Lipid Characteristics of Camellia Seed Oil
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Abstract: Camellia oleifera, C. japonica and C. sinensis are three representative crops of the genus Camellia. In this work, we systematically investigated the lipid characteristics of these seed oils collected from different regions. The results indicated significant differences in acid value (AV), peroxide value (PV), iodine value (IV), saponification value (SV) and relative density of the above-mentioned camellia seed oils (p < 0.05). The C. japonica seed oils showed the highest AV (1.7 mg/g), and the C. sinensis seed oils showed the highest PV (17.4 meq/kg). The C. japonica seed oils showed the lowest IV (79.9 g/100 g), SV (192.7 mg/g) and refractive index (1.4633) of all the oils, while the C. sinensis seed oils showed the lowest relative density (0.911 g/cm³). The major fatty acids in the camellia seed oils were palmitic acid (16:0), oleic acid (18:1) and linoleic acid (18:2); the oleic acid in C. oleifera and C. japonica seed oils accounted for more than 80% of the total fatty acids. The oleic acid levels in the C. oleifera and C. japonica oils were higher than those in the C. sinensis seed oils, while the linoleic acid levels in the former were lower than those in the latter one. Differences also exist in the triacylglycerol (TAG) composition, although the most abundant TAG molecular species in the camellia seed oils was trioleoylglycerol (OOO). Seven sterol species, squalene and α-tocopherol were detected in the camellia seed oils, however, the contents of tocopherol and unsaponifiable molecules in the C. oleifera and C. japonica seed oils were significantly lower than those in the C. sinensis seed oil. These results demonstrated that the varieties of Camellia affected the seed oil lipid characteristics.

Key words: camellia seed oil, physicochemical properties, systematic comparison

1 Introduction

The genus Camellia belongs to the Theaceae family, which is native to South and Southeastern China. This genus was firstly named by Linnaeus in honor of the Jesuit missionary G. J. Kamel, who first introduced ornamental plants to Europe. This genus contains more than 300 species worldwide, among which the most well-known specie is C. sinensis (tea), whose leaves are usually used in making tea, the most widely consumed drink in the world. Other species, such as C. reticulate, C. japonica, C. williamsonii, C. cuspidata and C. sasanqua, are ornamental plants that are popularly used in Europe. The seeds of C. japonica and C. oleifera can be raw materials for producing oils by special processing. These oils are rich in oleic acid, so for a long history they have been used as hair cosmetic in Japan and as edible oils in China.

In the past several decades, some researchers have focused on C. oleifera seed oil because C. oleifera showed the highest production yield of seed oil among the Theaceae family. According to the data from the National Bureau of Statistics of China, 2.43 million tons of C. oleifera seeds were processed in 2017 in China, which produced 600 thousand tons of oil. Moreover, C. oleifera seed oil often substitutes for olive oil, because it is from a woody plant and is rich in oleic acid. Previous studies have shown that 54.1-75.5% of the fatty acids in olive oil are oleic acid, while 76.0-81.4% of the fatty acids in C. oleifera oil are oleic acid. In addition, C. oleifera seed oil contains many bioactive substances, such as polyphenol, flavonoid, squalene and sesamin. C. oleifera seed oils were also reported to have antioxidant, anti-inflammatory, antimicrobial, hepatoprotective and gastroprotective properties. Several researchers have also reported that C. japonica seed oil has anti-inflammatory, anti-cancer and antiviral properties. Furthermore, people often use C. oleifera seed oil in daily life instead of C. japonica seed oil because former one is cheaper in the market. However, there is no systematic comparative research on C. oleifera oil and other camellia seed oils, such as C. Japonica and C. sinensis seed oils. C. sinensis is the most cultivated species among the Theaceae family. It has great potential for producing oils, however, the current applications of C. sinensis seed oil is still limited. Furthermore, most countries in the world have not yet formulated standard for ca-
mellia seed oil because of the lack of basic data. Thus, we investigated the chemical and physical characteristics of camellia seed oils based on the refractive index, density, acid value (AV), peroxide value (PV), iodine value (IV), saponification value (SV), fatty acid, triacylglycerol (TAG), tocopherol composition and unsaponifiable matters compositions of 17 camellia seed oil samples, and all these samples were collected from different regions and from three representative species of Camellia as oil crops.

