

VITAMIN, STEROL AND FATTY ACID CONTENTS OF SOME EDIBLE AND MEDICINAL PLANTS FROM EAST AND SOUTHEAST ANATOLIA (TURKEY)

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Abstract: *Achillea millefolium* L., *Crataegus monogyna* subsp. *monogyna* Jacq., *Rubus discolor* L., *Salvia multicaulis* Vahl., *Morus alba* L. and *Pistacia terebinthus* L. plants are consumed for some medicinal or nutritional purposes. The chemical composition, vitamins, sterols and fatty acid contents of these plants were presented in this study. Vitamin and sterol contents were high in *A. millefolium* flowers in comparison to leaves and seed. Vitamins E, K, and total sterol levels in *C. monogyna* subsp. *monogyna* fruit were higher than leaves and flower. For *R. discolor* fruit; vitamin and sterol contents were higher than leaves, flower and unripe fruit. For *S. multicaulis*, vitamin content was higher in leaves and the sterol content was higher in seed than other extracts. α -Tocopherol, vitamins K, D and total sterol levels in *M. alba* fruit were higher than leaves and unripe fruit. In *P. terebinthus*, retinol and α -tocopherol levels were higher in leaves, vitamins D, K, sterol levels were higher in flower than other extracts. The present study indicates that these plants can be a good natural source of fatty acids, vitamins and sterols. This study is first report about the phytochemical properties of *R. discolor*, and *S. multicaulis*.

Keywords: Blackberry, fatty acid, hawthorn, mulberry, sterol, vitamin, yarrow

DOĞU VE GÜNEYDOĞU ANADOLU'DA (TÜRKİYE) YETİŞEN BAZI YENEBİLİR VE TIBBİ BİTKİLERİN VİTAMİN, STEROL VE YAĞ ASİDİ İÇERİKLERİ

Özet: *Achillea millefolium* L., *Crataegus monogyna* subsp. *monogyna* Jacq., *Rubus discolor* L., *Salvia multicaulis* Vahl., *Morus alba* L. ve *Pistacia terebinthus* L. bitkileri halk tıbbında ve beslenme amacıyla kullanılmışlardır. Bu çalışmada yukarıdaki bitkilerin kimyasal kompozisyonları, vitamin, sterol ve yağ asidi içerikleri sunulmuştur. *A. millefolium* çiçeklerinde vitamin ve sterol içeriği yaprak ve **tohumlara** göre daha yüksek bulundu. *C. monogyna* subsp. *monogyna* meyvelerinde vitamin E, K ve total sterol seviyeler yaprak ve çiçeklerden daha yüksek bulundu. *R. discolor* meyvesinde vitamin ve sterol içeriği yaprak, çiçek ve ham meyveden daha yüksek bulundu. *S. multicaulis* yapraklarında vitamin içeriği, tohumda ise sterol içeriği diğer ekstrelerden daha yüksek bulundu. *M. alba* meyvesinde vitamin K, D ve total sterol seviyeleri yaprak ve ham meyveden daha yüksek bulundu. *P. terebinthus* yapraklarında retinol ve α -tokoferol seviyeleri, çiçeklerinde ise vitamin D, K, sterol seviyeleri diğer ekstrelerden daha yüksek bulundu. Sunulan çalışma göstermektedir ki bu bitkiler yağ asitleri, vitaminler ve steroller

bakımından doğal kaynak olabilirler. Ayrıca, bu çalışma *R. discolor* ve *S. multicaulis* bitkilerini fitokimyasal özellikleri hakkındaki ilk rapordur.

Anahtar kelimeler: Böğürtlen, yağ asidi, alıç, dut, sterol, vitamin, civanperçemi

INTRODUCTION

Nowadays, the medicinal and edible plants come into prominence since they contain chemical compounds having antioxidant properties (1-3). Antioxidants protect cells against oxidative stress and cell damage (4). Previous studies have shown that the medical or edible plants contain vitamins, terpenoids, flavonoids, phenolic acids, tannins, and exhibit the antioxidant activity (5-7).

Achillea millefolium (yarrow) belongs to Asteraceae family. It has been widely used for spasmodic, gastrointestinal disorders and skin inflammations in the folk medicine (8). *A. millefolium* includes sesquiterpenes, essential oils, and phenolic constituents, such as flavonoids and other phenolic acids (9). Previous studies have been demonstrated that this plant showed some important medical activities, including anti-tumor, antioxidant, anti-inflammatory and antimicrobial properties (10-17).

Crataegus monogyna subsp. *monogyna* Jacq. (hawthorn) is commonly used for treatment of circulatory and respiratory system disorders, insomnia and some nervous system disorders, such as memory loss, migraines, irritability and confusion (18-21). When dried or fresh fruits are boiled, this decoction can be used for diuretic purposes. The hawthorn fruits, leaves and flowers are used for production of coronary vasodilatoric, cardiogenic and hypotensive pharmaceutical drugs (22).

