Menina Brasileira seed is composed of fatty acids with molecular weight lower than the others'. The values are similar to those investigated by other researchers when analyzing the same kinds of species, but different varieties (Fokou *et al.*, 2009; Mitra *et al.*, 2009), and those contained in the Codex Alimentarius Commission (2009) for vegetable oils such as corn (187-195 mg KOH/g oil) and palm kernel oil (230-254 mg KOH/g oil).

The amount of unsaponifiable matter in the analyzed lipid fractions ranged from 1.35 to 6.22 per cent, and lipid fractions of Mini Paulista (2.27 per cent) and Menina Brasileira (6.22 per cent) seeds showed the highest values. Considering that the unsaponifiable matter corresponds to the compounds present in oils after saponification with alkalis

that are insoluble in an aqueous solution, including naturally occurring substances such as sterols, tocopherols, pigments and hydrocarbons, oils from these seeds must contain high amounts of these substances, especially the pumpkin oil from varieties Menina Brasileira seeds. According to the [Codex Alimentarius Commission \(2009\)](#), the maximum amount of unsaponifiable matter for soybean and cotton oil is 1.5 per cent, for corn oil is 2.8 per cent and for rice oil is 6.5 per cent. Based on these values, all the studied oils are in the range for edible vegetable oils.

The oxidative stability is an important aspect related to the nutritional and sensory quality of vegetable oils. The susceptibility of certain oils to oxidation limits their use in foods. It is defined as the time to reach the detectable rancidity level or surprising change in the oxidation rate ([Antoniassi, 2001](#)). In this work, the lipid fraction of seeds of Menina Brasileira pumpkin variety stands out, with an induction period of 66.8 hours, followed by Nova Caravela, Mini Paulista and Moranga de Mesa oils, indicating that these lipid fractions present good stability for shelf life without the addition of synthetic antioxidants.

According to [Liu *et al.* \(2002\)](#), oils with higher content of oleic or stearic acid show high oxidative stability, which is confirmed in this study. Similar results were achieved by [Parry *et al.* \(2006\)](#), when studying the pumpkin roasted seeds oil (61.7 hours) and the commercial soybean (46.8 hours) and corn (66.0 hours) oils, using the Rancimat at 80°C with an air flow of 7 L/hr, and lower values were found by [Rezig *et al.* \(2012\)](#) when analyzing the pumpkin (*C. maxima*) seed oil that originated in Tunisia using the Rancimat at 100°C with an air flow of 10 L/hr. While, [Ardabili *et al.* \(2010\)](#) found that the stability of canola oil increased in the presence of pumpkin seed oil, showing that a mixture of different oils may improve the antioxidant potential.

Vitamin A is responsible for important biological processes in the human body, especially its participation in the process of vision. In the body, retinol, retinal and retinoic acid are the active forms of vitamin A ([Meléndez-Martínez *et al.*, 2004](#)). Among the lipid fractions studied, the extracted lipid fractions of Mini Paulista and Menina Brasileira stood out, with 223 and 217 μg retinol/100 g, and can be considered good sources of vitamin A, to combat or prevent vitamin A deficiency. Regarding the activity of vitamin E, it was established that there was a variation from 14.6 to 60.2 α -TEs. Regarding nutrition, low levels of vitamin E may be associated with increased risk of developing degenerative diseases such as atherosclerosis. Adequate intake of this vitamin exerts a cardioprotective effect by inhibiting the oxidation of LDL-cholesterol, which has a key role in the atherogenic process ([Kornsteiner *et al.*, 2006](#)).

Fatty acid and TAGs profiles

The results of fatty acid profile of lipid fraction pumpkin seeds can be found in [Table II](#). Note that, in all the lipid fractions, ten fatty acids were identified. Among the saturated fatty acids, most of them were palmitic (12-18 per cent) and stearic (8-11 per cent). Among the unsaturated ones, linoleic (40-47 per cent) and oleic (28-30 per cent) stood out.