2 Materials and Methods

2.1 Materials and reagents

Seventeen camellia oils were collected from different factories in 2017. Among which, nine C. oleifera seed oils and three C. sinensis seed oils were purchased from the local market in Ganzhou city, Jiangxi Province of China; three C. japonica seed oils, two C. sinensis seed oils, extra virgin olive oil, and rapeseed oil were purchased from Tokyo in Japan. Detailed information describing the oil samples is shown in Table 1, which includes the brands, place of production, processing mode, and date of expiry. All the oil samples were stored at −20°C in a freezer to prevent oxidation before analysis.

Boron trifluoride, tocopherol standard, lanosterol, squalene and 5α-cholestan-3β-ol were purchased from Sigma-Aldrich (St. Louis, MO, USA). The other reagents were purchased from Wako Pure Chemical Co. (Osaka, Japan). All chemicals were of analytical reagent grade, and acetone, acetonitrile, n-hexane and 2-propanol were HPLC grade.

2.2 Refractive index and density

The refractive index of the oil samples was determined at 20°C by using a Refractometer ATAGO PAL-RI (Tokyo, Japan). Five milliliters of each oil sample was accurately weighed at 25°C to calculate the density.

2.3 Acid value (AV)\(^2\)

Ten grams of each oil sample was dissolved in an Erlenmeyer flask with 100ml of mixture of ethanol and diethyl ether (1:1, \(v/v\)), and the solution was titrated with 0.1 M potassium hydroxide. Phenolphthalein in an ethanol solution was used as the indicator. The AV was calculated through this equation:

\[
AV = (A \times f \times 5.611) / S,
\]

Table 1  Brand, production region, and expiry date of each oil.

| Type       | Brand            | Production region | Processing mode | Expiry date |
|------------|------------------|-------------------|----------------|-------------|
| C. oleifera| Wokang           | Changning, Hunan, China | RBD            | 2018/6     |
|            | Qiandaoyuan      | Hangzhou, Zhejiang, China | RBD            | 2018/4     |
|            | Lvhai            | Jian, Jiangxi, China | RBD            | 2018/3     |
|            | Yeling           | Liuan, Anhui, China | RBD            | 2018/5     |
|            | Wanyufang        | Wannian, Jiangxi, China | RBD            | 2018/2     |
|            | Baohua           | Shaoguan, Guangdong, China | RBD            | 2018/6     |
|            | Jinhao           | Yongzhou, Hunan, China | RBD            | 2018/6     |
|            | Yangshan         | Ganzhou, Jiangxi, China | RBD            | 2018/1     |
|            | Enquan           | Shangrao, Jiangxi, China | RBD            | 2018/6     |
| C. japonica| Imamura          | Goto, Nagasaki, Japan | RBD            | 2019/5     |
|            | Kuzusako         | Sakurajima, Kagoshima, Japan | RBD            | 2018/6     |
|            | Takada           | Oshima, Tokyo, Japan | RBD            | 2018/10    |
| C. sinensis| Liudachashan     | Puer, Yunnan, China | NM             | 2018/9     |
|            | Qiandaoyuan      | Hangzhou, Zhejiang, China | RBD            | 2018/2     |
|            | Liudaoxiang      | Wuzhou, Guangxi, China | RBD            | 2018/1     |
|            | Noguchitokutarosyouten | Sashimi, Ibaraki, Japan | NM             | NM         |
|            | Ryokumon         | Oyama, Tochigi, Japan | NM             | NM         |
| Olive      | Nissin oilio     | Isogo, Yokohama, Japan | Cold Pressed   | 2018/1     |
| Rapeseed   | Nissin oilio     | Isogo, Yokohama, Japan | RBD            | 2019/3     |

NM, not marked
RBD, refined, bleached and deodorized
2.7 Triacylglycerol composition

The triacylglycerol (TAG) composition was determined by high-performance liquid chromatography (HPLC) equipped with a refractive index detector. Five hundred milligrams of each oil sample was dissolved with acetone to 10 mL, and 20 μL of the sample solution was injected into the HPLC instrument. HPLC was conducted using Jasco CO-965 system (Tokyo, Japan) coupled to refractive index detector (Shodex RI-71, Showa Denko, Japan). TAG molecular species were separated with a Develosil C30-UG-5 column (4.5 mm × 250 mm, Nomura), and the mobile phase consisted of a mixture of acetone and acetonitrile (7:3, v/v) at 1.0 mL/min at 30°C. The triacylglycerol molecular species were identified using soybean oil triacylglycerol (Nisshin Oilio, Japan) as a standard.