Rubus discolor belongs to the Rosaceae family. The *Rubus* species are grown from Europe to northern Asia in the temperate regions. *Rubus* fruits are used for nutritional purposes and treatment of colic pain, wounds, renal disease and diarrhea in the folk medicine (23,24). These fruits have been used in the traditional medicine due to their antimicrobial and anticonvulsants activities (25,26).

Salvia multicaulis belongs to *Salvia* genus in the Lamiaceae family. Previous studies have been shown that the *Salvia* genus exhibited many biological activities (27-32). Many terpenoid compounds were isolated and characterized from *S. multicaulis* extracts (33-36).

Morus alba (mulberry), belonging to the genus *Morus* of the Moraceae family, can grow in a wide range of soil, topographical, and climatic conditions (37,38). Mulberry fruits are consumed as mulberry kome, mulberry pekmez and mulberry pestil for traditional productions in Turkey (39). This plant has been widely used for medicinal purposes in Turkey, such as laxative, worming agent, remedy for dysentery, expectorant, emetic and hypoglycemic (40).

Pistacia terebinthus (turpentine) belongs to the Anacardiaceae family. This specie is an annual plant, and it can grow in southern and northern Turkey, and Southern Europe and Middle East countries (41). The turpentine fruits have been used for the treatment of asthma, throat infections, stomach ache, eczema, rheumatism, diarrheic, cough and gastralgia in the folk medicine. In addition to, these fruits have the stimulant, antibacterial, antioxidant, antitussive, **antipyretic and diuretic** properties (42-47).

The aim of the present study is to investigate the chemical properties of *A. millefolium*, *C. monogyna* subsp. *monogyna*, *R. discolor*, *S. multicaulis*, *M. alba* and *P. terebinthus* collected from several regions in East and Southeast Anatolia (Turkey) concerning the composition of fatty acids, lipid-soluble vitamins, and sterols.

EXPERIMENTAL

Chemicals and Standards

All chemicals, reagents and standards were purchased from Sigma-Aldrich (Germany).

Plant Materials

Achillea millefolium L. leaves, flowers and seeds were collected from Muş in Turkey. *Crataegus monogyna* subsp. *monogyna* Jacq. leaves, flowers and ripened fruits were collected from Gaziantep in Turkey. *Rubus discolor* L. flowers, leaves, unripe fruits and ripe fruits were collected from Bingöl in Turkey. *Salvia multicaulis* Vahl. flowers, leaves, fruits and seeds were collected from Malatya in Turkey. *Morus alba* L. leaves, unripe fruits and ripe fruits were collected from Adıyaman in Turkey. *Pistacia terebinthus* L. flowers, leaves, unripe fruits, ripe fruits and seeds were collected from Gaziantep in Turkey. The collection details of plant materials are summarized in the Table 1. All samples were dried in air and at dark (48).

Extraction Procedures

2 g plant materials were extracted with hexane/isopropyl alcohol (60:40, v/v) for sterol, vitamin and fatty acid analyses (49). The lipid extracts were centrifuged at 10,000 rpm for 10 min. The supernatant was transferred to new tubes. Then, the solvent was removed with a rotary evaporator at 40 °C. The extracted lipids were stored at -25 °C until further analysis. All the experiments were repeated three times.

Fatty Acids Analyses

Fatty acids were converted into methyl esters via 2% sulfuric acid (v/v) in methanol (50). The fatty acid methyl esters were extracted with n-hexane. Then, the methyl esters were separated by gas chromatography and flame-ionization detection (Shimadzu GC 17 Ver.3) coupled to Glass GC 10 computer software. Chromatography was performed with a capillary column (25 m in length and 0.25 mm in diameter) (Permabound 25, Macherey-Nagel, Germany) using nitrogen as a carrier gas (flow rate 0.8 mL/min.). The temperatures of the detector, column, and injection valve were 240, 130-220, and 280 °C, respectively. Identification of the individual methyl esters was performed by frequent comparison with authentic standard mixtures that were analyzed under the same conditions.

Chromatographic Analysis and Quantification of Lipid Soluble Vitamins and Sterols

Lipid-soluble vitamins and phytosterols were extracted from the lipid fraction according to the method of Sanchez-Machado (51) with some minor modifications. The extracted lipids of plant material were dissolved in the acetonitrile/methanol (3:1, v/v) and 50 µL was injected into the HPLC instrument (Shimadzu, Kyoto Japan). A SupelcosilTM LC18 (250 x 4.6 mm, 5 µm, Sigma, USA) column was used. The mobile phase was acetonitrile/methanol (3:1, v/v) and the elution was performed at a flow rate of 1 mL/min. The analytical column temperature was kept at 40 °C. Identification of the individual vitamins and phytosterols were performed by frequent comparison with authentic external standard mixtures analyzed under the same conditions (52). Class VP 6.1 software was used in the workup of the data. The results of the analyses were expressed as mg/kg for samples.

