Journal of Food Measurement and Characterization (2024) 18:8031–8040
https://doi.org/10.1007/s11694-024-02785-3

ORIGINAL PAPER

Physicochemical characteristics and quality of oil extracted from privet fruits *(Ligustrum vulgare L.)*

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Received: 6 May 2024 / Accepted: 25 July 2024 / Published online: 9 August 2024
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Abstract
Privet (*Ligustrum vulgare L.*) fruit is a shiny blackberry with seeds. Oil was extracted from the pulp by solvent and from seeds using cold press. The pulp contained 2.6% oil, with the main fatty acid being oleic acid (47.21%), followed by linoleic acid (37.80%) and palmitic acid (6.62%). Furthermore, the major tocopherols and phytosterols included α-tocopherol (904.20 µg/g) and stigmasterol (1378.37 µg/g). The seeds contained 10% oil, which was then stored for 90 days to assess changes in the oil quality. Oleic acid (49.1%) was the major fatty acid in the seed oil, followed by linoleic acid (39.73%), and palmitic acid (4.59%). Significant increases were observed in acid and peroxide values and phenolic contents during storage for 90 days in the dark. Major sterol compositions included sitosterol (685.48 µg/g), Δ^5-avenasterol (356.69 µg/g) and stigmasterol (127.43 µg/g), which were generally unchanged during storage. Moreover, the seed oil contained α-tocopherol (477 µg/g), followed by δ-tocopherol (44 µg/g), both of which decreased during storage by 15%, and 56%, respectively. In conclusion, the results demonstrate that the seed has a reasonably high oil, and bioactive components and the stability of these during storage suggests that privet fruits can provide a novel vegetable oil source.

Keywords Oil · *Ligustrum vulgare* · Fatty acids · Storage · Cold-press

Introduction

Ligustrum vulgare L. belongs to the Oleaceae family, which consists of 200 species native to Asia, Northwestern Africa, Europe, and Southern Australia. Privet fruit consists of a small, shiny blackberry with a diameter of 6–8 mm and contains 1 to 4 seeds [1]. *Ligustrum vulgare L.* is usually referred to as common privet, wild privet, golden privet, or European privet (Fig. 1).

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Privet has widely been used as an edible herb and stuffing as well as traditional medicine as it contains biologically beneficial compounds, which have antioxidant, antidiabetic, anti-inflammatory, and pro-apoptotic activities. Furthermore, privet includes important pharmacological effects such as neuroprotective, anti-mutagenic, and hepatoprotective effects [2]. Although privet includes numerous uses in cosmetics and conventional medicine, information on its fatty acid and antioxidant activities has not been investigated.

Commercial vegetable oil production depends on cold or hot-pressing and solvent extraction [3]. Although extraction using solvent and hot-pressing methods has high oil yield, extracted oils have to be refined due to high levels of impurities which result from this method [4]. Cold pressed oils are mainly preferred to refined oils as they are free of added chemicals and may include high levels of natural antioxidants and phytochemicals [5].

As mentioned above, privet fruit has many applications, but there is no information regarding seed and pulp oil content, and composition, or effects of storage on its quality. Thus, the principal aims of present study were to evaluate

Fig. 1 Privet (Ligustrum vulgare L.) fruit and its seeds

privet seed and pulp oil and to determine their composition and bioactive component to introduce a new vegetable oil source.

Materials and methods

Materials, standards, and solvents

The privet ripe fruits were collected in Tabriz, Iran, and dried in an oven (50 ºC, 48 h), then the pulp and seed were separated. Phenolphthalein (≥ 97.0%), sodium thiosulfate (≥ 99.5%), chloroform (≥ 99.8%), ethanol (≥ 99.5%), *n*-hexane (≥ 95%), cyclohexane (≥ 95%), acetic acid (≥ 99.8%), methanol (≥ 99.9%), aluminum chloride (≥ 99.5%), potassium iodide (≥ 99.99%), isooctane (≥ 99.5%), and hydroxide sodium were purchased from Merck & Co., Inc (Darmstadt, Germany). Fatty-acid methyl ester standards (including 37 components ranging from C4:0 to C24:1), and different isomers of tocopherols were purchased from Sigma–Aldrich Co. (St. Louis, MO, USA). Moreover, sterol standards included brassicasterol, cholesterol, campesterol, stigmasterol, sitostanol, campestanol, and caffeic acid. Folin-Ciocalteu, quercetin and 2,2-diphenyl-1-picrylhydrazyl (DPPH) reagents were from Sigma–Aldrich Co. (St. Louis, MO, USA).

