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Research Article

COMPOSITION, PHYSICO-CHEMICAL AND ANTIOXIDANT PROPERTIES OF *OCIMUM GRATISSIMUM L.* ESSENTIAL OIL FROM BURKINA FASO

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ABSTRACT. *Ocimum gratissimum* L. is an aromatic herbaceous plant that is native to tropical countries especially West Africa, India and South America. It has been traditionally used for medicinal, condiment and culinary purposes and many biological properties have been reported on its essential oils (EOs). This study aims to determine the physico-chemical parameters and assess the antioxidant potential of this plant's EO. Thus, fresh leaves of *O. gratissimum* were collected from the cultivated field of Irsat (Ouagadougou), Burkina Faso at the full blooming stage. These leaves were hydrodistilled and analyzed immediately after collection (fresh) to evaluate the quality of volatile constituents in terms of composition by GC-MS. Physico-chemical properties were determined by using international standards ISO. The antioxidant activity was determined by 2,2'-diphenyl-1- picrylhydrazyl (DPPH) radical scavenging and the 2,2' azinobis 3 ethylbenzothiazoline 6 sulfonic acid (ABTS) methods. The study revealed the presence of thymol (29.5%), γ-terpinene (20.5%) and p-cymene (12.9%) as EO major constituents. For physico-chemical parameters, the relative density value was less than 1. A low content of free acids was found. The EO had low light refraction and was found to be dextro-rotatory. The EO was soluble in 7 volumes of ethanol (70%) and values obtained for the acid index and refractive index were less than 2. The antioxidant activity showed DPPH radical inhibition value of 41.16 % at 0.1% of EO concentration with an IC_{50} value of 3.9 µg/ml. The ABTS radical inhibition value was 36.14 % at 0.1% of EO concentration with an IC_{50} value of 3.13 mg/ml. The present study has permitted to verification of the quality of *O. gratissimum* EO produced in Burkina Faso and showed that this oil could be a promising source of antioxidant compounds.

Keywords: *GC-MS, phenolic compounds, standard ISO.*

INTRODUCTION

Reactive Oxygen Species (ROS) are known to have harmful effects at high concentrations on biomolecules such as DNA, RNA, proteins and lipids, resulting in many human diseases. Numerous studies have been reported on the need for the supplementation of antioxidants for body protection against oxidative damage caused by ROS overproduction [1–3]. In the past, synthetic antioxidants such as Butylated

hydroxyanisole, butylated hydroxytoluene, and tert-butylhydroquinone are extensively used as in the food industry. However, the use of synthetic antioxidants is restricted due to their carcinogenicity and liver toxicity [4]. In response to this situation, finding natural antioxidant compounds, for the food industry, becomes the priority of scientists. Thus, many researches were conducted and the results showed that natural plant substances such as essential oils (EOs) are very efficient to prevent radical chain reactions, inhibiting the oxidation process and delaying the lipid peroxidation process affected by ROS [5–7].

Ocimum gratissimum L. is a plant belonging to the Lamiaceae family that is commonly found in Africa, Asia, and South America [8]. It is popularly known as clove basil, African basil, and in Hawaii as wild basil. It is characterized by a woody stem at the base and reaching up to 3 m in height. It has ovate leaves ranging from 5 to 13 cm in length and 3 to 9 cm in width, with petioles 1 to 6 cm in length. Its flowers are arranged in simple or branched bunches; ranging from 5 to 30 cm in length [9]. The Ocimum genus contains approximately 30 known species that are distributed across the warmest regions of the planet [9]. Species are commonly used as a condiment in the food industry and as medicinal plants, given their anti-inflammatory, analgesic, hepatoprotective, anti-mutagenic, antihypertensive, and anticarcinogenic effects. Its antinociceptive, intestinal motility antagonistic, antibacterial, and antifungal activities have been proven in previous studies [10, 11]. *O. gratissimum* produces an essential oil (EO) that is valued by the perfumery, cosmetic, pharmaceutical, and food industries [12]. In addition, many biological properties have been reported on the EO of the plant including antiviral, inhibitory, anticoagulant, antitumor, antimicrobial, antimalarial, antioxidant, anti-inflammatory, antileishmania, anti-catabolic effects [11, 13, 14]. However, to the best of our knowledge, no study has been conducted on the antioxidant activity and physico-chemical properties of this EO in Burkina Faso.

