

of different plant parts did not yield the same production and gave rise to different amounts of essential oil, with average yields of 5.03 % (w/w on dry weight basis) in fruits and 1.48% in leaves. The extraction yield of *S. terebinthifolius* dried leaves and fruits essential oil was relatively high compared with certain plants which are industrially run as source of essential oil [21] such as peppermint (0,5-1 %), neroli (0,5-1 %), pink (rose) (0,1-0,35 %), , menthe (0.5-1%), Laurel (0.1-0.35%) [21] and *Tetraclinis* (0.22%) [22]. These values were nearly similar to those obtained by Ennigrou et al. [23] who mentioned that the hydrodistillation of *S. terebinthifolius* dried leaves yielded 1.06%. Our results are in agreement with those of Barbosa et al. [24] and Souza et al. [25] who reported that the amount of fruits EO corresponded to 4.65% and 4.87% dry weight. In contrast, Affonso et al. [26] found that *S. terebinthifolius* fruits EO yielded of about 2.6% (w/w) of dry weight. The difference between leaves and fruits EO yield could be due to the fact that essential oil accumulation is organ-dependent. Various physicochemical indexes were determined after the essential oil extraction from fruits and leaves. No data are available concerning physicochemical properties of *S. terebinthifolius* leaves and fruits EOs. Here, for the first time density, acid, ester and saponification values of EO were measured. Results are resumed in the Table 1.

Table 1: Physicochemical properties of *S. terebinthifolius* leaves and fruits essential oils

	Acid Value	Ester Value	Saponification Value	Density
Fruits EO	1.5	29.9	33.2	0.84
Leaves EO	5	23.35	28.35	0.89

According to the results presented in Table 1, it worth noting that the ester and saponification values characterizing the fruits EO were higher (29.9 and 33.2 mg (KOH) / g of EO, respectively) than those observed in the leaves EO (23.35, 28.35 mg (KOH) / g of EO, respectively). However, the acid value of the fruits EO was lower (1.5 mg (KOH) / g of EO) than that of leaves EO (5 mg KOH / g EO). Fruits and leaves EO were characterized by quite similar values of 0.84 and 0.89, respectively. These differences are mainly due to the chemical composition of leaves and fruits.

3.2. Essential oils composition of *S. terebinthifolius* fruits and leaves

The essential oil extraction of *S. terebinthifolius* was conducted by steam distillation. Volatile compounds of *S. terebinthifolius* leaves and fruits, their retention indexes and percentages, are listed in Table 2. All the constituents were arranged in order of their elution on the HP column. 23 compounds were identified in the leaves EO representing 97.99 % of the total EO while 22 compounds were detected in the fruits EO forming 93.88 % of the total EO (Table 2).

Table 2: Essential oil composition (%) of *S. terebinthifolius* leaves and fruits

N°	Volatils compounds	RI	Fruits	Leaves
1	α -thujene	930	0.26	0.54
2	α -pinene	939	7.37	9.63
3	sabinene	975	0.2	0.77
4	β -pinene	979	0.47	0.53
5	α -phellandrene	1003	14.06	11.69
6	<i>m</i> -cymene	1024	-	3.07
7	<i>p</i> -cymene	1025	2.1	3.31
8	β -phellandrene	1030	1.63	--
9	terpinolene	1089	0.56	0.48
10	carvacrol	1299	0.09	0.51
11	α -elemene	1338	1.37	5.6
12	α -copaene	1377	0.24	4.54
13	β -elemene	1391	7.32	--
14	β -caryophyllene	1419	2.07	--
15	aromadendrene	1441	0.3	0.46
16	α -humulene	1455	0.21	0.42
14	β -camigrene	--	--	1.6
17	allo-aromadendrene	1470	0.8	9.47
18	germacrene D	1485	7.41	--
19	bicyclogermacrene	1500	35.58	23.56
	elemol	1514	-	3.96
20	γ -cadinene	1523	0.51	0.4
21	Germacrene B	1561	--	13.71
22	spatulanol	1578	8.3	0.55
23	globulol	1585	1.66	--
24	viridiflorol	1593	0.85	1.2
25	γ -cadinol	1640	--	1.46
26	α -eudesmol	1654	0.52	0.53

RI: retention index; (-): not identified

As can be seen, both qualitative and quantitative differences were observed between the analyzed oils. Monoterpenes hydrocarbons were found to be the main chemical classe in both plant parts accounting for 82.46 % of the fruits EO and 89.78 % of the leaves EO. *S. terebinthifolius* fruits EO, was distinguishable from that of leaves EO by the abundance of sesquiterpenoid hydrocarbons which account 11.42 % of fruits EO against 4.25 % of leaves EO. Our results are similar to those of Affonso et al. [26] who revealed that the leaves and reddish fruits are rich in essential oil with high concentrations of monoterpenes along with some sesquiterpene hydrocarbons. Whatever the part of plant, monoterpenes hydrocarbons were dominated by bicyclogermacrene (35.58 % fruits against 23.56 % leaves). It is also important to notice that α - phellandrene (14.6 %), spatulanol (8.3 %), germacrene D 7.41% and α - pinene (7.37 %) were the most abundant compounds in the fruits EO. Whereas, germacrene B (13.71 %), α -phellandrene

(11.69%), α - pinene (9.63 %) and allo-aromadendrene (9.47 %) were among the major components of the leaves.