Oil extraction from fruit seed using the cold-press method

The privet seed oil was extracted by a cold press (Screw Press Model 85 mm, Kern Kraft, Germany), which temperature was below 40 °C [6]. The extracted oil samples were stored in dark bottles, at room condition for 90 days. This oil was analyzed on extraction day and after 30, 60, and 90 days of storage.

Oil extraction from fruit pulp, using the solvent method

The privet pulp oil was extracted using the *n*-hexane as a solvent [7]. Briefly, 100 g of the privet powder was extracted using 300 ml of solvent in Erlenmeyer flasks which was mixed for 1 h with vigorous stirring. Then, the obtained mixture was filtered, and then the solvent was separated by using a rotary vacuum evaporator. The obtained oil samples were stored at room temperature. As only small amounts of oil from the pulp were recovered, the characteristics of privet oil were investigated only on production day samples.

Chemical analysis of the oils

Acid value

The acid value (mg KOH/g) was determined according to the AOCS method (Cd 8–53) [8].

Peroxide value

The peroxide value (meq O_2/kg oil) was assessed using, the Cd 5a-40 method by AOCS [8].

Carotenoid and chlorophyll contents

The pigment content of chlorophyll and carotenoids was assessed using an original method described by [9]. The the absorption at 630, 670, and 710 nm was used to determine chlorophyll content. To determin carotenoid contents, 7.5 g of the oil sample was made up to 25 ml using cyclohexane, and absorption was measured at 470 nm. Chlorophyll and carotenoid contents were calculated using the following equations:

$$Chlorophyll = {345.3 \times \ (A670 - 0.5 \times \ A630 - 0.5 \times \ A710)}/{L}$$

$$Carotenoid = {A470 \times \ 106}/{2000 \times \ 100 \times \ L}$$

Where, A (λ) was the absorbance and L was the thickness of the cuvette (10 mm).

Fatty acid composition

FAMEs of the oil samples were prepared and analyzed by gas chromatography (GC) (Agilent 7890 B, Agilent, USA), by the method reported by [10]. The GC had a flame ionization detector (FID), split/splitless injector and BPX70 capillary column (50 m × 0.22 mm, 0.25 µm). Helium and nitrogen were used as the carrier and the make-up gases, respectively. The injector temperature was 230 °C and detector temperature was set at and 250 ºC. The temperature of the oven was stated from 158 ºC remained 5 min and then increased to 220 ºC. Detection of FAMEs was according to the retention time of FAMEs and peak areas used to calculate the fatty acid percentage.

Triacylglycerols

The the oil samples triacylglycerol (TAG) profile was analyzed using high-performance liquid chromatography (Cecil Instruments, Cambridge, UK). Characterization of the triacylglycerols was carried out based on the number of carbons from the acyl groups, as described by AOCS [11]. Moreover, TAG peaks were determined according to the retention time of TAG standards.

Total phenolic compounds

The total phenolic compounds (TPCs) of the oils were determined, using a Folin-Ciocalteu reagent method described by Caponio, et al. [12]. Briefly, oil (2.5 g) was mixed very well with 2.5 ml of *n*-hexane and 2.5 ml of methanol: water (80:20, v/v) solution, and then centrifuged. The supernatant was separated, and the previous extraction step was performed again. Folin-Ciocalteu reagent (2.5 ml) was added to the extracted solutions and the mixture was mixed very well. Then, sodium carbonate saturated solustion (5 ml) was added, and the total volume was made up to 50 ml, using distilled water (DW). After 1 h, the absorbance was measuerd at 765 nm, using a spectrophotometer (Aquaris 1100, Cecil Instruments, UK). Caffeic acid was used to plot the standard curve, and values were reported as mg caffeic acid/kg oil. All analyses were triplicated.