The present study aims to determine the antioxidant activity of this EO collected in the central part of Burkina Faso. The chemical composition and some physico-chemical parameters of the EO were determined.

MATERIALS AND METHODS

Plant material

Plant material is composed of aerial stems, leaves and flowers of *O. gratissimum L* collected in December 2021 in IRSAT experimental garden (Central region of Burkina Faso; 12.42452, -1.48738). A specimen of the plant was authenticated and deposited in the herbarium of the Joseph KI-ZERBO University under the number 6953

Extraction of the essential oil and extraction yield determination

The EO was obtained through steam distillation of fresh material during 3 hours using a Clevenger. The EO obtained was then dried on anhydrous sodium sulphate and stored in amber bottle at 4 °C for further analysis. The following formula was used to calculate the yield (R) in EO:

$$\mathrm{R}\ (\%) = \frac{\text{Essential oil mass (g)}}{\text{Mass of plant material (g)}}\, x\ 100$$

Chemical composition

Gas Chromatography–Mass Spectrometry (GC/MS) was used for the chemical analysis of the EO. Analyses were performed with a Varian CP-3800 gas chromatography equipped with a DB-5 capillary column (30 m 0.25 mm; coating thickness 0.25 mm) and a Varian Saturn 2000 ion trap mass detector. Analytical conditions :

- Injector and transfer line temperatures 220 and 240 °C, respectively; oven temperature programmed from 60 °C to 240 °C at 3 °C/min;
- Carrier gas helium at 1 mL /min ;
- Injection of 0.2 mL (10% hexane solution) ;
- Split ratio 1:30.

Compounds were identified by (i) comparison of their retention index (RI) against C5-C24 n-alkanes obtained on a non-polar DB-5MS column, with those provided in the literature and (ii) comparison of their mass spectra with those recorded in NIST (National Institute of Standards and Technology) or reported in published papers or by co-injection of available reference compounds.

Physico-chemical parameters

Physico-chemical parameters of the EO were determined according to the protocol described in ISO international standards 279, 280, 592, 875 and 1242 respectively for the relative density, refraction index, rotatory power, miscibility with ethanol and acid index [15–19]. For each parameter, 5 repetitions were performed. All measurements were taken at 22 °C.

Relative density (d)

The relative density is the ratio of the mass of a certain volume of the EO to the mass of the same volume of distilled water taken at the same temperature. Density measurement was performed using an analytical balance (Mettler AC 100, Mettler Toledo, and Columbus, OH, USA) and a pycnometer of 50 mL. It has been calculated from the following formula :

$$d = \frac{(m2 - mo)}{(m1 - mo)}$$

***m_0** = mass of the empty pycnometer in g;*
***m_1** = mass of the pycnometer filled with distilled water in g;*
***m_2** = mass of the pycnometer filled with essential oil in g.*

Refractive Index (RI)

The refractive index of an EO is the ratio of the sinus of the angle of incidence to the sinus of the angle of refraction of a light ray of a given wavelength passing from the air into the essential oil kept at a constant temperature. It has been measured using a refractometer (model ABBE, BOECO, Hamburg, Germany). The refractometer was previously calibrated at 1.333 (at 22±0.2 °C) corresponding to the refractive index of the

standard solution (distilled water). Then the refractive index was measured by placing a few drops of essential oil in the refractometer.

Rotatory power ($[\alpha]_T^\lambda$)

The rotatory power is measured value of the angle of rotation of the plane of polarisation of light under given experimental conditions. An automatic polarimeter (Mrc-P810, MRC, Holon, Israel) was used to measure the optical rotation of the EO.

Miscibility with ethanol

The ethanol miscibility consists to determine the volume and the concentration of hydro-alcoholic solution necessary to form a homogeneous mixture with 1 mL of essential oil.

