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ORIGINAL ARTICLE

Seed oil from Harmal (*Rhazya stricta* Decne) grown in Riyadh (Saudi Arabia): A potential source of δ-tocopherol

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Abstract *Rhazya stricta* (*R. stricta*) known as Harmal is widely distributed in Saudi Arabia and throughout the Middle East. It is used as a medicinal plant in traditional cultures and the seeds are a source of unsaturated oil. In the present study, tocol (tocopherol and tocotrienol), triacylglycerol, and fatty acid compositions, pigment content, thermal behavior, and various physicochemical properties of *R. stricta* oil were characterized to determine the potential uses of this seed oil. Our results indicate that the oil is a rich source of bioactive molecules, including δ-tocopherol (896 mg/100 g), γ-tocopherol (148 mg/100 g) and carotenoids (15.67 mg/kg). The oil content of the seeds was 13.68% and the triacylglycerols mainly consisted of linoleic acid (59.03%), and oleic acid (27.01%). The major triacylglycerols were trilinoleate, dilinoleate and monolinoleate. The ratio of unsaturated to saturated fatty acids (UFA/SFA) in the oil was high (9.20). Additionally, the oil showed a high degree of thermal stability and a low melting point of approximately −25 °C. These data indicate that *R. stricta* seed oil, which is low in saturated fats and rich in bioactive compounds, is potentially useful in food and pharmaceutical applications.

1. Introduction

In recent years, there has been renewed interest on the healthful benefits of the minor constituents in vegetable oils such as tocols (tocopherols and tocotrienols), sterols, polyphenols, phospholipids, carotenoids, squalene, etc. [1]. These bioactive compounds may delay or prevent the onset of chronic diseases, such as cardiovascular disease, and various cancers [2].

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Among the minor constituent of vegetable oils, tocols are well recommended for their ability to inhibit lipid oxidation in biological systems and foods. Both tocopherols and tocotrienols have the ability to break the chain propagation of lipid peroxidation reaction, preventing the spread of cell membranes damage and the rancidity of foods. Peroxidation reaction of lipids in human body contributes to the etiology of many diseases as well as to aging [3].

Vegetable oils are among the main sources of tocols (comprising α-T, β-T, γ-T, and δ-T tocopherols, α-T3, β-T3, γ-T3, and δ-T3 tocotrienols) in the human diet [4]. These minor compounds are the main lipid-soluble antioxidants in the human body. They cannot be synthesized by the human body and therefore must be obtained from the diet [3]. Tocols have complex biological effects, reflecting their diverse antioxidant, signaling, and nutritional properties [5]. High dietary intake of tocopherols from food decreased cardiovascular disease mortality. γ-T has activity against chronic diseases, such as inflammation [6].

The tocol contents of conventional vegetable oils range from 2 to 8 mg/100 g of coconut oil to 113 to 183 mg/100 g of corn oil [7]. Wheat germ oil shows a relatively high amount of tocols (268 mg/100 g) [8]. α-T and γ-T are the two most common homologs found in vegetable oils, except in crude palm oil (*Elaeis guineensis*), which is rich in tocotrienols (up to 800 mg/kg) [9].

Saldeen and Saldeen [6] mentioned that the lack of δ-tocopherol in most vitamin E preparations might be a limiting factor in promoting health. Furthermore, Wells et al. [10] indicated that tocopherols (δ-tocopherol in particular) delay many angiogenic and inflammatory activities, making them potentially useful against many diseases such as cancer, cardiovascular disease, arthritis, inflammatory bowel disease, and psoriasis. However, little δ-tocopherol is found in most vegetable oils (0–6% of total tocols). The need to find other unconventional oils with a high content of δ-tocopherol is therefore highlighted.

Rhazya stricta Decne (*R. stricta*), commonly known as Harmal (in Arabic), is an arid plant widely distributed in Saudi Arabia, throughout the Middle East, and South Asia [11]. It is a medicinal plant used in folk medicine to treat diseases such as diabetes mellitus, fever, sore throat, and syphilis [12,13]. Many bioactive compounds have been identified from the *R. stricta* plant, such as alkaloids [11]. A recent study by Nehdi et al. [14] showed that *R. stricta* seeds are a source of unsaturated oil which can be used as a feedstock for biodiesel production.

