



CHEMICAL COMPOSITION OF LEAVES OF CHINESE QUINCE (*PSEUDOCYDONIA SINENSIS* (THOUIN) C.K. SCHNEID.)

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Pseudocyonia sinensis (Thouin) C.K. Schneid. less known plant species in the Ukraine conditions, but the fruits were widely used in traditional Chinese medicine for the treatment of asthma, colds, sore throat, mastitis, rheumatoid arthritis, and tuberculosis. In this study, chemical compositions of the leaves of *Pseudocyonia sinensis* were investigated. They contained total protein 6.66%, ash 8.54%, lipids 3.38%, beta carotene 90.30 mg/kg DW. Monosaccharide analysis revealed that the neutral carbohydrate part (fructose, maltose, sucrose, and lactose) was found in low amounts only (<0.5 g/kg). The major quantitative tocopherol in leaves was α -tocopherol (80.73 mg/kg DW). Saturated, monounsaturated and polyunsaturated fatty acids, palmitic acid (C16:0; 53.36 g/100 g DW), oleic acid (C18:1; 12.49 g/100 g DW) and linoleic acid (C18:2; 8.24 g/100 g DW), respectively, were found predominant. Palmitic acid makes up 57.2% of the total amount. The total amount of amino acids found in the leaves was 53.90 g/kg DW, including total essential amino acids (28.60 g/kg DW) and percentage of total essential amino acids (53.06%). Glutamic acid was found of leaves to be the dominant free amino acid (6.5 g/kg DW) followed by aspartic acid (5.4 g/kg DW) and leucine (4.9 g/kg DW). The mineral composition of leaves of *P. sinensis* demonstrated the presence of elements in following order: Ca>K>Mg>P>S>Fe>Zn>Na>Mn>Al>Cu>Ni>Cr>Pb>Cd>Hg>As>Se. Studied antioxidant parameters showed that antioxidant activity by DPPH and molybdenum reducing power was 8.76 and 289.73 mg TE/g, respectively. Also, the total content of polyphenols, flavonoids, and phenolic acids amounted to 65.77 mg GAE/g, 22.47 mg QE/g, and 9.06 mg CAE/g, respectively. The obtained data represent that leaves of *P. sinensis* contain rich mineral composition, amino, and fatty acid composition and biologically active compounds such as polyphenols that can be used in the pharmaceutical study to validate its possible medicinal application. The study of less know and neglected plant species and it's raw can increase possible use in human life beneficial plant products.

Keywords: Chinese quince, leaves, chemical compositions, antioxidant activity

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Introduction

Interest in plants as a source of natural bioactive compounds has prompted researchers to investigate their tissue chemical composition and therapeutic potential. It is many plant species exist in the world have cultivated for food, but still less known, neglected and underutilized not full while they play important role in procuring the food security to improve health and nutrition, ecological sustainability and livelihoods (Mal, 2007; Magbagbeola et al., 2010; Dansi et al., 2012; Chivenge et al., 2015; Klymenko et al., 2017).

Chinese quince (*Pseudocydonia sinensis* (Thouin) C.K. Schneid.) of the family Rosaceae Juss. the only species in the genus *Pseudocydonia* C.K. Schneid., native to eastern Asia in China. It is closely related to the East Asian genus, *Chaenomeles* Lindl. (is sometimes placed in *Chaenomeles* as *C. sinensis*), and to the European genus, *Cydonia* Mill. (Suzuki, 1994).

Fruits of the *Pseudocydonia sinensis* are very fragrant, yellow edible pomes with an elliptical or ovoid shape (Mihara et al., 1987; Monka et al., 2014; Klymenko et al., 2017; Choi et al., 2018). Their fruits have a big size with a height of 98.06–124.48 mm, an average diameter of 62.33–88.64 mm, and an average weight in the range of 197.85–466.38 g (Monka et al., 2014).

The fresh fruit of *Pseudocydonia sinensis* are sour and hard and consumed after processing into spreads, marmalades, jams, fruit jellies, candied pulp, sweetened syrups and juices, wines, liqueurs, and use in preparing of flour products, candies (Hamauzu et al., 2006; Monka et al., 2014; Klymenko et al., 2017).

The fruit of investigated species includes organic acids, both flavonoids rutin and quercetin, procyanidins, and volatile compounds (Hamauzu et al., 2005; 2014). The main volatile compounds in Chinese quince peel are (E,E)- α -farnesene, isobutyl octanoate, ethyl octanoate, isobutyl 7-octanoate, and hexyl hexanoate (Mihara et al., 1987). In the peel, ethyl 2-methylpropanoate, ethyl (E)-2-butenolate, ethyl 2-methyl butanoate, methional, (Z)-3-hexenyl acetate, β -ionone, ethyl nonanoate, and γ -decalactone were found as the potent aroma-active compounds (Choi et al., 2018).