Acid index (AI)

The acid index is the number of milligrams of potassium hydroxide required to neutralise free acids in 1 g of essential oil. For this purpose, 2 g of the EO and a maximum of 5 drops of phenolphthalein were added to 5 mL of neutralised ethanol in a saponification flask. After homogenisation, the mixture was titrated using a burette with potassium hydroxide solution (0.1mol / L). The acid index was determined according to the formula:

$$\mathrm{AI} = \mathrm{V.C}\,\frac{56{,}11}{\mathrm{m}}$$

***V** is the volume, in milliliters, of potassium hydroxide solution used for the titration;*
***C** is the exact concentration, in moles per liter, of the potassium hydroxide solution;*
***m** is the mass, in grams, of the test sample.*

Antioxidant activity

DPPH Radical Scavenging Activity

DPPH radical scavenging activity was determined using the method described by Ling et al. [20] with minor modifications. Briefly, 0.5 mL of EO (0.1% v/v in methanol) was added to 1 mL of DPPH solution (20 mg/mL in methanol) freshly prepared. After shaking, the mixture was incubated for 15 min in darkness at room temperature and then absorbance was measured at 517 nm against a blank (mixture without essential oil). Gallic acid (1.5 µg/ml) and Ascorbic acid (3 µg/ml) were used as positive controls and 100 mg/mL of 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid (Throlox) is used as standard. Tests were carried out in three repetitions. The inhibition percentage of free DPPH radicals (I %) was calculated using the following equation:

$$\mathrm{I}\,(\%) = \frac{1 - \mathrm{A\ Sample}}{\mathrm{A\ Blank}}\,(100)$$

A_{Blank} and A_{sample} are respectively the absorbance of the blank and sample reactions. Essential oil concentration scavenging 50% of DPPH radicals (IC_{50}) was calculated from the plotting of inhibition percentage versus sample concentration.

ABTS Radical Scavenging Activity

The radical scavenging capacity of the essential oil was assayed with the 2,2' azinobis 3 ethylbenzothiazoline 6 sulfonic acid (ABTS) method according to the protocol described by Ling et al. [20] with some modifications. The ABTS radical solution was prepared by dissolving 10 mg of ABTS with 2.6 mL of distilled water and 1.7212 mg of potassium persulfate. The mixture was kept in the dark at room temperature for a maximum of 12 hours. A volume of 0.5 mL of EO (0.1% v/v) was added to 3.8 mL of the ABTS+ solution. Absorbance was measured at 734 nm. Gallic acid (1.5 µg/ml) and Ascorbic acid (3 µg/ml) were used as positive controls and 100 mg/mL of 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid (Throlox) is used as standard. Tests were carried out in three repetitions. The percentage inhibition of the ABTS+ was determined by the following formula :

$$\text{Inhibition of ABTS (\%)} = \frac{(A0 - A1)}{A0} X\ 100$$

A_0 is $ABTS^+$ blank absorbance ; A_1 is the EO absorbance. Essential oil concentration scavenging 50% of DPPH radicals (IC_{50}) was calculated from the plotting of inhibition percentage versus sample concentration.

Statistical analysis

Assays were performed in five replications; each data point represents the average of at least three independent experiments. All data are reported as the mean ± SD. Data were analyzed by 1-way analysis of variance followed by the Tukey multiple-comparison test. Analyses were done by using GraphPad Prism® software. A P value less than 0.05 was used as the criterion for statistical significance.

RESULTS AND DISCUSSION

Following the plan described in the methodology part, the following results were obtained:

Essential oil extraction yield

In the present study, the EO yield of *O. gratissimum* was 0.92% (Table 1). These results are confirmed in Cameroon with an extraction yield of 0.90 [21]. In contrast, in the same country, another study showed an essential oil content of 0.19% when the plant was collected in Yaoundé and 0.60% when collected in Dschang [22]. This situation shows that the soil's nature can affect essential oil yield. In Benin, a higher EO content of 1.24% in fresh *O. gratissimum* leaves which is largely superior to that of our study has been found [23]. This shows that the yield of EO can vary according to the geographical situation. In addition, other authors showed plants in pre-flowering of *O. gratissimum* with EO yields in the range of 0.65 and 0.71% while the flowering plant yields ranged between 0.70 and 0.78 [24]. This shows that the age of the plant can influence the EO yield. In Congo, the EO yield of fresh and dried leaves of *O. gratissimum* was compared [25]. The fresh leaves gave an EO content of 0.46% which is lower than in this study

while the dried leaves produced a higher yield of 1.01%. This shows that drying could have a positive influence on essential oil yield. Indeed, numerous authors showed that these different variations in EO content could effectively be related to several factors such as geographical situation, plant age, soil type, growing conditions, extraction method, drying effect and collection period [22, 23, 26].