While studies have investigated the medicinal uses of *R. stricta* plants and the oleochemical use of *R. stricta* seed oil, no studies have examined the characteristics of the oil extracted from *R. stricta* seeds. Therefore, this investigation was undertaken to valorize *R. stricta* seed oil with a view toward potential applications.

2. Experimental

Analysis was performed in triplicate. The values of different parameters were expressed as the mean ± standard deviation (±S.D.).

2.1. Seed materials and oil extraction

The seeds from opened *R. stricta* follicles from many *R. stricta* plants were collected in June from the Raudhat AI-Khafs plain located about 100 km northeast of Riyadh (Saudi Arabia) (24°27′N, 46°26′E). The soil composition is dominated by large-grained coarse sand and fine sand and the coarse sand ratio is higher than the fine sand. Soil pH was slightly alkaline. Phosphorus, potassium, magnesium, sodium and chloride were relatively higher in Raudhat AI-Khafs plain soil [15]. Annual precipitation is about 175 mm, occurring mostly during the period from December to April. The average temperature at the time of flowering until the fruit maturation was between 17 and 28 °C. Collected seeds were cleaned and finally oven-dried at 60 °C for 24 h. The oil was extracted with hexane in a Soxhlet apparatus as described by Nehdi et al. [16].

2.2. Seed analysis

The seed lipid content was determined by calculating the weight of oil extracted from 40 g of dry seed powder. The ash content was determined by incineration of approximately 2 g of powdered seeds at 550 °C for 12 h until a grey ash was obtained. The moisture content was determined by oven drying of ground seeds at approximately 105 °C for 24 h as described by Nehdi et al. [16].

2.3. Seed oil analysis

2.3.1. Triacylglycerol composition

A high performance liquid chromatography system (HPLC, Shimadzu, Kyoto, Japan) equipped with an SPD 20A UV/VIS detector (210 nm), an LC-20AT pump, and a Pinnacle II reverse phase column (150 × 4.6 mm, 5 μm particle size) was used to determine triacylglycerol (TAG) profile of the oil. The TAGs were separated using mobile phase (acetonitrile: propanol (60:40) (v/v)) with a flow rate of 1 mL/min at ambient temperature. A 20 μL aliquot of a 0.05 g oil/mL solution in chloroform/acetone (50/50, v/v) was injected. Due to limitations in TAG standards; the triacylglycerols were identified by comparison with the retention times from the chromatograms of standard TAG and of other conventional oils obtained under similar analytical conditions.

2.3.2. Fatty acid methyl esters (FAMEs)

GCMS-QP-2010 Ultra (Shimadzu, Kyoto, Japan,) was used for the GC–MS analysis. FAMEs prepared as described by Nehdi et al. [25], was injected through a Shimadzu auto sampler AOC-20s onto the Rt-2560 column (100 m length, 0.25 mm i.d., 0.25 μm film thickness). Initially the oven temperature was 115 °C and then increased by 2 °C/min up to 240 °C, and kept for 15 min. The injector temperature was held at 225 °C. Helium was used as a carrier gas at a flow rate of 1.5 mL/min and 1:30 was the split ratio. A scan speed of 1666 in 50–500 m/z scan range was applied for the operation of mass spectrometer. Ion source and interface temperatures were 200 and 245 °C, respectively. For the identification of mass spectra, NIST11 library and analysis program softwares were used. GCMS solution integrated software was also used for the chromatogram analysis.

2.3.3. Tocol composition

The tocols in *R. stricta* seed oil were analyzed by HPLC according to standard ISO 9936. The HPLC system was equipped with a Shimadzu-RF 20A fluorescence detector (set at emission and excitation wavelengths of 330 and 295 nm, respectively), a Rheodyne 7725(i) manual injector (Rohnert Park, USA), and a Shimadzu LC-20AT pump (Shimadzu, Kyoto, Japan). The tocols were separated on a normal phase column as described by Nehdi et al. [16].