2.8 Tocopherol

Tocopherol isomers were analyzed by the JOAC method using HPLC. A Jasco HPLC system (Tokyo, Japan), a Jasco CO-1580 pump (Tokyo, Japan), connected to a Jasco FP-2020 PLUS spectrophotometric detector (Tokyo, Japan) was used. One gram of each oil sample was placed in a 10 mL volumetric flask and dissolved in n-hexane. The injection volume was 10 μL. Tocopherol isomers were separated with a Shodex column 5SIL-4E (4.6 mm × 250 mm, Showa Denko, Japan) by using a mixture of n-hexane and 2-propanol (99:3, v/v) at 1.0 mL/min. The column temperature was 40°C. Tocopherols were detected at an excitation wavelength of 298 nm and an emission wave length of 325 nm. The content of tocopherol was calculated with α-, β-, γ-, δ-tocopherol standard curves.

2.9 Sterol analysis

The sterol content was determined by the GLC method. One gram of oil was saponified with 10 mL of 1 M potassium hydroxide in methanol at 80°C for 1 h in a glass stoppered test tube after 1 mg 5α-cholestan-3β-ol (internal standard) was added. After cooling to room temperature, 30 mL boiling water was added, and the unsaponifiable matter was extracted with 20 mL diethyl ether 3 times. The combined diethyl ether fractions were washed for 3 times with 6 mL water. Then, sodium sulfate was added and incubated overnight. The diethyl ether layer was filtered and concentrated with a rotary evaporator. Finally, the unsaponifiable matter was redissolved in chloroform at a concentration of 0.1 mg/mL and stored at −20°C until analysis.

The unsaponifiable molecules were analyzed on a shimadzu GC-MS-QP2010 Ultra gas liquid chromatography (Kyoto, Japan). The experimental conditions were as follows: column, VF-1701 ms (30 m × 0.25 mm, Agilent); injection temperature, 300°C; column temperature, 280°C; carrier gas, He; injection volume, 1 μL; MS ion source temperature, 200°C; interface temperature, 250°C; scan range, m/z 20-440; and event time, 0.4 sec. The lanosterol and squalene were identified by the standard, and the other unsaponifiable molecules were identified through matching with the mass spectra reported by the NIST library, all the
unsaponifiable molecules were calculated by comparing the peak area of each peak with the peak area of standard 5α-cholestan-3β-ol.

2.10 Statistical analyses

All the experiments were carried out in triplicate, and the mean and standard deviation were calculated by Excel 2010 (Microsoft, USA). One way analysis of variance was conducted by SPSS 25.0 (IBM, USA), and Duncan’s multiple range tests were applied for determining significant differences at \( p < 0.05 \) among the average values of the 5 different types of oil.

3 Results and Discussion

3.1 AV and PV

AV and PV are important quality indicators of edible oils. The AV and PV of oil samples are shown in Table 2. In the refining process of edible oil, the level of neutralization and deodorization will directly affect AV and PV, and the preservation environment will also affect the deterioration of these indices of edible oil (3). Camellia seed oils showed different AVs and PVs, which may be caused by differences in the processing and storage methods. As illustrated in Table 2, the average AVs were 0.3, 1.7, and 0.7 meq/kg oil for C. oleifera, C. japonica and C. sinensis seed oil, respectively; however, an AV below 0.6 meq/kg does not affect the original odor and taste of the oil according to the Codex standard for edible fats and oils (32). The C. sinensis seed oil showed the highest PV (17.4 meq/kg), while C. japonica seed oil showed the lowest PV (4.2 meq/kg). The above results might demonstrate that the C. sinensis seed oils were not sufficiently refined.

3.2 Physicochemical properties

The physicochemical properties of the camellia seed oils are shown in Table 3. The relative density at 25°C and the refractive index at 20°C of the camellia seed oils were within the range of 0.911-0.920 g/cm³ and 1.4633-1.4665 (20°C), respectively, while olive oil had a relative density of 0.912 g/cm³ (25°C) and a refractive index of 1.4696 (20°C) and rapeseed oil had a density of 0.918 g/cm³ (25°C) and a refractive index of 1.4762 (20°C).

The IV and SV of the camellia seed oils ranged from 79.9 to 89.1 g/100 g and 192.7-196.2 mg/g, respectively, while olive oil and rapeseed oil exhibited IVs of 79 g/100 g and 111 g/100 g respectively, and SVs of 197 mg/g and 196 mg/g, respectively. Significant differences showed in the relative density, refractive index, IV and SV among the 3 types of camellia seed oils. The above-mentioned properties of camellia seed oils were similar to those of olive oil but different from those of rapeseed oil. IV is derived from the content of unsaturated fatty acids and the number of double bonds in oils. The IV of these 3 types of camellia seed oils indicates that they are non-dried oils. The SV represents the number of milligrams of potassium hydroxide required for saponifying 1 g of oil and the average molecular weight of triacylglycerol (TAG) in the oil (33). The SV of the camellia seed oils suggests that they are composed of molecules with almost the same molecular weight as TAG.