Antioxidant activity

Effects of privet on DPPH were assessed, using a procedure described by [13]. Antiradicular activity of the privet oil spectrophotometric analysis was carried out, using DPPH. Briefly, 0.2 ml of the extract (1 mg/ml in methanol) was added to 1.8 ml of 0.004% methanolic DPPH. The mixture was set at RT for 1 h, followed by the absorption calculation at 517 nm, using a spectrophotometer (Aquaris 1100, Cecil Instruments, UK). The inhibition proportion of DPPH by the oil was calculated as follows:

$$\mathrm{Proportionofinhibition}(\%) = [(\mathrm{A.blank} - \mathrm{A.sample})/\mathrm{A.blanc}] \times 100$$

Phytosterol analysis

The oil samples were saponified, using 2 M ethanolic KOH and then the unsaponifiable were extracted. The trimethylsilyl ether derivatives were prepared according to the previously published method and analyzed using GC (Agilent Technologies, USA) [7]. The TMS ether derivatives of phytosterol fractions were separated on a J&W Scientific DB-5MS Fused-silica capillary Column (30 m × 0.18 mm, 0.18 µm) (J&W Scientific, Folsom, CA), using gas chromatography (Agilent GC 7890B). Nitrogen and helium were used as makeup and carrier gases, respectively. The oven temperature was regulated from 60 to 310 ºC at a 40 °C/min rate [7]. Phytoserols were detected by comparing the retention time of pure standards. Quantification was done by using 5a-cholestane as the internal standard.

Assessment of tocopherols

The tocopherol quantity of the oils was assessed using HPLC (Cecil Instruments, UK) based on a method described by [10]. In general, the oil sample (10 mg) was dissolved in *n*-heptane (1 ml). Then, 10 µl of the mixture was injected into a LiChroCART 250-4 Guard Column (Sigma-Aldrich, USA) filled with LiChrosphere 100 (5-µm particle size), using HPLC pump (Waters 510 HPLC Pump, Waters, USA). The mixture of n-heptane, tertbutylmethylether, tetrahydrofuran, and methanol (79:20:0.98:0.02, v/v) was used at 1 ml/min flow rate and isocratic elution was used as the mobile phase. Individual peaks were identified using a Varian 9070 Fluorescence Detector (Varian, USA) at 294 and 320 nm for excitation and emission, respectively. Tocopherols were detected by comparing the retention times with those of individual standards. Concentrations of the tocopherols were calculated, using calibration curves and external standard procedures based on the analysis of various tocopherol standard concentrations.

Oxidative stability

Rancimat 743 (Metrohm, USA) was used to calculate the oxidative stability of the privet oil according to AOCS (1997). Airflow and temperature for the acceleration of oil oxidation were 20 l/h and 110 ºC, respectively.

Statistical method

Experiments were done in triplicate and results were presented as mean ± SD (standard deviation). Completely randomized design was used to perform the statistical works. Analysis of variance (ANOVA) was carried out using GraphPad Prism Software v.5.01. Tukey's multiple comparison tests was used to determine the differences between the reported means and were reported as significant when $p < 0.05$.

Results and discussion

Oil yield

From an economical and nutritional point of view, the oil content is one of the most important factors to consider. Cold pressing was used to extract oil from the dried seeds. As the pulp had a very low oil content, hexane was used to extract the dried pulp samples. The oil yields of the privet seeds and pulp were 10 and 2.6%, respectively. Sufficient oil was extracted from the seeds to allow an analysis of the initial extracted seed oil and stored samples. As the yield of oil from the dried pulp was very low, analysis was only carried out on the initial extraction sample.

Acid value

AV is an important quality indicator of edible oils during storage which assesses the free fatty acid (FFA) content of the oils formed by the hydrolytic decomposition of lipid molecules. Higher FFA shows the low quality of the oil and can limit its use in food as well as for cosmetic, and pharmaceutical applications. Free acidity increases with storage, depending on the oil composition, packaging materials and time and storage conditions.

The results showed that the AV of the privet pulp oil extracted using a solvent was 5.22 (mg KOH/g). Also, the AV of privet seed oil extracted using the cold-press method was 1.93 (mg KOH/g) on Day 1 and reached 3.45 (mg KOH/g) at the end of storage (Fig. 2a). Moreover, the AV of privet seed oil, based on the Codex Alimentarius Commission (CAC) standard for virgin and cold-press oil, can be up to 4 mg KOH/g (Codex Alimentarius, 1999).