The presence of essential fatty acids, such as linoleic, makes these lipid fractions interesting from the nutritional point of view, as this fatty acid is not produced by the human body and is required for the formation of cell membranes, vitamin D and several hormones ([Fruhwrth and Hermetter, 2007](#)). However, the higher the amount of oleic to linoleic ratio, the better the oil quality to prevent the increase in LDL-cholesterol ([Rastogi *et al.*, 2004](#)). In the

Table II.
Fatty acid profile of
the lipid fractions
extracted from
pumpkin seeds

Fatty acid (%)	Nova Caravela*	Mini Paulista*	Menina Brasileira*	Moranga de Mesa*
Myristic (C14:0)	0.07 ± 0.01	0.09 ± 0.01	0.11 ± 0.01	0.13 ± 0.01
Palmitic (C16:0)	13.9 ± 0.0	14.9 ± 0.1	17.9 ± 0.1	12.1 ± 0.0
Heptadecanoic (C17:0)	0.12 ± 0.01	0.06 ± 0.01	0.09 ± 0.01	tr
Stearic (C18:0)	9.99 ± 0.01	8.54 ± 0.14	10.6 ± 0.0	9.08 ± 0.01
Palmitoleic (C16:1)	0.04 ± 0.01	0.06 ± 0.01	0.07 ± 0.01	0.11 ± 0.01
Oleic (C18:1n9c)	28.4 ± 0.0	30.3 ± 0.1	29.8 ± 0.0	30.5 ± 0.0
Linoleic (C18:2n6c)	46.1 ± 0.0	44.6 ± 0.1	40.1 ± 0.0	47.5 ± 0.0
Arachidic (C20:0)	0.53 ± 0.01	0.55 ± 0.01	0.67 ± 0.01	0.48 ± 0.01
α-Linolenic (C18:3n3)	0.12 ± 0.01	0.19 ± 0.01	0.13 ± 0.01	0.10 ± 0.01
Lignoceric (C24:0)	0.42 ± 0.01	0.52 ± 0.01	0.40 ± 0.03	0.10 ± 0.01
NI	0.13 ± 0.01	0.16 ± 0.02	0.18 ± 0.01	tr
Ratio: oleic/linoleic	0.62	0.68	0.74	0.64
Ratio: linoleic/α-linolenic	384	235	308	475
Σ saturated	25.1 ± 0.0 ^b	24.7 ± 0.2 ^b	29.7 ± 0.0 ^a	21.9 ± 0.0 ^c
Σ monounsaturated	28.5 ± 0.0 ^d	30.4 ± 0.1 ^b	29.8 ± 0.0 ^c	30.6 ± 0.0 ^a
Σ polyunsaturated	46.3 ± 0.0 ^b	44.8 ± 0.1 ^c	40.3 ± 0.0 ^d	47.6 ± 0.0 ^a
Ratio: unsaturated/saturated	2.98	3.04	2.36	3.58

Notes: * Average value of triplicate analyses (+SD); values not sharing same superscripts (a, b, c, d) are significantly different from each other within the row (Tukey's test, $p < 0.05$); NI: unidentified fatty acid content, tr: trace level (less than 0.1% of total fatty acids)

present study, this ratio ranged from 0.62 to 0.74, and the lipid fraction of Menina Brasileira seeds is highlighted.

As to the amount of saturated fatty acids, the lipid fraction of Menina Brasileira seeds showed 29.7 per cent, followed by Nova Caravela, Mini Paulista and Moranga de Mesa (21.9 per cent) seeds. In the case of the monounsaturated and polyunsaturated ones, it ranged from 28 to 31 per cent and 40 to 48 per cent, respectively.