3.3 Fatty acid composition

Fatty acid composition is one of the most important index in edible oils. The fatty acid compositions of the oil samples are shown in Table 4. Eleven kinds of fatty acids (exceeding 0.1% content) were detected in camellia seed oils, among which, palmitic acid (16:0), oleic acid (18:1) and linoleic acid (18:2) were the major fatty acids in camellia seed oils. Significant differences were observed in the fatty
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Table 4  Fatty acid composition of each oil(%) .

| Fatty acid                     | C. oleifera | C. japonica | C. sinensis | Olive | Rapeseed |
|--------------------------------|-------------|-------------|-------------|-------|----------|
| Myristic acid (C14:0)          | ND          | ND          | 0.1 ± 0.0   | ND    | ND       |
| Palmitic acid (C16:0)          | 8.1 ± 0.6 b | 7.5 ± 0.4 b | 14.8 ± 1.5 d| 11.2 c| 3.7 a    |
| Palmitoleic acid (C16:1)       | 0.1 ± 0.0 a | 0.1 ± 0.0 a | 0.1 ± 0.0 a | 0.9 b | 0.1 a    |
| Stearic acid (C18:0)           | 1.7 ± 0.2 a | 2.1 ± 0.1 b | 2.6 ± 0.4 c | 2.5 c | 1.5 a    |
| Oleic acid (C18:1)             | 80.5 ± 1.3 c| 86.6 ± 0.6 d| 58.4 ± 4.9 a| 77.2 c| 64.3 b   |
| Linoleic acid (C18:2)          | 8.3 ± 0.8 b | 3.0 ± 0.4 a | 22.3 ± 3.9 c| 6.7 b | 19.6 c   |
| α-Linolenic acid (C18:3)       | 0.2 ± 0.1 ab| 0.1 ± 0.1 a | 0.2 ± 0.1 b | 0.5 c | 8.3 d    |
| Arachidic acid (20:0)          | 0.1 ± 0.0   | 0.1 ± 0.0   | ND          | ND    | 0.5      |
| Gadoleic acid (C20:1)          | ND          | ND          | 0.1 ± 0.0   | 0.4   | 0.5      |
| Erucic acid (C22:1)            | 0.5 ± 0.1 b | 0.3 ± 0.1 b | 0.7 ± 0.2 c | 0.2 a | 0.9 d    |
| Lignoceric acid (C24:0)        | 0.1 ± 0.0   | ND          | 0.1 ± 0.1   | 0.1   | 0.2      |
| Other                          | 0.4 ± 0.2 b | 0.2 ± 0.1 a | 0.6 ± 0.3 b | 0.3 ab| 0.4 b    |
| ΣSFA                           | 10.0 ± 0.8 b| 9.7 ± 0.3 b | 17.6 ± 1.3 d| 13.8 c| 5.9 a    |
| ΣUFA                           | 89.6 ± 0.9 c| 90.1 ± 0.3 c| 81.8 ± 1.1 a| 85.9 b| 93.7 d   |
| ΣMUFA                          | 81.1 ± 1.3 c| 87.0 ± 0.5 d| 59.3 ± 4.9 a| 78.7 c| 65.8 b   |
| ΣPUFA                          | 8.5 ± 0.8 b | 3.1 ± 0.9 a | 22.5 ± 4.0 c| 7.2 b | 27.9 d   |

SFA, saturated fatty acid; UFA, unsaturated fatty acid; MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; ND, not detected.

C. oleifera, n=9; C. japonica, n=3; C. sinensis, n=5; Olive, n=1; Rapeseed, n=1; Mean ± SD.
a-d, Different letters indicate significant differences p < 0.05 (Duncan’s test).

The fatty acid composition of the 3 tested camellia seed oils. The content of oleic acid in C. oleifera seed oil was 81%, which was close to that in olive oil (77%), but lower than that in C. japonica seed oil (87%). C. sinensis seed oil showed the lowest content of oleic acid (58%), while it showed among the 3 camellia seed oils the highest contents of linoleic acid (22%) which were 8.3% and 3.0% respectively in C. oleifera and C. japonica seed oil. The fatty acid profiles in this work were in accordance with Wang et al.[11].