RESULTS

Achillea millefolium

The fatty acids and phytochemical contents of *A. millefolium* leaves, flowers and seeds extracts are summarized in Table 2. The dominant fatty acids were palmitic acid (40.11 %), and linoleic acid (16.71 %) in leaves; linoleic acid (48.70 %, 60.85 %), oleic acid (19.83 %, 18.33 %) in flowers and seed extracts (respectively). δ -tocopherol (2.24 mg/kg), β -sitosterol (184.42 mg/kg) and stigmasterol (86.11 mg/kg) levels were the highest in leaves extracts. Retinol (0.54 mg/kg), α -tocopherol (3.59 mg/kg), vitamin K (1.77 mg/kg), vitamin D (0.22 mg/kg) and ergosterol (105.12 mg/kg) levels were the highest in flowers extracts.

Crataegus monogyna subsp. *monogyna*

The fatty acids and phytochemical contents of *C. monogyna* subsp. *monogyna* leaves, flowers and fruits extracts are summarized in Table 3. The highest fatty acids were palmitic acid (32.97 %, 29.52 %), and linoleic acid (25.16 %, 16.60 %) in leaves and flowers (respectively); linoleic acid (36.20 %) and oleic acid (20.39 %) in fruits extracts. Retinol (0.27 mg/kg), δ -tocopherol (2.29 mg/kg) and vitamin D (3.82 mg/kg) levels were the highest in leaves extracts. β -sitosterol (519.22 mg/kg) level was the highest in flowers extracts. α -tocopherol (66.28 mg/kg), vitamin K (7.53 mg/kg), ergosterol (56.73 mg/kg) and stigmasterol (132.97 mg/kg) levels were the highest in fruits extracts.

Rubus discolor

The fatty acids and phytochemical contents of *R. discolor* leaves, flowers, unripe fruits and ripe fruits extracts are summarized in Table 4. The dominant fatty acids were palmitic acid (30.40 %) and linolenic acid (23.43 %) in leaves; palmitic acid (27.33 %) and linoleic acid (21.22 %) in flowers; linoleic acid (43.24 %, 24.37 %) and oleic acid (21.56 %, 24.25 %) in unripe fruits and ripe fruits extracts (respectively). Ergosterol (17.29 mg/kg) level was the highest in flowers extracts. Retinol (0.23 mg/kg), δ -tocopherol (2.19 mg/kg), α -tocopherol (85.06 mg/kg), vitamin K (6.97 mg/kg), vitamin D (28.11 mg/kg), β -sitosterol (167.92 mg/kg) and stigmasterol (56.78 mg/g) levels were the highest in ripe fruit extracts.

Salvia multicaulis

The fatty acids and phytochemical contents of *S. multicaulis* leaves, flowers, fruits and seeds extracts are summarized in Table 5. The dominant fatty acids were palmitic acid (38.48 %) and linolenic acid (12.78 %) in leaves; linoleic acid (34.28 %) and palmitic acid (21.98 %) in flowers; linoleic acid (57.38 %) and oleic acid (17.09 %) in fruits; oleic acid (23.29 %) and palmitic acid (20.47 %) in seeds extracts. Retinol (0.31 mg/kg), δ -tocopherol (1.56 mg/kg), α -tocopherol (7.91 mg/kg) and vitamin D (4.93 mg/kg) levels were the highest in leaves extracts. Vitamin K (16.88 mg/kg), β -sitosterol (414.31 mg/kg), ergosterol (18.81 mg/kg) and stigmasterol (129.97 mg/kg) levels were the highest seeds extracts.

Morus alba

The fatty acids and phytochemical contents of *M. alba* leaves, flowers and seeds extracts are summarized in Table 6. The highest fatty acids were palmitic acid (30.57 %, 27.07 %, 38.46 %) and linoleic acid (26.29 %, 39.26 %, 36.63 %) in leaves; unripe fruits and ripe fruits extracts (respectively). Retinol (0.61 mg/kg) and stigmasterol (150.87 mg/kg) levels were the highest in leaves extracts. δ -tocopherol (4.85 mg/kg) and ergosterol (58.33 mg/kg) levels were the highest in unripe fruits extracts. α -tocopherol (11.59 mg/kg), vitamin K (65.11 mg/kg), vitamin D (11.67 mg/kg) and β -sitosterol (369.61 mg/kg) levels were the highest in ripe fruits extracts.

Pistacia terebinthus

The fatty acids and phytochemical contents of *P. terebinthus* leaves, flowers, unripe fruits, ripe fruits and seeds extracts are summarized in Table 7. The major fatty acids were palmitic acid (31.60 %, 29.42 %) and linoleic acid (21.42 %, 23.65 %) in leaves and flowers (respectively); oleic acid (40.13 %, 38.19 %) and linoleic acid (28.85 %, 30.27 %) in unripe fruits and ripe fruits (respectively); oleic acid (33.38 %) and palmitic acid (26.55 %) in seeds extracts. Retinol (1.31 mg/kg) and α -tocopherol (71.59 mg/kg) levels were the highest in leaves extracts. Vitamin K (10.38 mg/kg), vitamin D (129.11 mg/kg), β -sitosterol (1512.44 mg/kg) and ergosterol (32.46 mg/kg) levels were the highest in flowers extracts. δ -tocopherol (1.64 mg/kg) level was the highest in unripe fruits extracts. Stigmasterol (264.12 mg/kg) level was the highest in ripe fruits extracts.