The fruits of the *Pseudocydonia sinensis* were widely used in traditional Chinese medicine for the treatment of asthma, colds, sore throat, mastitis, rheumatoid arthritis, and tuberculosis (Chung et al., 1988a; 1988b; Hamauzu et al., 2005; 2014; Mihara et al., 1987). The pharmacological studies have shown the antibacterial, antihemolytic (Osawa et al., 1997), anti-inflammatory (Osawa et al., 1999), antipruritic (Oku et al., 2003), antioxidant (Hamauzu et al., 2005; 2007; Monka et al., 2014; Grygorieva et al., 2020), antiviral (Hamauzu et al., 2005; 2007; Sawai et al., 2008; Sawai-Kuroda et al., 2013), anti-ulcerative (Hamauzu et al., 2006), gastroprotective (Hamauzu et al., 2018), antitumor (Chun et al., 2012), and antimicrobial (Essuman et al., 2017; Kabir et al., 2015) properties of *Pseudocydonia sinensis* fruit.

To the best of our knowledge, there is no previously reported study of the phytochemical characteristics of *Pseudocydonia sinensis* leaves and scientific information still not enough. Therefore, this work was carried out to determine the chemical composition of leaves of less known species *Pseudocydonia sinensis* to assess the possibility of using this species in the future.

Material and methodology

Biological material

Pseudocydonia sinensis (Figure 1) leaves were collected in the July 2018 from trees growing in an M.M. Gryshko National Botanical Garden (Kyiv, Ukraine). The concentration of bioactive compounds detected in the dry material.

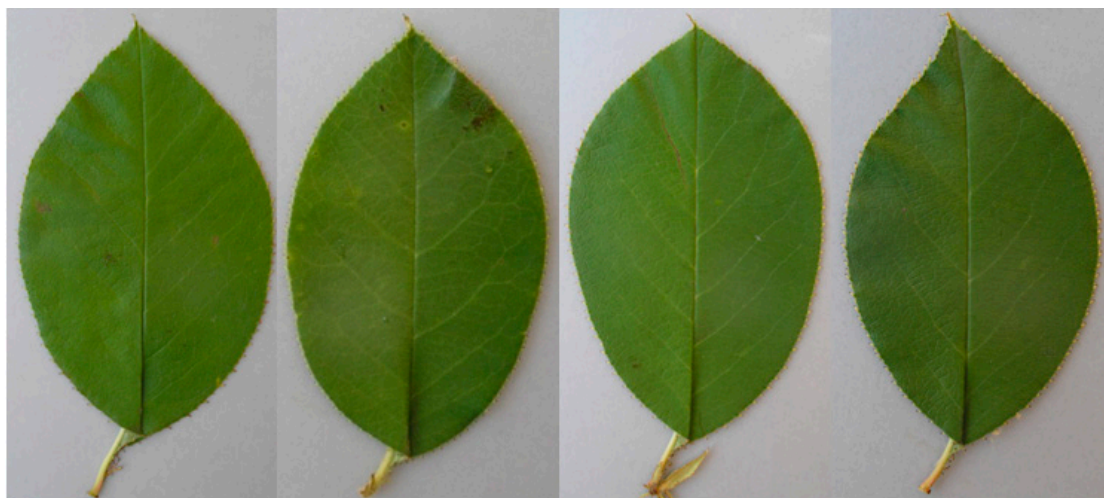


Figure 1 Leaves *Pseudocydonia sinensis* C.K. Schneid.

Chemicals

All the chemicals used were of analytical grade and were purchased from Sigma-Aldrich (Steinheim, Germany), Merck (Darmstadt, Germany) and CentralChem (Slovakia).

Phytochemical analyses

Determination of dry matter, ash and protein content

Total dry matter, ash, and protein content were determined according to EN method (CSN EN 12145, 1997). Total lipid content was determined according to methods specified in ISO method (ISO 659:1998).

Determination of saccharides

For the determination of saccharides, 1 g of sample was extracted with 10 mL of extraction solution (ultrapure water and ethanol mixed in ration 4 : 1) in a 50 mL centrifugation tube placed on vertical shake table (GFL, Germany). After 1 h of extraction, samples were centrifuged for 4 min at 6,000 rpm in a centrifuge (EBA 21, Hettich, Germany); the supernatant was filtered using a filter with 0.45 mm pore size (Labicom, Czech Republic) and filled up to 50 mL in a volumetric flask with ultrapure water. An Agilent Infinity 1260 liquid chromatography (Agilent Technologies, USA) equipped with ELSD detector was used for the determination of saccharides. A Prevail Carbohydrates ES column (250/4.6 mm) was used as a stationary

phase and acetonitrile (VWR) mixed with water in 75 : 25 volume ratio was used as the mobile phase.