Chemical composition

Essential oil analysis results are shown in Table 1. 56 chemical compounds were identified *O. gratissimum* EO. Monoterpene hydrocarbons (44.9%) and oxygenated monoterpenes (41.8%) were the main compounds identified. Among the monoterpene hydrocarbons, γ-terpinene (20.5%) and p-cymene (12.9%) were the predominant compounds identified. Among the oxygenated monoterpenes, thymol was the main chemical constituent (29.5%). These results are in agreement with those obtained by other authors in Cameroon [21,23]. Other studies have reported the presence of the same constituents in *O. gratissimum* EO but in different proportions than that in our study. Indeed, in Burkina Faso, an EO of *O. gratissimum* with γ-terpinene as the most abundant compound (20.95 %), followed by thymol (18.56 %) and p-cymene (11.73 %) has been found [27]. In Ivory Coast, an EO with 37.79% of p-cymene and 24.57 % of thymol and another with 46.1% of thymol and 17.56 % of γ-terpinene have been reported [28,29]. However, other studies showed another chemotype of *O. gratissimum* EO with eugenol (74.83%) and 1.8-cineole (15.16%) [30] or linalool (32.9%) and 1.8-cineole (21.9%) [9]. According to many reports, these different variations in the chemical composition of EOs could be explained by various factors including seasonality, temperature, water availability, incidence of ultraviolet radiation, nutrient availability, altitude… These factors can interfere with a plant's secondary metabolism and considerably modify the composition of EOs [31,32].

Table 1. *Chemical composition*

Terpenes group	Retention Index	Chemical constituents	% of constituents
Monoterpene hydrocarbons	906	Tricyclene	1.4
	911	α-thujene	1.1
	917	α-pinene	0.4
	934	Camphene	0.3
	958	β-caryophyllene	2.3
	963	Myrcene	1.3
	977	α-phellandrene	0.4
	985	β-phelladrene	0.1
	998	δ-3-carene	0.3
	1021	α-terpinene	1.2
	1065	Sabinene	0.8
	1069	β-pinene	0.5
	1076	*(E)*-β-ocimene	0.5
	1088	δ-2-carene	0.1
	1096	**P-cymene**	**12.9**
	1101	Limonene	0.7
	1116	**γ-terpinene**	**20.5**
	1121	Terpinolene	0.1

Table 1. *Continues*

Terpenes group	Retention Index	Chemical constituents	% of constituents
Oxygenated monoterpenes	1156	Linalool	1.3
	1189	**1.8-cineole**	0.1
	1199	**Thymol**	**29.5**
	1204	Carvacrol	0.3
	1213	Thymyl acetate	1.1
	1228	Carvacryl acetate	0.2
	1247	**Camphor**	2.1
	1267	Terpinene-4-ol	0.1
	1274	Sabinene cis-hydrate	1.3
	1223	Octene-3-yl acetate	0.2
	1249	δ-terpineol	0.1
	1261	α-terpineol	0.6
	1281	Fenchyl acetate Endo	1.1
	1349	Piperitone	0.1
	1378	Bornyl acetate	0.8
	1391	Isopropyl acetate	1.8
	1399	Myrtenyl acetate	1.1
Sesquiterpene Hydrocarbons	1404	α-copaene	1.4
	1421	β-elemene	0.1
	1433	β-copaene	0.6
	1436	β-caryophyllene	0.9
	1467	α-Trans-bergamotene	0.1
	1488	*(Z)*- β-farnesene	1.1
	1489	α-humulene	0.1
	1496	Allo-aromadendrene	0.2
	1507	γ-murolene	0.4
	1513	Germacrene-D	2.7
	1536	β-trans-bergamotene	0.1
	1552	β-selinene	0.7
	1571	β-bisabolene	0.3
	1583	*(Z,E)*- α-farnesene	0.1
	1595	α-muurolene	0.1
	1598	δ-cadinene	0.4
Oxygenated sesquiterpenes	1609	Elemol	0.4
	1617	Spathulenol	1.1
	1624	*(E)*-nerolidol	0.3
	1638	Caryophyllene oxide	0.2
	1641	α-eudesmol	1.1

Table 1. *Continues*

Terpenes group	Retention Index	Chemical constituents	% of constituents
Extraction yield			**0.92**
Monoterpene hydrocarbons			**44.9**
Oxygenated monoterpenes			**41.8**
Sesquiterpene Hydrocarbons			**9.3**
Oxygenated sesquiterpenes			**3.1**
Total			**99.1**

Physico-chemical properties

The knowledge of physico-chemical properties is important because it allows to identify an EO and verify its quality. The results obtained on these properties for *O. gratissimum* EO are consigned in Table 2.