DISCUSSION

In the present study, the levels of fatty acids, sterols and vitamins in *R. discolor* and *S. multicaulis* have been firstly reported.

In this study, it was determined that the content of vitamin and sterol were high in *A. millefolium* flower than leaves and seed (Table 2). In particular, the ergosterol level was much higher than in flower extract. The highest fatty acid content of *A. millefolium* was found linoleic acid in the flower and seed extracts (48.70 %, 60.85 %, respectively), palmitic acid in the leaf extract (40.11 %). Dias et al. (53) have reported that fatty acids and tocopherol contents of *A. millefolium* inflorescences and upper leaves methanolic extracts. They were showed that these extracts contain 15.54-20.70 % palmitic acid (16:0), 9.79-28.23 % oleic acid (18:1), 26.22-47.16 % linoleic acid (18:2); 0.87-0.95 mg/100 g α -tocopherol.

In the present study, it was observed that vitamin E, vitamin K and total sterol levels were higher in *C. monogyna* subsp. *monogyna* fruit than leave and flower extracts (Table 3). Boudraa et al. (54) suggested that *C. azarolus* and *C. monogyna* fruits have rich vitamin contents. Barros et al. (21) were reported tocopherol contents of *C. monogyna* flower and fruit extracts: flower extract contain 110.09 mg/100 g α -tocopherol, 22.73 mg/100 g δ -tocopherol; fruit extract contain 113.42 mg/100 g α -tocopherol, 0.90 mg/100 g δ -tocopherol. According to these results, α -tocopherol level was high in fruit extract; δ -tocopherol was high in the flower extract. It was observed that similar result in our study: α -tocopherol level (66.25 mg/kg) was higher in the fruit than leave and flower extract.

Barros et al. (21) reported that the highest fatty acid content is tricosylic acid (23:0; 33.67 %), linolenic acid (18:3; 29.51 %), followed by linoleic acid (18:2; 14.17 %), palmitic acid (16:0; 11.23 %) in the flower extract of *C. monogyna*; the highest fatty acid content is tricosylic acid (23:0; 32.77 %), linoleic acid (18:2; 17.53 %), followed by palmitic acid (16:0; 13.73 %), linolenic acid (18:3; 7.41 %) in the fruit extract of *C. monogyna*. In this study, we found that Turkish *C. monogyna* flower and fruit contain palmitic acid, linoleic acid and linolenic acid dominant fatty acids. But, it was not detected tricosylic acid in our extracts, which is observed Portuguese *C. monogyna* extracts. This alteration in fatty acid composition from the same *C. monogyna* species may be related to different ecological conditions.

The vitamin and sterol content of *R. discolor* fruit extract were higher than leaves, flower and unripe fruit extracts (Table 4). The major fatty acid content of *R. discolor* was found palmitic acid in the leaves and flower extracts (30.40 %, 27.33 %, respectively), linoleic acid in the unripe and ripe fruit extracts (43.24 %, 24.37 %, respectively).

In the present study, the vitamin contents of *S. multicaulis* leaves extract were higher than the other extracts; the sterol contents of seed extracts were higher than the other extracts (Table 5). Kara et al. (55) reported that the major fatty acid content is linolenic acid (18:3, 33.35 %), palmitic acid (16:0, 16.06 %), followed by linoleic acid (18:2, 5.78 %) in leaves extract of *S. sclarea*; the dominant fatty acid content is linolenic acid (18:3, 29.37 %), palmitic acid (16:0, 11.37 %), followed by linoleic acid (18:2, 8.49 %) in flower extract of *S. sclarea*; the high fatty acid content is linolenic acid (18:3, 52.03 %), linoleic acid (18:2, 15.83 %), followed by palmitic acid (16:0, 6.24 %) in seed extract of *S. sclarea*. In our study, we found that the dominant fatty acids are palmitic acid, linoleic acid and linolenic acid in *S. multicaulis* leaves, flower and seed extracts. However, some differences among quantities were observed. These variations in fatty acid composition and content from the *Salvia* genus may be attributed to different species.

In this study, α -tocopherol, vitamin K, vitamin D and total sterol levels of *M. alba* fruit extracts were higher than leaves and unripe fruit extracts (Table 6). Yang et al. (56) were reported *M. alba* fruit contains 0.074 mg/g δ -tocopherol, 0.004 mg/g α -tocopherol. In contrast to this study, α -tocopherol level (11.50 mg/kg) of *M. alba* fruits were higher than δ -tocopherol level (4.60 mg/kg) in our study.