Determination of carotenoid

Total carotenoid content expressed as beta-carotene was analyzed at a wavelength of 445 nm spectrophotometrically (VIS spectrophotometer UV Jenway Model 6405 UV/VIS). Sample (1 g) was disrupted with sea sand and extracted with acetone until complete discoloration. Petroleum-ether was added and then water, in purpose to the separation of phases. After the separation, the petroleum ether-carotenoid phase was obtained and the absorbance was measured (ČSN 560053, 1986).

Determination of mineral contents

Sample for elemental analysis was prepared using the wet ashing method in a microwave oven (Milestone 1200, Milestone, Italy). Total of 0.25 g sample matrix was decomposed in a mixture of nitric acid (6 mL) (Analytika Praha spol. s.r.o., Czech Republic) and hydrochloric acid (2 mL) (Analytika Praha spol. s.r.o., Czech Republic). After the decomposition sample was filtered using a filter with 0.45 mm pore size and filled up to 25 mL in a volumetric flask with ultrapure water. Elemental analysis was performed using ICP-OES (Ultima 2, Horiba Scientific, France) according to the procedure described by Divis et al. (2015).

Determination of amino acids

Amino acids were determined by ion-exchange liquid chromatography (Model AAA-400 amino acid analyzer; Ingos, Czech Republic) using post-column derivatization with ninhydrin and a VIS detector. A glass column (inner diameter 3.7 mm, length 350 mm) was filled manually with a strong cation exchanger in the LG ANB sodium cycle (Laboratory of Spolchemie) with average particles size 12 μM and 8% porosity. The column was tempered within the range of 35 to 95 °C. The elution of the studied amino acids took place at a column temperature set to 74 °C. A double-channel VIS detector with the inner cell volume of 5 μL was set to two wavelengths: 440 and 570 nm. A solution of ninhydrin (Ingos, Czech Republic) was prepared in 75% v/v methyl cellosolve (Ingos, Czech Republic) and in 2% v/v 4 M acetic buffer (pH 5.5). Tin chloride (SnCl_2) was used as a reducing agent. The prepared solution of ninhydrin was stored in an inert atmosphere (N_2) in darkness at 4 °C. The flow rate was 0.25 mL/min. and the reactor temperature was 120 °C.

Determination of total polyphenol, flavonoid, and phenolic acid content

The total polyphenol content (TPC) was measured by the method of Singleton and Rossi (1965) using the Folin-Ciocalteu reagent. A quantity of 0.1 mL of each sample was mixed with 0.1 mL of the Folin-Ciocalteu reagent, 1 mL of 20% (w/v) sodium carbonate, and 8.8 mL of distilled water. After 30 min in darkness, the absorbance at 700 nm was measured with the spectrophotometer Jenway (6405 UV/Vis, England). Gallic acid (25–300 mg/L; $R^2 = 0.998$) was used as the standard. The results were expressed in mg/g DM gallic acid equivalent.

The total flavonoid content (TFC) was determined by the modified method described by Shafii et al. (2017). An aliquot of 0.5 mL of the sample was mixed with 0.1 mL of 10% (w/v)

ethanolic solution of aluminum chloride, 0.1 mL of 1 M potassium acetate and 4.3 mL of distilled water. After 30 min in darkness, the absorbance at 415 nm was measured using the spectrophotometer Jenway (6405 UV/Vis, England). Quercetin (1–400 mg/L; $R^2 = 0.9977$) was used as the standard. The results were expressed in mg/g DM quercetin equivalent.

Total phenolic acid (TPA) content was determined using the method of Farmakopea Polska (1999). A 0.5 mL of sample extract was mixed with 0.5 mL of 0.5 M hydrochloric acid, 0.5 mL Arnova reagent (10% NaNO_2 + 10% Na_2MoO_4), 0.5 mL of 1 M sodium hydroxide (w/v) and 0.5 mL of water. Absorbance at 490 nm was measured using the spectrophotometer Jenway (6405 UV/Vis, England). Caffeic acid (1–200 mg/L, $R^2 = 0.999$) was used as a standard and the results were expressed in mg/g DM caffeic acid equivalents.