The results also demonstrated that the AV of the seed oil samples increased during storage. Similar results had been previously reported for other stored vegetable oils such as sunflower, black seed, and rapeseed [14, 15].

Peroxide value

PV is an assay commonly used to assess the quality of fats and oils, which shows that hydroperoxides are formed during the oxidation of fatty acids [16].

The current results revealed that the PV in privet pulp oil was 5.8 meq O_2/kg. Also, the PV of privet seed oil extracted via cold-press method significantly increased from 5.7 (meq O_2/kg) on Day 1 to 9.7 (meq O_2/kg) on Day 90 (Fig. 2a). However, an upper limit of PV for cold- pressed oils is 15 meq O2/kg (Codex Alimentarius, 1999). These results were in agreement with the previously published data reporting that PV could increase significantly during storage [17–19]. Increased PV during storage might have resulted from the degradation of unsaturated fatty acids (UFA) as well as oxidation at room temperature [20].

Carotenoid and chlorophyll pigment contents

Carotenoid and chlorophyll pigments are recognized as natural components of oilseeds, which can affect oil quality and stability. Chlorophyll plays important roles in oxidative stability through its potent antioxidant characteristics in the dark and proxidant activities in the light. Therefore, high chlorophyll contents increase oil sensitivity to oxidation and accelerate rancidity. Moreover, carotenoids are effective

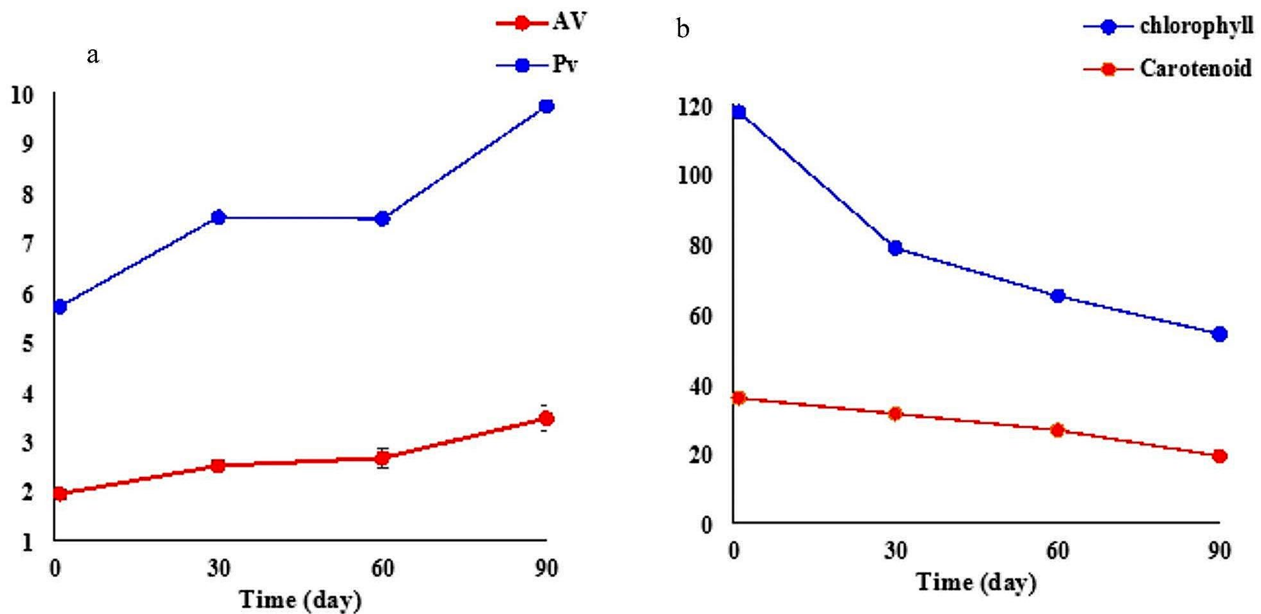

Fig. 2 Changes in chlorophyll and carotenoid contents (mg/kg oil) of the oil extracted from privet seeds during storage

inhibitors of light oxidation due to the quenching of singlet oxygen, which increases oil oxidative stability [21]. Results showed that chlorophyll and carotenoid contents of the pulp oil extracted with a solvent were 142.5 and 150 mg/kg, respectively.