We found that the major fatty acid content of *M. alba* leaves, unripe and ripe fruit extracts: leaves extract contains 30.57 % palmitic acid (16:0), 26.29 % linoleic acid (18:2), 25.66 % linolenic acid (18:3); unripe fruit extract contain 39.26 % linoleic acid (18:2), 27.07 % palmitic acid (16:0), 12.96 % linolenic acid (18:3); fruit extract contain 38.46 % palmitic acid (16:0), 36.63 % linoleic acid (18:2), 11.30 % oleic acid (18:1). Similarly, previous studies have been showed that palmitic acid, linoleic acid and linolenic acid are dominant fatty acid content in *M. alba* fruit extract (56,57). However, the oleic acid level of *M. alba* fruit extract was higher than linolenic acid level in our study. These variations in fatty acid content for the same mulberry species (*M. alba*) can be attributed to different ecological conditions.

In the present study, retinol and α -tocopherol level of *P. terebinthus* leaves extract were higher than the other extracts, vitamin D, vitamin K, β -sitosterol, ergosterol and stigmasterol level of flower extract were higher than the other extracts (Table 7). Matthaus and Özcan (47) reported that *P. terebinthus* seed extract contains 116.4-157.7 mg/kg α -tocopherol, 0.0-13.8 mg/kg δ -tocopherol, 37.6-54.8 mg/kg stigmasterol and 1096.8-1418.9 mg/kg β -sitosterol. We found 3.55 mg/kg α -tocopherol, 0.35 mg/kg, δ -tocopherol, 106.85 mg/kg stigmasterol and 440.30 mg/kg β -sitosterol in *P. terebinthus* seed extract.

Çiftçi et al. (58) found that *P. terebinthus* coffee extracts contain 9.95 mg/kg vitamin D, 21.00 mg/kg vitamin K, 15.35 mg/kg α -tocopherol, 35.45 mg/kg δ -tocopherol, 25.65 mg/kg retinol. Durmaz and Gökmen (59) suggested that *P. terebinthus* fruit extracts contain 159.93 mg/kg α -tocopherol, 5.1 mg/kg δ -tocopherol. In our study, *P. terebinthus* fruit contains 11.51 mg/kg α -tocopherol and 1.02 mg/kg δ -tocopherol.

We found that the highest fatty acids are palmitic acid, linoleic acid and linolenic acid in *P. terebinthus* leaves and flower extracts. Palmitic acid, oleic acid and linoleic acid were dominant fatty acids in the unripe, ripe fruits and seed extracts. In previous studies, it has been shown that the fatty acids are same as dominant fatty acid (47,58-63).

CONCLUSION

This study intended to assess levels of vitamins, fatty acids and sterols in the six plants (*A. millefolium*, *C. monogyna* subsp. *monogyna*, *R. discolor*, *S. multicaulis*, *M. alba* and *P. terebinthus*) grown in East and Southeast Anatolia from Turkey. The present study is expected to deliver preliminary data on phytochemical composition of these plants grown in Turkey and provide useful information for future studies, which will be conducted phytochemical properties

of these plants and nutritional and medical effects in relation to these plants. It is seen that these plants are a good natural source of fatty acids, vitamins and sterols. In addition, these findings are important for the nutrition sciences, because fatty acids, vitamins and sterols, in particular, seem to have considerable effect on health.

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Table 1. The collection details of plant materials

Plant Material	Location of Collection	Collected Parts	Coordinates	Altitude	Voucher Specimen Numbers and Herbarium Details
<i>Achillea millefolium</i>	Mus	leaves, flowers, seeds	N 38 ⁰ 43.958' E0 41 ⁰ 33.884'	1300 m	Türkoğlu 4811
<i>Crataegus monogyna</i> subsp. <i>monogyna</i>	Gaziantep	leaves, flowers, ripened fruits	N 37 ⁰ 09.415' E0 37 ⁰ 12.864'	1090 m	Türkoğlu 4790
<i>Rubus discolor</i>	Bingol	flowers, leaves, unripe fruits, ripened fruits	N 38 ⁰ 54.731' E0 40 ⁰ 35.312'	1059 m	Türkoğlu 4812
<i>Salvia multicaulis</i>	Malatya	flowers, leaves, fruits, seeds	N 38° 14.490' E0 38° 00.912'	1031 m	Türkoğlu 4813
<i>Morus alba</i>	Adiyaman	leaves, unripe fruits, ripe fruits	N 37° 44.997' E0 37° 47.788'	796 m	Türkoğlu 4814

<i>Pistacia terebinthus</i>	Gaziantep	flowers, leaves, unripe fruits, ripe fruits, seeds	N 37° 09.415' E0 37° 12.864'	1090 m	Türkoğlu 4816
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Table 2. The phytochemical contents of *Achillea millefolium*