2.3.4. Iodine value, peroxide value, acidity, and refractive index

The iodine value (IV) was calculated based on ^{1}H NMR spectra of the oil using the equation mentioned by Miyake et al. [17]:

$$IV = 253.8^{*}100^{*}((A - B/4)/(B/4^{*}2^{*}873.1)) \quad (1)$$

873.1 g/mol – average molecular weight of the oil determined from the fatty acid profile (Table 2). 253.8 g/mol – molecular weight of the iodine. A – signal area at 5.33 ppm of the methine protons in the glyceryl group and the olefinic protons. B – signal area at 4.25 and 4.13 ppm of the four methylene protons in the glyceryl group. 1H NMR analysis was determined using a JEOL ECLIPSE 400 spectrometer at 400 MHz (JEOL, Peabody, MA, USA) equipped with 5 mm BBO probes at 7.05 T. TMS and CDCl3 were used as the internal standard and solvent, respectively.

Standards ISO (International Organization for Standardization) were used for the determination of peroxide value (ISO 3960) and acidity (percentage of free fatty acid was calculated as oleic acid; ISO 660). An Abbe refractometer (Bellingham and Stanley Ltd, Kent, England) was used to determine the refractive index of the oil.

2.3.5. Carotenoid and chlorophyll contents

The carotenoid and chlorophyll contents were determined from the absorption spectra of *R. stricta* oil samples following the method of Minguez-Mosquera et al. [18]. 7.5 g of oil was dissolved in 25 mL of cyclohexane. The absorption band at 470 nm is related to the carotenoid fraction, and that at 670 nm is related to the chlorophyll fraction. The specific extinction wavelengths applied were $E_0 = 2000$ for lutein (a carotenoid component), and $E_0 = 613$ for pheophytin (a chlorophyll component). The equations used for the pigment content calculation were:

Table 1 Physicochemical properties of *R. stricta* seeds and seed oil.

Seed	
Oil yield (w/w) – dry mater (%)	13.68 ± 0.15
Ash – dry matter (%)	6.11 ± 0.11
Moisture content (%)	5.44 ± 0.09
Seed oil	
Peroxide value (meq.O_2/kg)	3.95 ± 0.18
Acidity (free fatty acid (%)	3.13 ± 0.08
Chlorophyll content (mg/kg oil)	10.84 ± 0.11
Carotenoid content (mg/kg oil)	15.67 ± 0.09
Iodine number (g/100 g oil)	131.83 ± 1.32
Refractive index (27 °C)	1.4746 ± 0.002
State at ambient temperature	Liquid
Color	Dark yellow

Table 2 Fatty acid (%) composition of *R. stricta* seed oil.

Fatty acid	Trivial name	(%)
Saturated		
$C_{14:0}$	Myristic	< 0.01
$C_{15:0}$	Pentadecylic	0.02 ± 0.01
$C_{16:0}$	Palmitic	5.96 ± 0.13
$C_{17:0}$	Margaric	0.11 ± 0.04
$C_{18:0}$	Stearic	2.14 ± 0.05
$C_{20:0}$	Arachidic	0.76 ± 0.03
$C_{22:0}$	Behenic	0.50 ± 0.02
$C_{23:0}$	Tricosylic	0.06 ± 0.01
$C_{24:0}$	Lignoceric	0.16 ± 0.03
Monounsaturated		
$C_{15:1}$ ω9		0.04 ± 0.01
$C_{16:1}$ ω5		0.10 ± 0.02
$C_{16:1}$ ω7	Palmitoleic	0.18 ± 0.04
$C_{16:1}$ ω9		0.10 ± 0.02
$C_{17:1}$ ω7		0.10 ± 0.04
$C_{18:1}$ ω9	Oleic	27.01 ± 0.44
$C_{18:1}$ ω7	*cis*-Vaccenic	1.57 ± 0.07
$C_{19:1}$ ω9		0.14 ± 0.05
$C_{20:1}$ ω9	Gondoic	0.37 ± 0.05
$C_{22:1}$ ω9	Erucic	0.04 ± 0.01
Polyunsaturated		
$C_{18:2}$ ω6	Linoleic	59.03 ± 0.33
$C_{18:2}$ ω3		0.11 ± 0.02
$C_{18:3}$ ω3	Linolenic	0.62 ± 0.06
Unknown (sum)		0.88
SFA		9.71
MUFA		29.65
PUFA		59.76
UFA/SFA		9.20
PUFA/SFA		6.15