Chlorophyll and carotenoid contents significantly decreased from 117.8 to 35.9 mg/kg on Day 1 to 54.2 and 19.3 mg/kg on Day 90, respectively (Fig. 2b), as the storage time increased. These results show that privet oil has high carotenoid and chlorophyll contents compared to black seed and sunflower oil [14]. These results were in agreement with previous studies published by Morelló and Naebi [22, 23], who reported that decreases in the contents of carotenoids and chlorophylls during storage might be due to the factors such as enzymatic activity, temperature, and oxygen which have hydrolytic and oxidative activities.

Fatty acid profile

Composition of the fatty acid is widely used for the establishment of oxidative stability, oil authenticity, and nutritional characteristics [24]. The FA composition of oils can determine their application for different purposes.

The major fatty acid compositions of the privet pulp oil were oleic acid (18:1) (47.2%), followed by linoleic acid (18:2) (37.8%) and palmitic acid (16:0) (6.6%) (Table 1). In this study, oleic acid (18:1, n-9), with 49.15%, was the major FA, followed by linoleic acid (18:2, n-6) with 38.56%, and these two typically included nearly 87% of the FA composition of the seed oil.

Based on the privet fatty acid profile, this oil was similar to peanut, sunflower, sesame, arachis, and argan oils [25, 26]. The privet seed oil included saturated fatty acids (7.1%), monounsaturated fatty acids (49.8%), and polyunsaturated fatty acids (40.2%).

In general, no significant changes were reported in the FA contents of the oil sample during 90 days of storage (Table 1). Linoleic acid had an approximately 3% decrease during storage. This finding was in agreement with previously published data Mazaheri and Naebi for *Nigella* and balangu seed oils, respectively [6, 22]. A high-MUFA diet can lead to lower cholesterol profiles and improve immune functions. Also, linoleic acid as an ω6 essential fatty acid has been reported to affect immune functions with protective effects against cancer, diabetes, obesity, and atherosclerosis [27].

Triacylglycerols

The composition of TAGs in the oil is a quality index which can be used for detecting adulteration and controlling the purity of the oil [28].

Results indicated that privet seed and pulp oil consisted of 16 TAGs. The major TAGs of the pulp oil included OOL, 23.67%, followed by LLO, 19.57%, OOO, and 13.31%, LLL. Moreover, OOL (27.38%) and LLO (21.52%) were typically the dominant TAGs of the seed oil (Fig. 3).

Findings showed that oleic acid and linoleic acid were the major FAs in the sn-2 position of TAGs. Previous studies on vegetable oils have reported that the major FAs in sn-2 position of TAGs are oleic acid and linoleic acid [29]. It is

Table 1 Changes in the fatty acid composition (%) of privet oil during storage for 90 days

Storage time	C16:0		C18:0		C18:1		C18:2		C18:3		C20:0	
	Day 1	Day 90	Day 1	Day 90	Day 1	Day 90	Day 1	Day 90	Day 1	Day 90	Day 1	Day 90
Seed oil	$4.59 \pm 0.04^{Ba*}$	4.80 ± 0.01^{a}	2.42 ± 0.05^{Ba}	2.31 ± 0.06^{a}	49.10 ± 0.01^{Aa}	48.70 ± 0.03^{a}	39.73 ± 0.04^{Aa}	36.7 ± 0.03^{b}	1.80 ± 0.05^{Ba}	1.71 ± 0.05^{a}	0.66 ± 0.03^{Ba}	0.70 ± 0.04^{a}
Pulp oil	6.62 ± 0.01^{A}	-	2.98 ± 0.6^{A}	-	47.21 ± 0.03^{B}	-	37.80 ± 0.04^{B}	-	2.47 ± 0.04^{A}	-	1.03 ± 0.03^{A}	-

Mean are shown as ± SD. * Different small letters in each row indicate a significant difference between days and different capital letters in each column indicate significant differences for seed and pulp oils

noteworthy that FAs in position 2 of TAGs include highly effective nutritional values, and they are efficiently absorbed in higher levels [30]. The privet oil has similar TAG composition to the corn, argan, and peanut oils [31, 32].