Determination of antioxidant activity

Free radical scavenging activity

Free radical scavenging activity of samples was measured using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) (Sanches-Moreno et al., 1998). An amount of 0.4 mL of the sample was mixed with 3.6 mL of DPPH solution (0.025 g DPPH in 100 mL methanol). The absorbance of the reaction mixture was determined with the spectrophotometer Jenway (6405 UV/Vis, England) at 515 nm. Trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid) (10–100 mg/L; $R^2 = 0.989$) was used as the standard and the results were expressed in mg/g DM Trolox equivalents.

Molybdenum reducing antioxidant power

Molybdenum reducing (MRP) antioxidant power of samples was determined by the method of Prieto et al. (1999) with slight modifications. The mixture of the sample (1 mL), monopotassium phosphate (2.8 mL, 0.1 M), sulfuric acid (6 mL, 1 M), ammonium heptamolybdate (0.4 mL, 0.1 M) and distilled water (0.8 mL) was incubated at 90 °C for 120 min, then rapidly cooled. The absorbance at 700 nm was detected with the spectrophotometer Jenway (6405 UV/Vis, England). Trolox (10–1,000 mg/L; $R^2 = 0.998$) was used as the standard and the results were expressed in mg/g DM Trolox equivalent.

Statistic analysis

Basic statistical analyses were performed using PAST 2.17. Data were analyzed with ANOVA test and differences between means compared through the Tukey-Kramer test ($p < 0.05$). The variability of all these parameters was evaluated using descriptive statistics.

Results and discussion

Biochemical study of fruit plants, basically, relates to the composition of fruits and few only highlight the accumulation of biochemical compounds in the leaves. But, evidently, that leaves of fruit plants also can be a useful source of nutrients with beneficial biological activities.

Chemical analyses of *Pseudocycdonia sinensis* leaves revealed the presence of protein (6.66 wt/wt%), lipids (3.38 wt/wt%) and inorganic material (8.54 wt/wt%) (Table 1).

Table 1 The contents of some phytochemical compounds of *Pseudocymodoia sinensis* C.K. Schneid.

| Components | $\bar{x} \pm S_x^-$ | Components | $\bar{x} \pm S_x^-$ |
|---|---------------------|--|---------------------|
| Total dry matter (%) | 92.66 ± 3.05 | Polyunsaturated fatty acids (g/100 g oil) | 13.40 ± 0.11 |
| Total content of protein (%) | 6.66 ± 0.14 | Fructose (g/kg) | <0.5 |
| Total content of ash (%) | 8.54 ± 0.31 | Maltose (g/kg) | <0.5 |
| Total content of lipids (%) | 3.38 ± 0.12 | Sucrose (g/kg) | <0.5 |
| Beta carotene (mg/kg) | 90.30 ± 1.09 | Lactose (g/kg) | <0.5 |
| Saturated fatty acids (g/100 g oil) | 70.0 ± 0.56 | Vitamin A (retinyl acetate) (mg/kg) | <0.1 |
| Monounsaturated fatty acids (g/100 g oil) | 12.95 ± 0.16 | Vitamin E (α-tocopherol) (mg/kg) | 80.73 ± 2.12 |

Note: \bar{x} – arithmetic mean; S_x^- – standard error of the mean.

Monosaccharide analysis revealed that the neutral carbohydrate part (fructose, maltose, sucrose, and lactose) was found in low amounts only (<0.5 g/kg). Monosaccharides are primary products of photosynthesis. They are involved in nearly all fundamental processes within plant metabolism, including synthesis of organic and amino acids, polyphenols, pigments and aroma compounds (Halford et al., 2011). It is important to underline that leaves with increased monosaccharide content were found in plants when grown under stressful factors (Wind et al., 2010). Therefore, a lower level of sugars in the leaves indicates optimal environmental conditions for plant growth.

It should be noted that the main attention of researchers is aimed at studying the composition of monosaccharides and polysaccharides of fruits and seeds of *Chaenomeles* species. Thus, the polysaccharide fraction from the seeds of *Chaenomeles sinensis* and *Chaenomeles speciosa* consists of arabinose, glucose, xylose, galacturonic acid and glucuronic acid (Wang et al., 2018; Deng et al., 2020). Hypoglycemic analyzes showed that polysaccharides have good activity in inhibiting α-amylase and α-glucosidase. Therefore, a polysaccharide from the *Chaenomeles* species can be used as a potential natural source to slow down the effects of postprandial hyperglycemia. Also, polysaccharides and monosaccharides from these plants can be used in the food and pharmaceutical industries.

Pseudocymodoia sinensis contains beta carotene (90.30 mg/kg). Carotenoids are among the most common natural pigments, and with β-carotene as the most prominent. They are pigments that play a major role in the protection of plants against photooxidative processes. Carotenoids are efficient antioxidants scavenging singlet molecular oxygen and peroxy radicals. They interact synergistically with other antioxidants (Stahl and Sies, 2003).