SFA: saturated fatty acids.
MUFA: monounsaturated fatty acids.
PUFA: polyunsaturated fatty acid.
UFA/SFA: unsaturated/saturated ratio of fatty acids.
PUFA/SFA: polyunsaturated/saturated ratio of fatty acids.

$$\text{Carotenoid content (mg/kg)} = (A_{470} \times 10^6)/(2000 \times 100 \times d)$$
$$\text{Chlorophyll content (mg/kg)} = (A_{670} \times 10^6)/(613 \times 100 \times d)$$

where d is the cell thickness (1 cm) and A is the absorbance.

2.3.6. Differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA)

DSC was used to determine the melting point of the oil and any endothermic or exothermic event; however TGA is a technique used to study the behavior of the oil when heated under controlled atmosphere. DSC curves were measured with a Shimadzu DSC-60 differential scanning calorimeter (Shimadzu, Kyoto, Japan) that had been previously calibrated with indium. Samples weighing between 10 and 12 mg were packed in DSC pans before being placed in DSC cells. The samples were subjected to the following temperature program: 100 °C isotherm for 1 min, cooled to −100 °C at a rate of 20 °C/min and held for 1 min. The same sample was then heated from −100 to 100 °C at the same rate. The samples were cooled and heated under a constant flow of nitrogen (99.9999% purity).

TGA plots were recorded with a Shimadzu thermogravimetric analyzer TGA-50 following the method mentioned by

Nehdi et al. [16]. The oil sample that was placed in aluminum crucible was heated from 25 to 600 °C under synthetic air atmosphere at a rate of 10 °C/min.

3. Results and discussion

3.1. Seed analysis

The results of *R. stricta* seed analysis are shown in Table 1. The seeds contained 5.44% of moisture and 6.11% of ash. The moisture content was comparable to those of *Maclura pomifera* (5.88%) and *Zizyphus lotus* (6.05%) seeds [19,20]. Seed moisture can cause hydrolysis of the seed oil and increases the free fatty acid content. The high ash content in *R. stricta* seeds indicates the presence of a considerable amount of minerals. Alabi and Alausa [21] found that the ash and mineral contents are proportional. Magnesium, potassium, and calcium are the major elements in the ashes of plant seeds, as observed for *Zizyphus lotus* [20], *Phoenix canariensis* [22] and *Washingtonia filifera* [23]. Furthermore, the seeds contained approximately 13.7% (w/w) crude oil, which is similar to the content found by Nehdi et al. [14]. This oil content is relatively high compared to that of other non-conventional seed oils, such as cypress (10.08%) and *Chamaerops humilis* (9.76%) seed oils [24,25].

3.2. Physicochemical properties of seed oil

The *R. stricta* oil showed a high refractive index (1.4746) and iodine value (131.83), indicating its richness in unsaturated triacylglycerols. The refractive index and iodine value are proportional to the unsaturated fatty acid content. Sunflower and soybean oils show comparably high iodine values [7].

Frequently, acidity and peroxide value are used to determine the quality of edible oils. The peroxide value of *R. stricta* seed oil is 3.95 meq.O_2/kg of oil, and this value is lower than that mentioned (<10 meq.O_2/kg) by the Codex Alimentarius Commission [26]. Thus, the oil contained a low quantity of hydroperoxides, which may adversely affect its nutritional value. In addition, *R. stricta* oil showed medium free fatty acid content (3.13%) comparable to that found by Nehdi et al. [14]. The presence of this quantity of free fatty acids is most likely due to the hydrolysis of triacylglycerols [27] and to some anomalies during biosynthesis of the oil in the seeds.