Phytochemical Contents (mg/kg)	Leaves	Flowers	Seeds
Retinol	0.27 ± 0.02	0.54 ± 0.05	0.06 ± 0.00
δ-tocopherol	2.24 ± 0.21	nd	0.18 ± 0.01
α-tocopherol	1.44 ± 0.12	3.59 ± 0.32	1.92 ± 0.019
Vitamin K	0.96 ± 0.09	1.77 ± 0.02	1.21 ± 0.05
Vitamin D	nd	0.22 ± 0.02	0.14 ± 0.01
β-sitosterol	184.42 ± 1.89	135.87 ± 1.54	61.04 ± 1.07
Ergosterol	7.82 ± 0.98	105.12 ± 1.85	13.48 ± 0.54
Stigmasterol	86.11 ± 2.79	67.52 ± 2.54	22.44 ± 0.77
Fatty Acids (%)			
14:0	3.84 ± 0.09	1.28 ± 0.07	0.54 ± 0.01
16:0	40.11 ± 1.58	15.73 ± 1.21	11.26 ± 1.02
16:1	4.66 ± 0.51	1.78 ± 0.55	1.27 ± 0.09
17:0	0.84 ± 0.01	0.57 ± 0.00	nd
18:0	7.61 ± 0.21	4.93 ± 0.98	2.26 ± 0.19
18:1	11.38 ± 0.29	19.83 ± 1.29	18.33 ± 1.87
18:2	16.71 ± 0.09	48.70 ± 2.58	60.85 ± 4.98
18:3	8.46 ± 0.05	2.92 ± 0.27	1.47 ± 0.09
20:1	nd	0.36 ± 0.00	0.30 ± 0.00
20:3	nd	0.98 ± 0.03	0.44 ± 0.00
22:0	2.86 ± 0.03	1.21 ± 0.05	0.77 ± 0.02
22:2	nd	nd	1.68 ± 0.11
24:0	3.53 ± 0.90	1.70 ± 0.02	0.83 ± 0.00
Sat. FA	58.79	25.42	15.66
Unsat. FA	41.21	74.58	84.34

nd: not detected

Table 3. The phytochemical contents of *Crataegus monogyna subsp. monogyna*

Phytochemical Contents (mg/kg)	Leaves	Flowers	Fruits
Retinol	0.27 ± 0.08	0.07 ± 0.00	0.21 ± 0.01
δ-tocopherol	2.29 ± 0.89	0.43 ± 0.05	0.48 ± 0.09
α-tocopherol	4.06 ± 1.06	7.09 ± 1.25	66.28 ± 3.54
Vitamin K	4.26 ± 1.15	3.41 ± 0.54	7.53 ± 0.88
Vitamin D	3.82 ± 1.44	2.34 ± 0.15	2.24 ± 0.04
β-sitosterol	204.77 ± 7.85	519.22 ± 12.58	379.81 ± 9.89
Ergosterol	6.98 ± 1.25	24.39 ± 1.88	56.73 ± 5.47
Stigmasterol	62.92 ± 2.87	23.13 ± 1.01	132.97 ± 2.24
Fatty Acids (%)			
14:0	nd	1.15 ± 0.09	2.80 ± 0.98

16:0	32.97 ± 2.96	29.52 ± 3.56	15.40 ± 2.14
16:1	5.18 ± 0.88	4.76 ± 1.02	1.59 ± 0.26
17:0	0.79 ± 0.01	3.31 ± 0.96	0.32 ± 0.00
18:0	8.93 ± 2.45	10.42 ± 1.66	4.09 ± 1.19
18:1	11.76 ± 2.83	6.32 ± 1.11	20.39 ± 2.48
18:2	25.16 ± 3.38	16.60 ± 3.28	36.20 ± 3.67
18:3	10.89 ± 1.85	15.44 ± 3.45	15.15 ± 1.76
20:1	nd	nd	0.32 ± 0.00
20:3	3.35 ± 0.99	3.70 ± 1.21	nd
22:0	0.97 ± 0.02	1.17 ± 0.05	1.43 ± 0.09
22:2	nd	nd	nd
24:0	nd	7.61 ± 0.85	2.31 ± 0.39
Sat. FA	43.66	53.18	26.35
Unsat. FA	56.34	46.82	73.65