The major quantitative tocopherol in *Pseudocymodoia sinensis* leaves was α-tocopherol (80.73 mg/kg DWP). Four tocopherols and tocotrienols are collectively referred to as vitamin E. The reactivity with organic peroxy radicals accounts for their antioxidant activity and is believed to be their major biochemical function (Shahidi and Ambigaipalan, 2015). These reactions are

the basis that vitamin E functions as an antioxidant, protecting tissue lipids from free radical attack.

The oil contents were 3.4% dry weight plant material (Table 1). It is reasonable because the majority of botanical materials (leaves) contain low amounts of lipids. The fatty acids composition was comprised of saturated fatty, monounsaturated, and polyunsaturated fatty acids (70.0; 12.95 and 13.40 g/100 g oil, respectively).

The lipophilic fraction contains of 20 fatty acids (Figure 2); five acids (palmitic acid C-16:0 in quantity 53.4 g/100 g; oleic acid C-18:1 in quantity 12.5 g/100 g; linoleic acid C-18:2 in quantity 8.2 g/100 g; stearic acid, C-18:0 in quantity 8.0 g/100 g; linolenic acid, C-18:3 in quantity 8.0 g/100 g) are dominated. Of these acids, amounted to 87.3% of the total (Figure 2). *P. sinensis* fatty acid profiles showed the presence of high amounts of palmitic acid (53.4%) (Figure 2). Palmitic acid is dominated in fatty acid profiles of leaves of many species such as Lamiaceae species (27.7–60.0%) (Cacan et al., 2018; Kilic, 2018); *Cassia tora* (L.) Roxb. (18.6–38.7%) (Shukla et al., 2018); *Nicotiana* species (13–18%) (Koiwai et al., 1983); *Cistus ladanifer* L. (13.6–17.5%) (Jerónimo et al., 2020). The second quantitatively major compound was oleic acid (12.5%). There are literature reports of insecticidal activity of oleic acid against *Aedesae gyptii* larvae (Kumar et al., 2009).

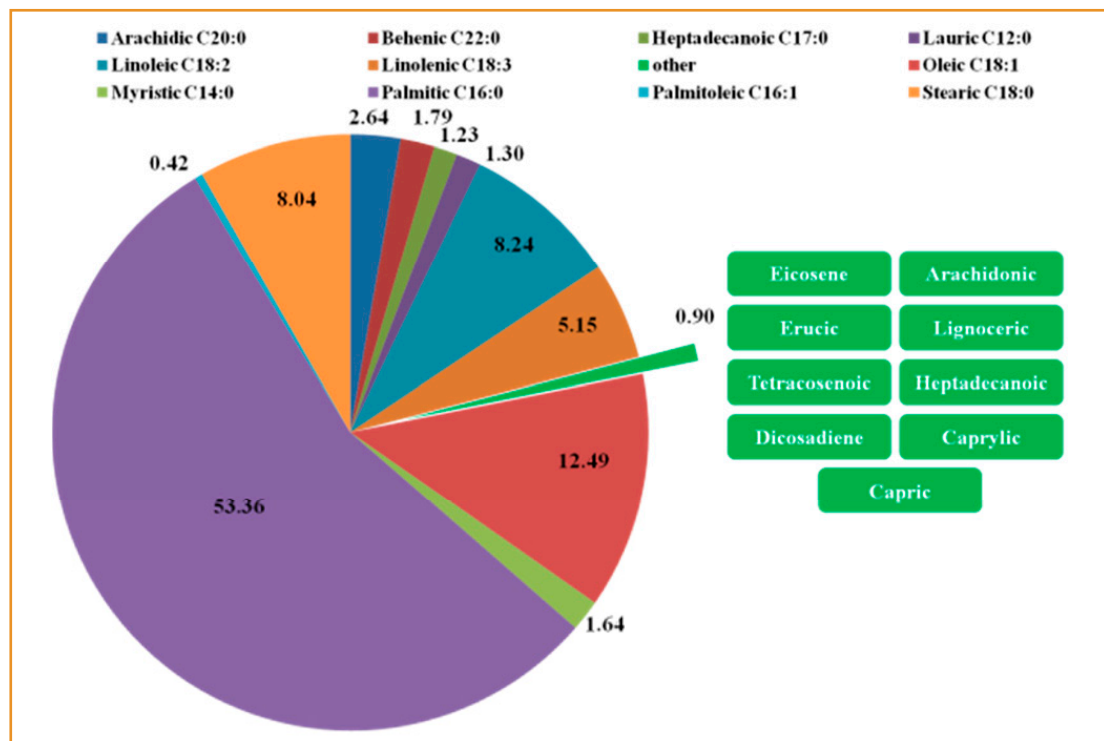


Figure 2 Fatty acid composition from leaves of *Pseudocydonia sinensis* C.K. Schneid. (g/100 g oil). Minor components (<0.1) Eicosene C20:1; Arachidonic C20:4; Erucic C22:1; Lignoceric C24:0; Tetracosenoic C24:1; Heptadecanoic C17:1; Dicosadiene C22:2; Caprylic C8:0; Capric C10:0 are in the right column, their total amount is 0.9 g/100 g oil