3.3. Pigments and color

Chlorophylls, pheophytins and carotenoids are the pigments present in vegetable oils [7,28]. The presence of various pigments depends on different factors, such as the fruit ripeness, the plant cultivar, the climatic conditions and the type of soil, and the extraction procedures. *R. stricta* oil contained a notable amount of carotenoids (15.67 mg/kg) and chlorophylls (10.84 mg/kg), which are responsible for the dark yellow color of the seed oil. Carotenoid contents are low in most vegetable oils, except in palm oil, which shows high concentration of 0.05–0.2% [29]. Carotenoids are not only precursors of vitamin A but are known as primary antioxidants by preventing free radical chain reaction [30]. In foods such as vegetable oils, carotenoids are typically secondary antioxidants by quenching singlet oxygen. Furthermore, at low oxygen pressures (<150 mmHg) carotenoids can neutralize free radicals and act as primary antioxidants *in vitro* [30].

3.4. Fatty acid (FA) composition

The *R. stricta* seed oil showed a very high unsaturated/saturated fatty acid ratio (UFA/SFA) of 9.20 (Table 2) compared with other seed oils, such as those from sunflower (6.75), *Citrullus colocynthis* (4.62), *Chamaerops humilis*, soybean (3.69), *Albizia julibrissin* (2.96), corn (6.99), and *Acacia senegal* (5.05) (1.23) [16,25,31,32]. The high UFA/SFA value of *R. stricta* oil is due to its low content (9.71%) of saturated fatty acids (SFA), whose deleterious effects on low-density lipoprotein (LDL) cholesterol have been previously demonstrated [33].

The two major fatty acids were linoleic acid (59.03%) and oleic acid (27.01%), followed by palmitic (5.96%), stearic (2.14%), and *cis*-vaccenic (1.57%). Additionally, the *R. stricta* seed oil also contained linolenic, arachidic, behenic, palmitoleic, gondoic, margaric, lignoceric, and erucic acids, but in small quantities (0.10–0.53%). Trace amounts (<0.1%) of myristic, pentadecylic, tricosylic, and other fatty acids were also detected. The FA composition of the studied *R. stricta* seed oil is slightly different than that mentioned by Nehdi et al. [14]. This difference is probably due to the seed origin. Indeed, the distance between the two seed collection sites is about 100 km.

Linoleic acid (LA), a ω-6 polyunsaturated fatty acid (PUFA), is known to have a potent role in insulin sensitivity [34], immune response [35], and the regulation of plasma lipid levels [36]. Furthermore, it has been found that LA can decrease the plasma total cholesterol, which is associated with cardiovascular disease [37]. Regarding oleic acid, Lopez-Huertas [38] mentioned its role in reducing the risk of coronary disease, mainly *via* LDL-cholesterol reduction. Other beneficial effects of oleic acid on risk factors for cardiovascular disease, such as insulin sensitivity, thrombogenesis, and *in vitro* LDL oxidative susceptibility have also been reported [38]. Harris et al. [36], in a recent review from the American Heart Association Nutrition Commission, showed evidence that ω-6 PUFA lowers cardiovascular risk and reinforced that ω-6 consumption should be encouraged; therefore, *R. stricta* seed oil, with its high PUFA/SFA ratio of 6.10, is recommended as dietetic oil.

3.5. Triacylglycerol composition

The determination of the TAG profile is essential to understand the physical properties of vegetable oils. The TAG contents with equivalent carbon number (ECN) are presented in Table 3. A correlation is evident between the TAG and FA compositions according to the results of Tables 2 and 3. Indeed, given the high content of linoleic acid in *R. stricta* seed oil, trilinoleate, dilinoleate and monolinoleate polyunsaturated TAG (LLL, OLL, PLL, OOL and PLO) together represented approximately 94.56% of the total TAG content.