The density value obtained was 0.89. This value is lower than 1, which is the density of water. This constitutes the criteria of good quality of our essential oil. This result is confirmed in Vietnam with a density of 0.96 [33]. The acid index gives an idea about the free acid of essential oil content. The value obtained in our study was 0.11. The acid value is an important parameter of physico-chemical properties that indicate the age, quality, edibility and suitability of essential oils [34]. The high acid value indicates that the essential oil is becoming rancid due to storage of the plant under improper conditions or adulteration there in. The lower the acid index value, the most the quality of the EO. This shows the good quality of our EO and indicates that it has been well-preserved after extraction. Solubility in ethanol is an important physical characteristic that distinguishes essential oils. The ethanol miscibility with ethanol results shows that approximately 7 volumes of 70% (v:v) hydroethanolic solution are required to fully dilute 1 g of *O. gratissimum* EO. This result shows that ethanol is a dilution medium for the *O. gratissimum* EO. The refractive index is a physical property that is used frequently to test the purity of oils. The lower the refractive index is, the better the quality of the EO. The refractive index value in our study was 1.334. The value obtained in our study was low as it was slightly higher than that of water (1.333). So, our essential oil could be considered to be of good quality in terms of purity [35]. In the other hand, a low refractive index of an EO indicates its low refraction of light which could favor its uses in cosmetic products This last result is confirmed by another study that showed that major chemical constituents found in *O. gratissimum* (p-cymene, thymol and γ-terpinene) EO have various applications in cosmetic, agri-food, pharmaceutical and cleaning products industries [36].

The rotatory power is also an important parameter that is decisive in the control of the naturality of EOs and for the detection of counterfeits. The enantiomeric composition of EO molecules constitutes its identity card; it allows to specify its origin and biological activities [37]. *O. gratissimum* EO become clockwise polarised (dextro-rotatory). The

enantiomeric molecules found in this EO (α-thujene, α-pinene, myrcene, sabinene, β-pinene and p-cymene) could probably be references molecules that will allow to verify its authenticity.

Antioxidant properties

Antioxidant activity results are shown in Table 3. The compound diversity present in EOs can exhibit different mechanisms of antioxidant action. Thus, using more than one type of assay is common in evaluating antioxidant activity. In the present study, DPPH and ABTS methods were used.

The test of DPPH intends to measure the ability of the essential oil to scavenge the stable radical 2,2- diphenyl-1-picrylhydrazyl (DPPH•) in solution by donating hydrogen atom or electron. Results showed a radical inhibition value of 41.16 % at 0.1% with an IC_{50} value of 3.9 µg/ml. This value was 1.56 times less active than ascorbic acid and two times less active than gallic acid. These results agree with those obtained by other authors who showed that this essential oil possesses antioxidant properties. Indeed, a study conducted in India on the antioxidant activity of *O. gratissimum* EO showed higher free radical inhibition than the present study, with an IC_{50} value in the range of 2.02 to 3.02 µg/mL [22]. This essential oil was mainly composed of eugenol (65-85.71%). This difference in efficacy could be explained by the presence of eugenol in this essential oil because the antioxidant activity of this compound has been demonstrated [38].

In contrast, another EO composed mainly of eugenol (83.33-89.54 %) and eucalyptol (5.14-9.60%) showed a lower antioxidant activity (15.6 µg /mL). This could be explained by the presence of eucalyptol or other minor compounds in the EO that act antagonistically to the action of eugenol. The antioxidant activity of *O. gratissimum* EO has been reported in another study which reported higher DPPH radical inhibition percentage values (68.83 - 73.85 %) [39]. However, this essential oil contained the same significant constituents as the one in the present study. Therefore, the difference observed could be explained by the higher content of these compounds compared with that of the present study.

For ABTS radical scavenging assay, the percentage inhibition value for the radical was 36.14% with an IC_{50} value of 3.13 mg/mL. This value was respectively 1.58 and 2 times lower than for ascorbic and gallic acids. It differs slightly from the value obtained by the DPPH radical method, whose value was higher. This result agrees with those obtained by other authors who evaluated essential oils' antioxidant activity using these two methods [40–41].