According to the literature, *Pseudocyclonia sinensis* fruit was rich in oleanolic acid and ursolic acid (Zhou et al., 2020). In addition, from the twigs of *Pseudocyclonia sinensis* isolated five new oxylipins of chaenomic acid (Kim et al., 2014).

Lipids consisted of fatty acids, classified on saturated, monounsaturated, and polyunsaturated fatty acids (Mišurcová et al., 2011). Fatty acids play an important role as nutritious substances and metabolites in living organisms (Cakir, 2004). Many fatty acids are known to have antibacterial and antifungal properties (McGaw et al., 2002; Seidel and Taylor, 2004) and also have an important impact on human health, particularly in the prevention of cardiovascular disease, coronary heart disease, cancer, hypertension, diabetes type two, renal diseases, rheumatoid arthritis, ulcerative colitis, and Crohn's disease (De Caterina et al., 2000; Abedi and Sahari, 2014).

Fatty acids are involved in the formation of plant adaptive capacity to abiotic stresses: extreme positive and negative temperatures, lack of moisture causes a change in the composition of fatty acids (Gigon et al., 2004; Liu and Huang, 2004; Zhong et al., 2011; Li et al., 2017).

Amino acid analysis has shown that the studied *Pseudocyclonia sinensis* leaves contained 18 amino acids (10 essential and 8 non-essential) (Figure 3).

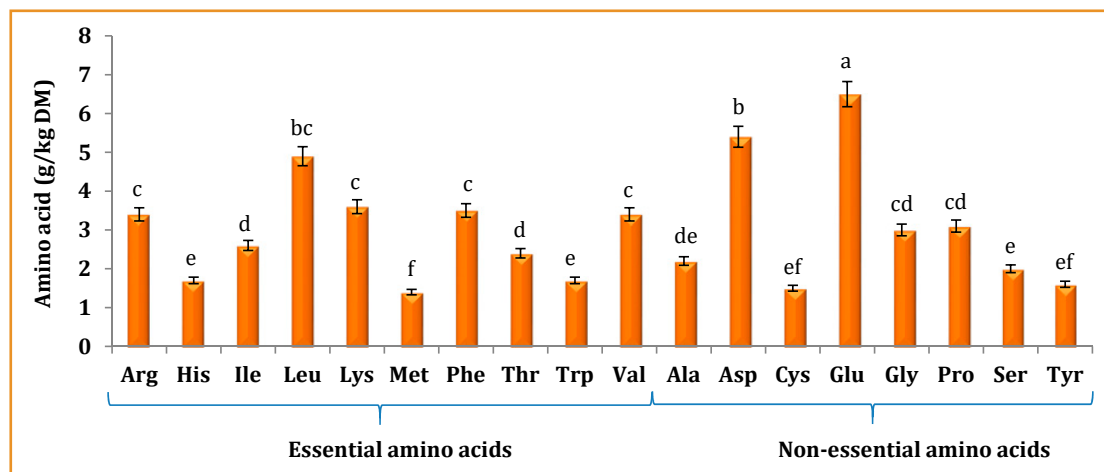


Figure 3 Amino acid composition of *Pseudocyclonia sinensis* C.K. Schneid. leaves, g/kg DM (different superscripts in each column indicate the significant differences in the mean at $p < 0.05$)

Total amount of amino acids found in the leaves was 53.90 g/kg DM, including total essential amino acids (28.60 g/kg DM) and percentage of total essential amino acids (53.06%). Glutamic acid was found of leaves to be the dominant free amino acid (6.5 g/kg) followed by aspartic acid (5.4 g/kg) and leucine (4.9 g/kg).

One important factor for the formation of active constituents in plants is the trace elements because they are known to play an important role in plant metabolism and active constituents of medicinal plants are metabolic products of plant cells. In fact, the chemical constituents present in plants are responsible for their medicinal as well as toxic properties which

include vegetable bases comprising of alkaloids and amines, glycosides, essential oils responsible for their characteristic odour, toxic substances known as toxalbumin, resins, and antibiotics. Whereby the trace elements play a very important role in the formation of these compounds.