nd: not detected

Table 4. The phytochemical contents of *Rubus discolor*

Phytochemical Contents (mg/kg)	Leaves	Flowers	Unripe Fruits	Ripe Fruits
Retinol	0.17 ± 0.03	0.06 ± 0.00	0.11 ± 0.02	0.23 ± 0.05
δ-tocopherol	0.22 ± 0.01	0.54 ± 0.04	0.33 ± 0.05	2.19 ± 0.27
α-tocopherol	4.79 ± 0.88	6.18 ± 1.03	19.01 ± 3.24	85.06 ± 2.99
Vitamin K	1.64 ± 0.87	3.12 ± 0.09	2.66 ± 0.08	6.97 ± 0.96
Vitamin D	0.63 ± 0.05	0.45 ± 0.07	3.83 ± 0.54	28.11 ± 1.25
β-sitosterol	152.81 ± 3.69	65.04 ± 3.87	141.51 ± 2.94	167.92 ± 4.64
Ergosterol	nd	17.29 ± 1.73	nd	1.08 ± 0.06
Stigmasterol	23.20 ± 1.54	35.81 ± 2.47	21.77 ± 0.66	56.78 ± 1.09
Fatty Acids (%)				
14:0	1.94 ± 0.14	1.92 ± 0.31	2.08 ± 0.09	3.80 ± 0.73
16:0	30.40 ± 2.85	27.33 ± 2.63	11.90 ± 1.05	24.13 ± 1.94
16:1	4.06 ± 0.21	3.28 ± 0.36	1.52 ± 0.31	3.04 ± 0.09
17:0	0.88 ± 0.02	5.54 ± 0.88	0.36 ± 0.00	nd
18:0	9.21 ± 1.23	6.78 ± 0.79	5.28 ± 1.04	6.93 ± 0.49
18:1	9.42 ± 1.69	6.59 ± 1.41	21.56 ± 2.49	24.25 ± 2.26
18:2	14.35 ± 2.01	21.22 ± 1.39	43.24 ± 3.55	24.37 ± 2.09
18:3	23.43 ± 2.56	19.37 ± 1.26	13.64 ± 0.93	13.36 ± 1.33
20:1	0.73 ± 0.01	nd	nd	nd
20:3	nd	2.05 ± 0.09	nd	nd
22:0	3.14 ± 0.25	3.62 ± 1.06	0.42 ± 0.00	nd
24:0	2.44 ± 0.31	2.30 ± 0.21	nd	nd
Sat. FA	48.01	47.49	20.04	34.86
Unsat. FA	51.99	52.51	79.96	65.14

nd: not detected

Table 5. The phytochemical contents of *Salvia multicaulis*

Phytochemical Contents (mg/kg)	Leaves	Flowers	Fruits	Seeds
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Retinol	0.31 ± 0.03	0.07 ± 0.00	nd	nd
δ-tocopherol	1.56 ± 0.19	0.21 ± 0.05	0.44 ± 0.04	0.12 ± 0.01
α-tocopherol	7.91 ± 1.26	2.32 ± 1.06	1.80 ± 0.09	7.71 ± 1.49
Vitamin K	6.54 ± 1.09	0.64 ± 0.05	2.26 ± 0.24	16.88 ± 1.16
Vitamin D	4.93 ± 0.88	0.84 ± 0.06	2.96 ± 0.36	2.64 ± 0.29
β-sitosterol	115.97 ± 5.25	66.77 ± 2.74	82.22 ± 3.82	414.31 ± 8.94
Ergosterol	3.17 ± 0.69	1.19 ± 0.42	4.98 ± 0.94	18.81 ± 1.89
Stigmasterol	69.42 ± 2.54	22.41 ± 1.36	31.15 ± 1.54	129.97 ± 5.79
Fatty Acids (%)				
14:0	9.26 ± 0.93	1.12 ± 0.06	1.30 ± 0.07	1.40 ± 0.09
16:0	38.48 ± 3.16	21.98 ± 3.46	7.70 ± 0.64	20.47 ± 2.14
16:1	3.54 ± 0.64	3.53 ± 0.97	1.11 ± 0.06	18.64 ± 1.94
17:0	nd	0.43 ± 0.00	nd	nd
18:0	9.87 ± 1.09	6.39 ± 1.39	2.11 ± 0.03	1.11 ± 0.09
18:1	8.20 ± 0.96	9.50 ± 2.43	17.09 ± 1.44	23.29 ± 2.16
18:2	8.35 ± 0.99	34.28 ± 4.39	57.38 ± 4.73	8.16 ± 0.87
18:3	12.78 ± 1.25	11.48 ± 1.89	7.68 ± 1.17	14.31 ± 0.96
20:1	nd	3.20 ± 0.34	1.08 ± 0.04	3.78 ± 0.09
20:3	3.30 ± 0.39	3.40 ± 0.29	1.37 ± 0.06	1.50 ± 0.04
22:0	4.08 ± 0.79	4.01 ± 1.76	0.77 ± 0.01	2.02 ± 0.08
22:2	nd	0.68 ± 0.01	0.84 ± 0.02	1.48 ± 0.07
24:0	2.14 ± 0.36	nd	1.57 ± 0.09	3.84 ± 0.74
Sat. FA	63.83	33.93	13.45	28.84
Unsat. FA	36.17	66.07	86.55	71.16