All seed lipid fractions were found to be composed predominantly of unsaturated fatty acids, making up more than 50 per cent of the total fatty acids. It is known that the consumption of unsaturated fatty acid leads to a lower risk of cardiovascular diseases, because it does not increase rates of blood cholesterol. It can be argued that among these lipid fractions, the Moranga de Mesa variety, which showed approximately 78 per cent of unsaturated fatty acids, is the one that can provide greater health benefits.

These values are close to the ones observed by [Ardabili et al. \(2010\)](#), who found a total of 19.3 per cent of saturated fatty acids and 40.1 and 40.5 per cent of mono and polyunsaturated fatty acids, respectively, and also the ones obtained by [Fokou et al. \(2009\)](#), whose variations were 20-30 per cent for saturated fatty acids and 66-79 per cent for unsaturated fatty acids. According to the relation between saturated and unsaturated fatty acids, it was found that value of the lipid fraction of the Moranga de Mesa seed was higher, thus shown to be the best one, nutritionally.

The results of TAGs profile of lipid fractions of pumpkin seeds can be found in [Table III](#). Note that, in all the lipid fractions, 15 TAGs species containing four different fatty acids (P, S, O, L) and 50-54 carbon atoms were identified.

Triacylglycerols	Group	(% weight)			
		Nova Caravela	Mini Paulista	Menina Brasileira	Moranga de Mesa
POP	50:1	1.68	2.07	2.92	1.34
PLP	50:2	2.71	3.06	3.89	2.09
SOP	52:1	2.39	2.33	3.43	2.01
SLP	52:2	3.87	3.44	4.59	3.15
POO	52:2	3.41	4.16	4.86	3.36
PLO	52:3	11.0	12.3	12.9	10.5
PLL	52:4	8.93	9.05	8.68	8.23
SLS	54:2	1.38	0.97	1.35	1.18
SOO	54:2	2.44	2.34	2.86	2.52
SLO	54:3	7.88	6.91	7.65	7.90
OOO	54:3	2.32	2.78	2.70	2.81
SLL	54:4	6.38	5.09	5.11	6.19
OLO	54:4	11.2	12.3	10.8	13.2
OLL	54:5	18.2	18.2	14.5	20.7
LLL	54:6	9.79	8.93	6.45	10.8

Notes: P = Palmitic; S = Stearic; O = Oleic; L = Linoleic

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Table III.
Triacylglycerols
profile of the lipid
fractions extracted
from pumpkin seeds

To determine this profile, two aspects were considered. First is the main TAG component of highest concentration in the isomer with x and y carbon double bonds. Groups with a total concentration of less than 1 per cent TAGs were ignored for this reason; some fatty acids shown in Table II do not explicitly appear in Table III. The major TAG species found in all oils were OLL (14.5-20.7 per cent), OLO (10.8-13.2 per cent), PLO (10.5-12.9 per cent), LLL (6.45-10.8 per cent) and PLL (8.23-9.05 per cent), showing that the major fatty acids of these lipid fractions are oleic, linoleic and palmitic.

Conclusion

All lipid fractions analyzed showed good physical and chemical quality, especially checked by analysis of free fatty acids and peroxide index, which indicated that neither the seeds nor the lipid fractions obtained suffered inadequate treatments during cell extraction and storage. Furthermore, they showed values of quality parameters similar to those found in most vegetable oils consumed in Brazil.

The lipid fraction of Menina Brasileira pumpkin variety seeds showed high amounts of saturated fatty acids and, consequently, higher oxidative stability and may be used in thermal processing. Moreover, the lipid fraction from Moranga de Mesa variety seeds was characterized by having high amount of unsaturated fatty acids (linoleic and oleic acids), making it more suitable for human consumption. However, all lipid fractions analyzed showed high amounts of TAGs, mainly formed by the fatty acids oleic, linoleic and palmitic.

It was possible to see great potential for using these lipid fractions in foods as much as in the chemical, pharmaceutical and cosmetics industries. This may add value to products that are most often disposed as residues, increasing the viable sources of raw material and reducing waste.

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