Some researchers have reported that rapeseed oil is prone to produce toxic substances such as acrolein when heated at high temperatures. This was mainly due to the high level of linolenic acid (18:3)[34]. This situation may be avoided in the camellia seed oils, for the reason that low amounts of linolenic acid (0.1-0.2%) in camellia seed oils. C. oleifera and C. japonica seed oils are rich in oleic acid, so they have superior oxidation stability to other liquid oils. In conclusion, C. oleifera and C. japonica seed oils may be a good source of oil for cooking with high temperatures.

There were also some differences between the saturated fatty acid (SFA) and unsaturated fatty acid (UFA) in the camellia seed oils. The SFA in C. sinensis seed oil (18%) was 80% higher than that in the other 2 kinds of camellia seed oils (approximately 10%). The monounsaturated fatty acid (MUFA) in C. oleifera, C. sinensis and C. japonica seed oils were 81.1%, 87.0%, and 59.3%, respectively. C. oleifera and C. japonica seed oils contained high levels of monounsaturated fatty acid (MUFA) but not polyunsaturated fatty acid (PUFA). These results suggest that C. oleifera and C. japonica seed oils may not be susceptible to the oxidation that produces unpleasant smells. Therefore they may be more suitable for cosmetic applications.

3.4 Triacylglycerol (TAG) composition

Natural edible oils have their own characteristic TAG composition[35], reflecting their physicochemical properties[36]. The TAG compositions of camellia seed oils were analyzed by using HPLC in according to the JOCS method 2.4.6.2-2013[37] (Table 5). The equivalent carbon numbers (ECNs) of the TAGs in C. oleifera and C. japonica seed oils ranged from 44 to 50, while those in C. sinensis seed oils ranged from 42 to 52. Eight to twelve TAG molecular species were separated and identified in camellia seed oils. Among which, the trioleoylglycerol (OOO) level was the highest, based on the high oleic acid content in camellia seed oils. The OOO in C. oleifera and C. japonica seed oils comprised more than 60% of the total TAG molecular species content, while the levels of OOO in olive and rapeseed oils were 47% and 40%, respectively. However, the dominant TAG molecular species in C. sinensis seed oils were OOO (28.5%), dioleolylmonooleoylglycerol (OOL, 16.2%) and dioleolylpalmitoylglycerol (POO, 16.1%), which was
remove free radicals from human body can not only to prevent oxidation of edible oils but also to 
3.5 Tocopherol contents

The tocopherol plays an important role as antioxidant, which can not only to prevent oxidation of edible oils but also to remove free radicals from human body. In general, vegetable oils are the food sources with the highest concentrations of tocopherols, so it is important to determine the tocopherol content in edible oil. The tocopherol contents of the camellia seed oils, olive oil and rapeseed oil are presented in Table 6. It is interesting that only α-tocopherol was detected in camellia seed oils. The total contents of tocopherols in camellia seed oils were similar to that in olive oil and lower than that in rapeseed oil. The tocopherol contents in camellia seed oils depended on the species. The levels in C. oleifera, C. japonica and C. sinensis seed oils ranged from 134 to 238 mg/kg, 154 to 254 mg/kg, and 234 to 361 mg/kg, respectively. In the process of edible oil refining, some minor compounds, such as tocopherols and sterols are decreased. Therefore, different tocopherol levels in camellia seed oils may be due to the different refining ability of producers.

3.6 Sterol composition

The main component of the unsaponifiable matter in edible oil is sterol. There are extremely limited reports on sterols in camellia seed oil, although the most common sterols in vegetable oils were β-sitosterol, campesterol and stigmasterol. The gas chromatogram of unsaponifiable matters prepared from C. japonica seed oil was shown in Fig. 1a. Eight peaks were mainly observed on the chromatogram. EI-MS spectra of peaks 5 and 7 were shown in Fig. 1b and Fig. 1c, which were the major sterol compo-
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Components in *C. japonica* seed oil. Peak 5 was identified as lanosterol by m/z 215, 241, 393, and peak 7 was identified as β-amyrin by m/z 189, 203, 218. Similarly, peaks 1, 3, 4, 6 and 8 were identified as squalene, ergosterol, 7-stigmasterol, tirucallol, and cycloartenol, respectively, by MS spectra.