Total phenolic compounds

Total polyphenols content has favorable properties, e.g., shelf life, nutritional and health- promoting effects such as anti-apoptosis, anti-carcinogen, anti-inflammation, and organoleptic characteristics, as well as particularly promising antioxidant properties in oils [33].

Results demonstrate that the TPC of privet pulp oil extracted using a solvent was 382.6 mg caffeic acid/kg. Also, the phenolic content of privet seed oil was 147.7 (mg caffeic acid/kg oil) on Day 1 and reached to 286.0 (mg caffeic acid/kg oil on Day 90 (Table 2). However, the TPC of the oil demonstrated a significant ($p < 0.05$) reduction during storage until Day 30, possibly due the hydrolytic and oxidation activities caused by enzymes, oxygen and temperature. The TPC of the oil increased significantly ($p < 0.05$) on Days 60 and 90, which might be attributed to the breakdown of complex phenols to simple phenols in the oil samples. This showed that privet oils included high TPCs, compared to the vegetable oils such as flaxseed (55.8%), husked seed, and pumpkin (22.1%) [34–36].

Privet seed oil a good source of phenolic compounds, which can be easily extracted using cold-pressing methods. These compounds include antioxidant characteristics with anti-hydrolytic effects [37]. The findings were similar to previous literature published by [6, 18] in that TPC levels increased in the oil samples of Nigella sativa seeds during storage.

Antioxidant activity

In general, fruits and vegetables are the most important natural sources of antioxidants. These important nutraceuticals have numerous health benefits and are extensively used in food industries as lipid peroxidation inhibitors [38].

In the present study, the proportion of DPPH scavenged by antioxidants in privet seed and pulp oils were 39.05 and 43.2%, respectively. These values are significantly higher than other common vegetable oils such as soybean (17.4%), corn (11.1%), grapeseed (13.4%), sunflower (23.8%), flaxseed (19.3%), and passion fruit (6.73%) oils [39, 40]. Previously reported data have shown that these antioxidant activities, are mostly attributed to their phenolic contents [41].