In addition, leaf analysis for mineral elements is an important guide to sustainable plant nutrition. The mineral composition of plants is influenced by factors such as growing conditions (climate, soil) and the phase of plant development (phenophase) (Penauelas et al., 2001; Erdal et al., 2006; Lipa, 2013; Yildirim et al., 2015).

The results of the elemental analysis of *Pseudocydonia sinensis* leaves are summarized in Table 2.

Table 2 Mineral composition of *Pseudocydonia sinensis* C.K. Schneid. leaves (mg/kg)

| Components | $\bar{x} \pm S_x^-$ | Components | $\bar{x} \pm S_x^-$ | Components | $\bar{x} \pm S_x^-$ |
|------------|---------------------|------------|---------------------|------------|---------------------|
| P | 1,776 ±117 | Mg | 3,113 ±218 | Se | <0.2 |
| K | 10,628 ±321 | Na | 13.0 ±0.7 | As | <0.3 |
| Ca | 24,304 ±450 | Al | 8.9 ±1.4 | Cd | 0.051 ±0.003 |
| S | 1,335 ±98 | Cr | 0.20 ±0.08 | Ni | 1.37 ±0.02 |
| Fe | 56.0 ±1.6 | Cu | 6.0 ±0.7 | Hg | 0.024 ±0.005 |
| Mn | 9.8 ±0.8 | Zn | 32.0 ±1.5 | Pb | 0.100 ±0.003 |

Note: \bar{x} – arithmetic mean; S_x^- – standard error of the mean.

Concentration of various elements of leaves decreases in the order: Ca>K>Mg>P>S>Fe>Zn>Na>Mn>Al>Cu>Ni>Cr>Pb>Cd>Hg>As>Se. Among the various elements As, Se, Cd, Hg are found to be present at the trace level. Fe, Zn, Mn, Na, Al, Ni, and Cu are at the minor level, and Ca, K, Mg, P, and S are at the major levels. This result confirmed by the data Lewko et al. (2004) and showed that the leaves of quince (*Cydonia oblonga*) contained a large amount of calcium. Calcium is an essential mineral for human health, participating in the biological functions of several tissues (musculoskeletal, nervous and cardiac system, bones and teeth, and parathyroid gland). In addition, Ca can act as a cofactor in enzyme reactions (fatty acid oxidation, mitochondrial carrier for ATP, etc.) and it is involved in the maintenance of the mineral homeostasis and physiological performance in general (Theobald, 2005; Huskisson et al., 2007; Morgan, 2008; Williams, 2008).

Based on a large amount of scientific data proving the beneficial effect of phenolic content in humans, it is appropriate to perform estimation of these compounds content of leaves extracts of *Pseudocydonia sinensis*.

The amount of total phenolic acid, flavonoids, and polyphenols content was 9.06 mg CAE/g DW, 22.47 mg QE/g DW, and 65.73 mg GAE/g DW, respectively (Figure 4).

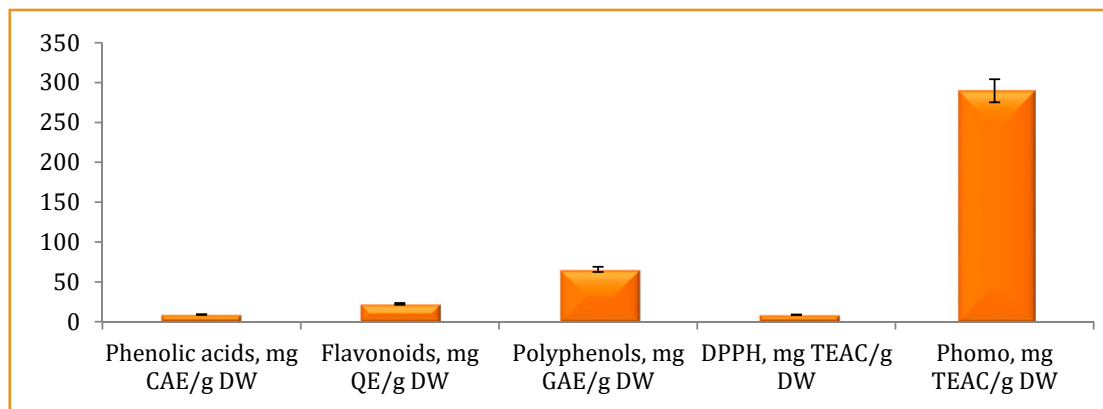


Figure 4 Parameters of antioxidant activity of *Pseudocydonia sinensis* C.K. Schneid. leaves