3.6. Thermal behavior

The DSC heating curve (Fig. 1) shows an endothermic peak at −24.92 °C, corresponding to the melting of *R. stricta* oil. The polyunsaturated TAGs in the seed oil behave as a single TAG

Table 3 Triacylglycerol (TAG) composition of *R. stricta* seed oil.

TAG	ECN	%
LLLn	40	0.14 ± 0.02
LLL	42	33.77 ± 0.43
PLLn	42	0.47 ± 0.04
OLL	44	28.07 ± 0.66
PLL	44	12.70 ± 0.52
OOL	46	11.04 ± 0.11
PLO	46	8.98 ± 0.22
PPL	46	0.31 ± 0.08
OOO	48	2.02 ± 0.12
POO	48	0.86 ± 0.11
POP	48	2.78 ± 0.08
SOO	50	1.45 ± 0.12

Ln, linolenic; L, linoleic; P, palmitic; S, stearic; O, oleic; ECN, equivalent carbon number.

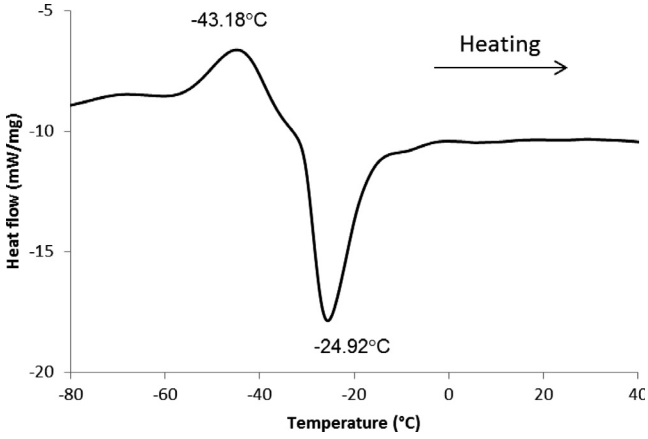

Figure 1 DSC curve of *R. stricta* seed oil.

melting at very low temperature (≈−25 °C). *R. stricta* oil is highly resistant to freezing. Its melting point was lower than that of soybean oil (−16 °C) [39]. A lower melting point is desirable in terms of nutrition. Furthermore, a polymorphism was detected in *R. stricta* seed oil at −43.18 °C, corresponding to the transition between the α-crystalline and β-crystalline form [40,41]. The β-form has relatively large and stable crystals and is recommended in food applications, such as in frying preparations [29].

The TGA curve (Fig. 2) revealed that *R. stricta* seed oil was highly thermally stable and can be used for high temperature

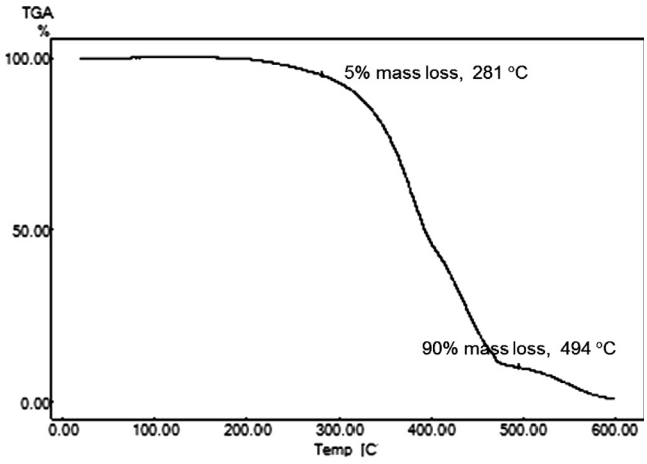

Figure 2 TGA curve of *R. stricta* seed oil in dry air atmosphere.

applications such as frying purposes. Compared with conventional seed oil such as sunflower oil [16], *R. stricta* oil showed 5% and 90% weight losses at 281 and 494 °C, respectively, however sunflower oil loses the same weights at 247 and 483 °C. This difference is probably due to the different FA compositions.