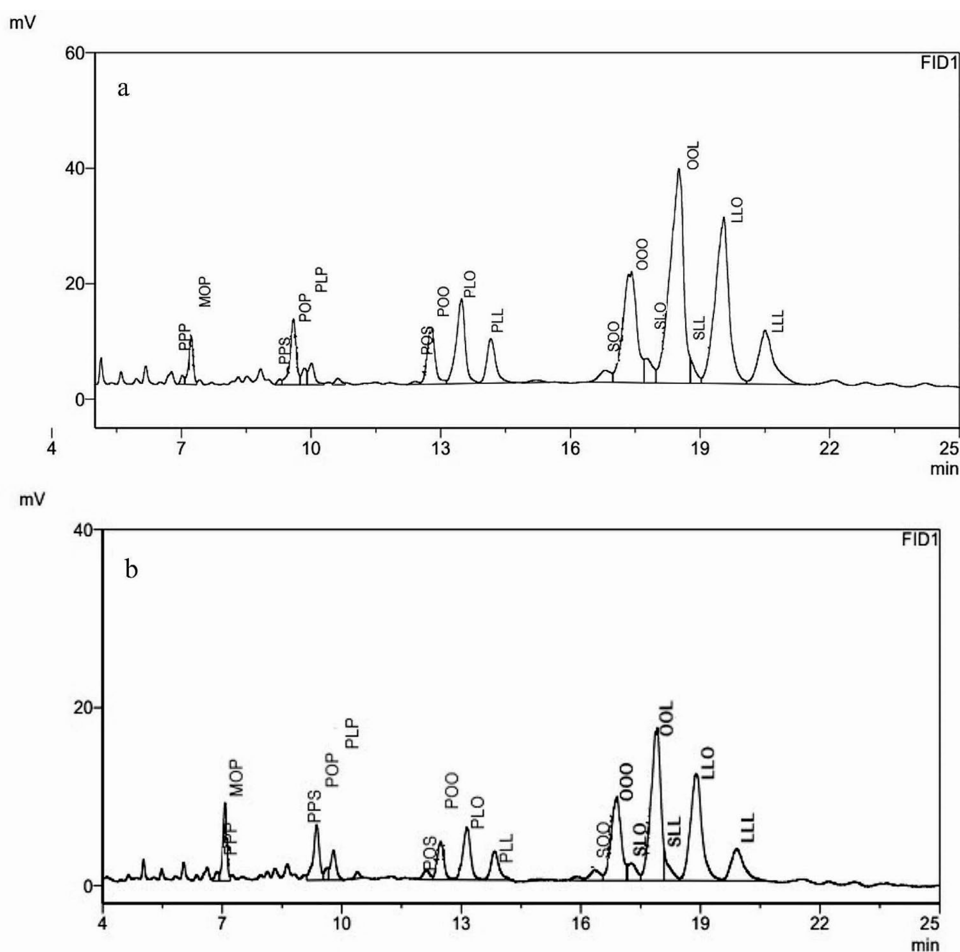

Fig. 3 Chromatograms of triacylglycerol composition of oil extracted from a) fruit and b) seed of privet

Table 2 Changes in phenolic content and antioxidant activity of the extracted privet oils during storage

	Phenolic content (mg caffeic acid/kg oil)				Antioxidant activity (%)	Oxidative stability (h)
	1 day	30 day	60 day	90 day		
Seed oil	147.7 ± 4.4[Bc*]	119.9 ± 1.6[d]	212.4 ± 3.06b	286.0 ± 4.07a	39.05 ± 0.3[B]	8.04 ± 0.05[B]
Pulp oil	382.6 ± 3.2[A]	-	-	-	43.2 ± 0.8[A]	9.78 ± 0.03[A]

Mean are shown as ±SD. * Different small letters in each row indicate a significant difference between days and different capital letters in each column indicate significant differences for seed and pulp oils

Phytosterol composition

Plant sterols (phytosterols) form the major unsaponifiable fractions of vegetable oils and may occur in various forms in plants [7]. Phytosterols in vegetable oils are critically important for nutritional and nutraceutical formulations because these biochemicals can help to prevent various diseases such as cancers and inflammatory diseases. These compounds naturally have antioxidant effects which increase oxidative stability and increase the shelf-life of foods containing them. In addition, they play useful roles in detecting adulteration of vegetable oils [42]. The most important phytosterol in oxidative stability and increased the shelf life of vegetable oils is Δ^5- avenasterol sterol [43].

In the present study, cholesterol, campesterol, stigmasterol, Δ^5- avenasterol, and sitosterol were identified in privet oils. The major phytosterol of the pulp oil was stigmasterol (1378.37 µg/g), followed by Δ^5-avenasterol (121.2 µg/g) and sitosterol (106.94 µg/g) (Table 3).

Sitosterol (685.48 µg/g) was the predominant compound, followed by Δ^5-avenasterol (356.69 µg/g), and stigmasterol (127.78 µg/g) in privet seed oil. The amount of β-sitosterol in privet seed oil was 50.36% of the total phytosterol content. The predominant phytosterol in oils such as walnut, rosehip, milk thistle, and flaxseed oils was also β-sitosterol [34].

No significant changes in phytosterol contents of the oils during storage up to 90 days. These results were in line with data presented in previous studies by [18], who also

Table 3 Change in the phytosterol (μg/g) and tocopherol (μg/g) contents of privet oil during storage

	Cholesterol		Campesterol		Stigmasterol		Sitosterol		Δ^5-avenasterol	
	Day 1	Day 90	Day 1	Day 90	Day 1	Day 90	Day 1	Day 90	Day 1	Day 90
Seed oil	$13.8 \pm 0.01^{Aa*}$	13.7 ± 0.05^{a}	113.6 ± 0.01^{Aa}	113.6 ± 0.04^{a}	127.4 ± 0.08^{Ba}	127.5 ± 0.02^{a}	685.5 ± 0.02^{Aa}	684.8 ± 0.01^{a}	356.7 ± 0.06^{Ab}	361.1 ± 0.02^{a}
Pulp oil	6.79 ± 0.01^{B}	-	71.29 ± 0.05^{B}	-	1378.37 ± 0.1^{A}	-	106.94 ± 0.2^{B}	-	121.20 ± 0.02^{B}	-
	α-Tocopherol		γ-Tocopherol		δ-Tocopherol					
	Day 1	Day 90	Day 1	Day 90	Day 1	Day 90				
Seed oil	477.0 ± 0.01^{Ba}	403.4 ± 0.05^{b}	19.38 ± 0.01^{Bb}	21.8 ± 0.05^{a}	44.00 ± 0.01^{Ba}	19.16 ± 0.01^{b}				
Pulp oil	904.2 ± 0.06^{A}	-	60.2 ± 0.03^{A}	-	62.7 ± 0.01^{A}					