The leaves of crops and wild plants are a valuable source of antioxidant substances, especially polyphenols. According to published data, the total phenol content for the leaves of *Mangifera indica* L. was 65 mg/g, for *Anacardium occidentale* L. 58.57 mg/g, for *Cymbopogon citratus* (DC.) Stapf 28.30 mg/g, for *Carica papaya* L. 21.80 mg/g (Iyawe and Azih, 2011), for *Euphorbia* spp. 19.10–20.30 mg/g (Gapuz and Besagas, 2018) and for *Azadirachta indica* Juss. 14.43 mg/g (Iyawe and Azih, 2011). Thi and Hwang (2014) found that the total polyphenol content of *Aronia mitschurinii* ranged from 139.3 to 250.8 mg GAE/g DW. The result of another study submitted by Shahin et al. (2019), related to *Aronia melanocarpa*, demonstrated that the total polyphenol content in the dried leaves was 765.63 mg GAE/g. According to Męczarska et al. (2017), *Amelanchier alnifolia* leaves showed a total polyphenol content of 185.23 mg GAE/g DW. As reported by Barreira et al. (2010), the total flavonoid content of *Castanea sativa* Mill. 73.31–90.39 mg/g, for data of Stankovic et al. (2014) *Cornus mas* L. leaves had a total flavonoid content of 22.18 mg/g, according to Al-Saedi et al. (2016) for *Ziziphus jujuba* Mill. methanol extracts were 90.28 mg/g.

The information about the characterization of *Pseudocydonia sinensis* leaf extract is limited. Zhou et al. (2020) using HPLC reported the phenolic profile of leaves and found 5-compounds. Phthalic acid, di(2,3-dimethylphenyl) ester (3.693%), heptasiloxane, hexadecamethyl (25.425%) and neophytadiene (25.309%) are major compound in the leaves.

Most research on *Cydonia oblonga* leaf characterization is from Portugal (Oliveria et al., 2007). The total phenolic content of *C. oblonga* leaves was very high, varying from 4.9 to 16.5 g/kg dry matter (mean value of 10.3 g/kg dry matter). In the phenolic profile of Portuguese quince leaves were found 9 compounds. The 5-O-caffeoylquinic acid was the major compound (36.2%), followed by quercetin-3-O-rutinoside (21.1%) and kaempferol-3-O-rutinoside (12.5%). The leaves of Tunisian quince variety “Commune” have 9-phenolic acids and flavonoids (Benzarti et al., 2018). Among these polyphenols, 6-were identified, one as caffeoylquinic acid (4-O-caffeoylquinic acid), two as quercetin heterosides (quercetin-3-O-rutinoside and quercetin-3-O-galactoside), and three as kaempferol heterosides (kaempferol-3-O-rutinoside, kaempferol-3-O-glycoside, and kaempferol-3-O-glucoside).

The evaluation of the antioxidant activity of leaf extracts showed that *Pseudocydonia sinensis* leaves have reducing capacity and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity. Antioxidant activity by DPPH method and molybdenum reducing antioxidant power method 8.76 and 289.79 mg TEAC/g DW, respectively (Figure 4).

Zhou et al. (2020) described *Pseudocydonia sinensis* leaves contain abundant bio-energy components, such as Heptasiloxane, hexadecamethyl-, which has a higher content in ethanol extracts, and the active components of medical components, such as d-alpha-tocopherol, which are contained in both solvent extracts (ethanol and acetone.) Hamauzu et al. (2006) described Chinese quince fruits and leaves comprise a hopeful natural source of bioactive compounds, namely caffeoylquinic acids and epicatechin. The antioxidant and antiproliferative activities described for this material may be indicative of application in nutritional and pharmaceutical fields, in the prevention and treatment of free radical-mediated human chronic pathologies, such as cardiovascular diseases and cancer. Leaves from *Pseudocydonia sinensis* can be used as an immense natural and inexpensive source of bioactive compounds with major antioxidative properties along with other mechanisms of action. By modulating various cardiovascular risk factors such as atherosclerosis, smoking, endothelial dysfunction hypertension, diabetes, and hyperhomocysteinaemia, *Pseudocydonia sinensis* leaf extract may have relevance in the prevention and treatment of different pathological states of ischemic inflammatory and hypertrophic heart disease.

Conclusion

As a result, this study demonstrates that leaves of *Pseudocydonia sinensis* rich source of useful biochemical compounds that conclude mineral components and polyphenol compounds. Among mineral compounds, the high concentrations found for calcium, potassium, magnesium, and phosphorus. Also, plant raw of *Pseudocydonia sinensis* leaves had potential as an antioxidant resource that can be used in further study. The findings of this study support the fact that leaves of *Pseudocydonia sinensis* can be used as a raw material in medical practice as well as the development and production of dietary supplements and cosmetic preparations rich in biologically active compounds.

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