The sterol compositions in camellia seed oils were different from those in other vegetable oils (Table 7). Three types of camellia seed oils had the same unsaponifiable matter, but the content depended on the varieties. *C. sinensis* seed oils showed the highest concentrations (648 mg/100 g), while the *C. japonica* seed oils showed the lowest concentrations (194 mg/100g). The high amounts of unsaponifiable molecules in *C. sinensis* seed oils may be due to insufficient refining, as mentioned earlier. Seven sterols and squalene were identified in camellia seed oils. Lanosterol, β-amarin and 7-stigmasterol were the main sterols, and they occupied approximately 70% of all unsaponifiable molecules. The most abundant sterols in camellia seed oil were lanosterol and β-amarin; the concentrations of lanosterol in *C. oleifera*, *C. japonica* and *C. sinensis* seed oils were 81.7, 50.4, and 270.8 mg/100 g, respectively. The concentrations of β-amarin in *C. oleifera*, *C. japonica* and *C. sinensis* seed oils were 52.0, 59.5, and 42.2 mg/100 g, respectively. Other sterols are also found in camellia seed oils, such as ergosterol, lupeol, tirucallol and cycloartenol. However, the β-sitosterol reported by Wang et al. was not detected.

In animals and fungi, lanosterol is synthesized as a steroid; however, we detected lanosterol in camellia seed oils. Other researchers have reported that lanosterol may prevent the formation of cataracts in mammals. β-Amyrin is the precursor of oleanolic acid, which shows anti-HIV activity. The unsaponifiable molecules found in camellia seed oils may have biological activity.

In this study, we found that the tocopherol and sterol compositions of camellia seed oil is unique, and that they could distinguish camellia seed oil and other oils, although it was difficult to characterize camellia seed oil by the physicochemical properties, fatty acid composition, or tria-
Table 7  Sterol and squalene composition of each oil (mg/100 g).

| Species      | C. oleifera | C. japonica | C. sinensis | Olive | Rapeseed |
|--------------|-------------|-------------|-------------|-------|----------|
| Squalene     | 29.5 ± 0.8 a| 22.3 ± 2.1 a| 63.2 ± 4.4 b| 295.2 c | ND       |
| Brassicasterol| ND         | ND          | ND          | ND    | 33.0     |
| β-Sitosterol | ND         | ND          | ND          | 96.4 a | 190.8 b  |
| Campesterol  | ND         | ND          | ND          | 26.0 a | 87.5 b   |
| Ergosterol   | 8.2 ± 0.4 b | 5.1 ± 0.4 a | 20.6 ± 2.7 c| ND    | ND       |
| Lupeol       | 12.1 ± 0.8 b| 7.3 ± 1.3 a | 18.6 ± 2.2 c| ND    | ND       |
| β-Amyrin     | 52.0 ± 7.7 ab| 59.5 ± 4.1 b| 42.2 ± 4.3 a| ND    | ND       |
| Lanosterol   | 81.7 ± 14.2 b| 50.4 ± 4.4 a| 270.8 ± 27.1 c| ND | ND       |
| Tirucallol   | 7.3 ± 1.0 a | 11.1 ± 1.7 b| 30.6 ± 3.4 c| ND    | ND       |
| 7-Stigmastenol| 38.5 ± 1.8 b| 24.5 ± 0.7 a| 178.2 ± 8.1 c| ND    | ND       |
| Stigmastanol | ND         | ND          | ND          | 12.8 a | 11.1 a   |
| Cycloartenol | 16.4 ± 1.7 b| 13.5 ± 2.0 a| 23.6 ± 0.4 c| ND    | ND       |
| Total        | 245.7 ± 2.1 b| 193.7 ± 2.7 a| 647.8 ± 9.6 e| 430.4 d | 322.4 c  |

ND, not detected.

C. oleifera, n=9; C. japonica, n=3; C. sinensis, n=5; Olive, n=1; Rapeseed, n=1; Mean ± SD.

a-e, Different letters indicate significant differences p < 0.05 (Duncan’s test).

cylglycerol composition.

4 Conclusions

This study focused on the basic data of 3 types of camellia (C. oleifera, C. japonica, C. sinensis) seed oils and systematically compared the chemical and physical characteristics of these oils. We found that these camellia seed oils had different sterol and tocopherol compositions from olive oil, although among all the camellia seed oils there were no differences in sterol and tocopherol levels. There were significant differences in the fatty acid and tri- cylglycerol compositions of C. sinensis seed oil and the other oils, although the major fatty acid of all the camellia seed oils was oleic acid. The lipid characteristics of camellia seed oils depended on the variety. This finding could be useful for the nutritional, cosmetic and medical applications of camellia seed oils.

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