Mean are shown as ±SD. * Different small letters in each row indicate a significant difference between days and different capital letters in each column indicate significant differences for seed and pulp oils

reported that the quantity of phytosterols did not change during storage.

Tocopherol contents

Tocopherols are naturally occurring antioxidants soluble in lipids. Tocopherols are important for health and detection of adulteration; they, also have positive effect on the oxidative stability of oils [44].

The major tocopherols measured in the pulp oil were α-tocopherol (904.2 μg/g), followed by δ-tocopherol (62.7 μg/g) and γ- tocopherol (60.2 μg/g), while seed oil contained, α-tocopherol (477 μg/g), δ (44 μg/g) and γ-tocopherol (19.35 μg/g). The α- and δ-tocopherol contents of the seed oil were significantly reduced ($p < 0.001$) following 90 days of storage; in contrast, the γ- tocopherol contents significantly increased during storage (Table 3). Overall, Privet seed oil contains higher amounts of tocopherols compared to other vegetable oils such as corn (22.78 μg/g), olive (236 μg/g), and canola oils (365.9 μg/g) [45, 46].

Oxidative reactions may decrease tocopherol content during storage. The reported increases in γ-tocopherols might have resulted from the decomposing of tocopheryl esters to free tocopherols, which might increase γ-tocopherol contents during storage [47]. In 2022, Naebi reported that the concentrations of α and δ-tocopherols in balangu oils decreased during storage, while γ-tocopherol concentrations increased [22]. Similar findings for common ash seed oils showed that α-tocopherol concentrations decreased while the concentrations of γ and β-tocopherols increased during storage [18].

Oxidative stability

Oil resistance against oxidative degradation during processing and storage is an important parameter in assessing oxidative stability and quality of vegetable oils. Oxidative stability of an oil depends on several characteristics, such as minor bioactive compounds, antioxidants and FA compositions [6]. Oxidative stability index usually assesses the oil shelf life using a rancimat test. Increased oxidation and shelf-life of vegetable oils have scientifically been ascribed to the levels of phytosterol and tocopherol in freshly processed oil [48].

Seed and pulp oils were assessed using rancimat analysis in this study. The oxidative stability was respectively, 8.04 and 9.78 h for the seed and pulp oils. These oils had higher oxidative stabilities compared to vegetable oils such as cress seed (2.67) and Spanish sage seed (0.65) oils but much lower oxidative stabilities than soybean (46.5), canola (10.25), hazelnut (8.9), and sesame (10.18) oils which were extracted, using similar cold-pressing methods [49, 50]. The

higher stability of these oils could be due to their higher contents of tocopherols and phytosterols [51].

Conclusion

The results obtained from this study showed that privet pulp had a low oil content (2.6%); however, the seed had a higher oil content (10%). The main fatty acids for the oil samples were oleic acid, linoleic acid, and palmitic acid in order of prominence. Also, seed and pulp oil had suitable oxidative stability, 8.04 and 9.78 h, respectively as well as contained high levels of bioactive components such as phenolic compounds, tocopherols, and phytosterols. In conclusion, the seeds of privet, due to their higher oil content, good stability and high levels of bioactive components, can be recommended as a new vegetable oil source. However, there is a need for further research to suggest this oil consumable in the daily diet or in the food formulations.

Funding This research was funded by Tabriz University of Medical Sciences and University of Tabriz grant number 3702.

Data availability Detail data are available upon request from authors.

Declarations

Competing interest The authors report no declarations of interest.

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