Table 2. *Physico-chemical parameters*

	Chemical properties			**Physical properties**		
Essential Oil	AI (mg of KOH / g of EO	Miscibility with ethanol at 22 °C		Relative density (d) at 22 °C	Refractive Index at 22 °C	Rotatory power (°C) at 22 °C
		Hydro-ethanol mixture (% v/v)	Number of Volume of hydro-ethanol solution for complete miscibility of EO			
O. gratissimum	0.11 ± 0.01	70	0.89 ± 0.04	1.334 ± 0.21	+51 ± 4.35	

Indeed, this difference may be linked to the mechanisms involved in the radical antioxidant reactions. Indeed many factors can affect the ability of each EO to react to different radicals, such as the stressing agent used, the mechanism of action of the antioxidant, the solubility of EOs in different testing systems, etc [44]. However, in the current study, the difference observed could be explained by the last factor, which is the difference in solubility of the essential oil in methanol for the DPPH method and in water for that using ABTS. In effect, certain compounds contributing to the antioxidant activity that were soluble in methanol were not soluble in water.

According to several studies, this activity could be explained by the presence of the EO's phenolic compounds, which can stabilize by hydrogen donation and form the link DPPH-H [43–45]. The higher the phenolic content of the EO, the higher the antioxidant activity [42]. The main phenolic compound in our essential oil was thymol (29.5%). This compound is known to have strong reducing properties because of its capacity to form stable intermediates due to the conjugation of the aromatic ring [39]. The antioxidant potential of thymol can mainly be attributed to its greater steric accessibility to the DPPH radical site when compared to other more giant molecules [39]. However, another study showed an EO of *O. gratissimum* containing 4% phenolic compounds but with an IC_{50} value of 5.5 µg/ml. This EO was rich in γ-terpinene (26.33%) and methyl cinnamate (48.29%). Indeed, antioxidant activity can also be due to the synergistic action between the terpinene (in its various configurations), terpinolene, and phenolic compounds [46]. Therefore, the antioxidant activity observed in our study can be related to the presence of thymol. Still, it could also be explained by the interactions between the thymol and other compounds, such as p-cymene (12.9%) and γ-terpinene (20.5%), which were predominantly present in the EO.

Table 3. *Antioxidant activity*

Essential oil	DPPH Radical scavenging activity		ABTS Radical scavenging activity	
	% Inhibition (mean values ± standard deviation)	IC_{50} (µg/ml)	% Inhibition (mean values ± standard deviation)	IC_{50} (mg/ml)
O. gratissimum	41.16 ± 0.51^{a}	3.9 ± 0.01^{a}	36.14 ± 0.05^{a}	4.13 ± 0.01^{a}
Ascorbic acid (3 µg/ml)	64.30 ± 0.48^{b}	1.89 ± 0.02^{b}	57.11 ± 1.8^{b}	2.17 ± 0.07^{b}
Gallic acid (1.5 µg/ml)	88.21 ± 1.9^{c}	0.83 ± 0.07^{c}	72.1 ± 1.89^{c}	1.09 ± 0.01^{c}

DPPH *= 2,2-diphenyl-1-picrylhydrazyl ;* ***ABTS*** *= 2,2' azinobis 3 ethylbenzothiazoline 6 sulfonic acid.*

CONCLUSION

The present study has permitted us to determine the chemical composition, physico-chemical and antioxidant properties of *O. gratissimum* EO from Burkina Faso. Physico-chemical properties allow a positive assessment of the EO and indicate its applications, especially in culinary, industrial, cosmetics and therapeutic domains. Furthermore, *O.*

gratissimum EO exhibited an interesting antioxidant activity mainly due to the presence of its monoterpene compounds.

This property of the EO shows that it constitutes a source of compounds which could be used for the prevention of oxidative stress related diseases. The antioxidant properties of the EO probably explain partly, the use of this plant in food and in traditional medicine for the treatment of infectious diseases and inflammations. However, if this essential oil is to be used for foods or medicinal purposes, issue of its toxicity need to be addressed.

Conflict of Interest. The authors declared that there is no conflict of interest.

Authorship Contributions. Concept: A.C., Chemical composition of the essential oil: I.S., Measure of physico-chemical parameters: A.C., M.T., D.M.H., Measure of antioxidant activity: A.C, D.M.H., Supervision: M.K., R.C.H.N.

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