nd: not detected

Table 6. The phytochemical contents of *Morus alba*

Phytochemical Contents (mg/kg)	Leaves	Unripe Fruits	Ripe Fruits
Retinol	0.61 ± 0.05	0.17 ± 0.01	0.09 ± 0.00
δ-tocopherol	0.44 ± 0.04	4.85 ± 0.64	4.62 ± 0.78
α-tocopherol	2.76 ± 0.24	2.88 ± 0.36	11.59 ± 1.19
Vitamin K	60.07 ± 4.98	55.24 ± 3.69	65.11 ± 5.02
Vitamin D	3.21 ± 0.45	9.08 ± 0.47	11.67 ± 1.69
β-sitosterol	223.73 ± 5.49	332.35 ± 6.97	369.61 ± 7.85
Ergosterol	2.31 ± 0.69	58.33 ± 1.43	45.78 ± 3.34
Stigmasterol	150.87 ± 5.49	nd	28.58 ± 1.37
Fatty Acids (%)			
14:0	0.62 ± 0.02	0.75 ± 0.01	2.24 ± 0.06
16:0	30.57 ± 2.98	27.07 ± 1.58	38.46 ± 3.74
16:1	5.13 ± 0.67	4.15 ± 0.46	3.33 ± 0.29
17:0	0.40 ± 0.00	0.52 ± 0.00	0.17 ± 0.00
18:0	6.14 ± 1.54	4.83 ± 0.89	2.69 ± 0.46
18:1	3.04 ± 0.58	5.38 ± 0.97	11.30 ± 1.07
18:2	26.29 ± 1.73	39.26 ± 2.67	36.63 ± 2.91
18:3	25.66 ± 1.96	12.96 ± 1.09	3.44 ± 0.39

20:1	0.67 ± 0.00	0.25 ± 0.00	0.13 ± 0.00
20:3	nd	0.38 ± 0.00	nd
22:0	0.70 ± 0.01	2.23 ± 0.07	1.35 ± 0.09
22:2	nd	1.16 ± 0.02	nd
24:0	0.78 ± 0.02	1.06 ± 0.06	0.26 ± 0.00
Sat. FA	39.21	36.46	45.17
Unsat. FA	60.79	63.54	54.83

nd: not detected

Table 7. The phytochemical contents of *Pistacia terebinthus*

Phytochemical Contents (mg/kg)	Leaves	Flowers	Unripe Fruits	Ripe Fruits	Seeds
Retinol	1.31 ± 0.09	1.07 ± 0.04	0.52 ± 0.01	0.07 ± 0.00	0.08 ± 0.00
δ-tocopherol	nd	0.91 ± 0.00	1.64 ± 0.04	1.02 ± 0.02	0.36 ± 0.01
α-tocopherol	71.59 ± 3.98	23.62 ± 1.31	nd	11.51 ± 1.03	3.55 ± 0.77
Vitamin K	5.51 ± 0.56	10.38 ± 0.91	5.37 ± 1.01	2.42 ± 0.49	1.71 ± 0.09
Vitamin D	nd	129.11 ± 1.67	100.62 ± 4.61	37.15 ± 2.43	17.83 ± 1.93
β-sitosterol	197.62 ± 5.78	1512.44 ± 32.46	1005.85 ± 25.89	315.13 ± 3.56	440.31 ± 4.97
Ergosterol	nd	32.46 ± 2.41	17.32 ± 1.01	15.84 ± 1.31	7.23 ± 0.94
Stigmasterol	nd	174.74 ± 2.84	127.81 ± 1.96	264.12 ± 3.14	106.88 ± 2.14
Fatty Acids (%)					
14:0	1.31 ± 0.03	1.04 ± 0.09	1.23 ± 0.06	nd	0.23 ± 0.00
16:0	31.60 ± 2.43	29.42 ± 1.64	20.11 ± 2.64	24.02 ± 2.16	26.55 ± 1.92
16:1	6.34 ± 0.89	3.90 ± 0.31	2.45 ± 0.36	4.17 ± 0.40	2.76 ± 0.21
17:0	1.70 ± 0.05	3.06 ± 0.28	nd	nd	0.23 ± 0.00
18:0	4.89 ± 0.49	5.33 ± 1.01	2.70 ± 0.54	1.83 ± 0.06	4.87 ± 0.44
18:1	7.59 ± 0.58	8.41 ± 1.19	40.13 ± 4.16	38.19 ± 2.36	33.38 ± 1.95
18:2	21.42 ± 1.26	23.65 ± 1.81	28.85 ± 2.96	30.27 ± 2.19	20.99 ± 1.24
18:3	17.31 ± 1.04	15.00 ± 1.54	3.51 ± 0.64	1.52 ± 0.06	10.27 ± 0.63
20:1	nd	0.44 ± 0.00	0.20 ± 0.01	nd	0.58 ± 0.01
20:3	2.56 ± 0.04	3.96 ± 0.25	nd	nd	nd
22:0	1.29 ± 0.06	2.36 ± 0.13	0.24 ± 0.02	nd	0.14 ± 0.00
22:2	1.90 ± 0.07	0.76 ± 0.03	0.18 ± 0.00	nd	nd
24:0	2.09 ± 0.09	2.67 ± 0.34	0.40 ± 0.03	nd	nd
Sat. FA	42.88	43.88	24.68	25.85	32.02
Unsat. FA	57.12	56.12	75.32	74.15	67.98

nd: not detected