3.7. Tocol composition

Table 4 shows the tocol composition of *R. stricta* oil; compared with common conventional seed oils such us soybean, corn, and sunflower [16,42]; this seed oil is an important source of tocols (1082.35 mg/100 g) and in particular δ-T (896.25 mg/100 g). Furthermore, γ-T is present in considerable quantity (148 mg/100 g) such as in corn and soybean oils. Small amounts of α-T, β-T, and δ-T3 were also detected. It should be noted that *R. stricta* oil contains also a quantity of α-tocopherol acetate (29.56 mg/100 g) that is another form of vitamin E.

Tocols in vegetable oils can protect polyunsaturated triacylglycerols from oxidative damage [6]. Reiter et al. [43] found that among all tocols, δ-T more strongly suppressed proliferation and cancer cell signaling. Wells et al. [10] showed that δ-T might be useful therapeutically. This vitamin E isomer has strong effects on invasiveness, proliferation and capillary angiogenesis and can suppress many inflammatory activities. Saldeen and Saldeen [6] (mentioned that food supplements containing PUFA should also contain a mixture of α-T, δ-T and γ- T to inhibit oil peroxidation.

Table 4 Tocol composition of *R. stricta* and some conventional seed oils (mg/100 g oil).

Tocol	*R. stricta*	Sunflower [16]	Corn [42]	Soybean [42]
α-T	15.12 ± 0.14	92.89 ± 1.07	21.01 ± 1.11	8.31 ± 0.81
β-T	5.13 ± 0.18	0.26 ± 0.04	1.88 ± 0.15	2.50 ± 0.18
γ-T	148.22 ± 2.23	1.88 ± 0.15	109.34 ± 1.22	90.91 ± 1.22
δ-T	896.25 ± 4.96	–	10.74 ± 1.74	77.89 ± 1.64
α-T_3	–	–	6.13 ± 0.72	–
γ-T_3	–	–	3.82 ± 0.22	–
δ-T_3	17.63 ± 0.55	–	–	–
∑ tocols	1082.35	95.02	152.94	179.62

Concerning γ-T, this isomer can potentially protect against chronic diseases, such as inflammation [6]. Due to it anti-inflammatory effect, γ-T might prevent the incidence of colon cancer [44]. Another report also showed that γ-T protects insulin-producing cells and pancreatic β- cells against inflammation [45]. Thus, higher blood levels of γ-T, decrease the risk of prostate cancer. Moreover, both γ-T and δ-T were found to be superior to α-T in terms of the inhibition of the neoplastic transformation of certain cells [6].

The very high content of δ-T and γ-T could make *R. stricta* seed oil more attractive from a nutritional and pharmaceutical perspective.

4. Conclusion

The characterization of *Rhazya stricta* seed oil has not been previously reported. In the present study, GC/MS, HPLC, ^{1}H NMR, DSC, TGA, UV/Visible spectroscopy and ISO standards were used to determine the tocol composition, the physicochemical properties, and other characteristics of *R. stricta* seed oil. The knowledge gained from this study will help to determine the health benefits of this oil and its food and non-food applications. This investigation revealed that *R. stricta* seed oil has a relatively high δ-tocopherol (896 mg/100 g) and γ-tocopherol (148 mg/100 g) content. Furthermore, this seed oil showed a very high unsaturated/saturated fatty acid ratio of 9.20 and a high carotenoid content. It also showed high thermal stability and a low melting point. These findings, combined with the physicochemical properties mentioned above, show that this oil has a positive effect on health and can be used as a food supplement. However, the safety of this oil must be tested before use for human nutrition. In the pharmaceutical industry, *R. stricta* oil which is a potential source of δ-tocopherol, appears to be useful for the prevention, delay, or treatment of chronic and acute diseases. A clinical trial should be carried out to confirm the medicinal properties of this oil. *R. stricta* crop has the potential to positively impact Saudi Arabia rural communities and wherever this plant will grow.

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