Different results were reported by [27, 28] who mentioned that GC-MS analysis of most leaves EO samples originating from India revealed α -pinene (15.01-51.82%) as the major component. Also, Silva et al. [29] studied the EO from leaf of the Brazilian pepper tree and revealed different results highlighting that the main components were *p*-cymen-7-ol (22.5%), 9-epi-(E)-cariophyllene (10.1%), carvone (7.5%) and verbenone (7.4%). Moreover, Bendaoued et al. [30] mentioned that, among 62 compounds identified in *S. terebinthifolius* fruits EO, a marked quantity of γ -cadinene (18.04%) was identified and the main constituents were α -phellandrene (34.38%), β -phellandrene (10.61%), α - terpineol (5.60%), *p*-cymene 7.34% and α -pinene (6.49%).

The essential oils from leaves, flowers and fruits of *S.terebinthifolius* from different locations have been previously investigated and some variation on their chemical composition have been observed by (Ibrahim et al., 2004; Singh et al., 1998; Malik et al., 1994). Moreover, a number of studies with leaf's essential oil of plants collected at different regions of the globe have shown distinct chemotypes by GC/MS analyses, and prevalence of distinct chemical compounds. For example, α -pinene (51,82%) in Indian plants, α -phellandrene (24,2%) in Egypt plants, limonene (17,7%) and *p*-cymene (15,7%) in Reunion Island plants [29].

3.3. Total Phenolic and Flavonoids Content of *Schinus terebinthifolius* Essential oils

Table 3 summarizes the results from the quantitative determination of the phenols and flavonoids of *S. terebinthifolius* fruits and leaves essential oils. Total phenolic content was determined as gallic acid equivalents in milligrams per gram essential oil (mg GAE/g EO) while total flavonoids content was calculated as myricetin equivalents in milligrams per gram essential oil (mg MYR/g EO).

Schinus terebinthifolius fruits essential oil showed a polyphenol content of 16 μ g / mL GAE which was lower than that found for leaves essential oil (40 μ g / mL GAE). On the other hand, our findings indicated that the flavonoids content of fruits was about 13 μ g / ml while that of leaves, was of 28 μ g / ml.

To the best of our knowledge this is the only comparative study between *Schinus terebinthifolius* leaves and fruits essential oil phenolics. Several studies showed that phenolics exhibit a wide range of biological effects including antibacterial, antiinflammatory, antiallergic, hepatoprotective, antithrombotic, antiviral, anticarcinogenic, and vasodilatory actions [31, 32]

Table 3: Total Phenolic and Flavonoids Contents of *S. terebinthifolius* Essential Oils

Samples	Total Phenolic Content (mg/mL)	Total Flavonoids Content (mg/mL)
Fruits EO	0.016	0.013
Leaves EO	0.04	0.028

3.4. Antioxidant activity of *Schinus terebinthifolius* Essential oils

DPPH can be used to determine the free radical scavenging activity as it forms a stable molecule on accepting an electron or hydrogen atom [33]. There was a reduction in the concentration of DPPH due to the scavenging effect of the essential oil. Essential oils and standard antioxidants reduced DPPH to yellow coloured product in a concentration dependent manner. Free radical scavenging properties of *S. terebinthifolius* essential oils are presented in Table 4. Leaves and fruits essential oils showed higher IC₅₀ value (96 μ g/mL and 82 μ g/mL, respectively) than that of the standard antioxidant BHT (IC₅₀ = 30 μ g/mL) indicating a low antioxidant capacity. Fruits essential oil had higher antiradical activity than leaves one.

Table 4: Antioxidant Activity of *S. terebinthifolius* Essential Oils

Samples	IC ₅₀ (μ g/mL)
BHT	30
Fruits EO	82
Leaves EO	96

To the best of our knowledge this is the only comparative study between *Schinus terebinthifolius* leaves and fruits essential oil antiradical activity. However, Bendaoued et al. [30] confirmed that the *S. terebinthifolius* essential oil possess antiradical activity.

This antiradical activity may be related to the presence of polyphenols in *Schinus terebinthifolius* Raddi leaves and fruits essential oil. In fact, phenolic phytochemicals are thought to promote optimum health partly via their antioxidant and free radical scavenging effects thereby protecting cellular components against free radical induced damage. But due to their diverse chemical structures, they are likely to possess different antioxidant capacities [34]. In addition, according to Tepe et al. [35], monoterpenes act as radical scavenging agents.

4. Conclusion

The objective of this work is to provide more useful information on the species *Schinus terebinthifolius* Raddi. Despite the richness of this plant on compounds with high added value, it is exploited neither commercially nor industrially. For that reason, a comparative study between leaves and fruits essential oils, was established. *Schinus terebinthifolius* fruits essential oil showed lower total phenolic and flavonoids content than the leaves one but higher antiradical activity. Bicyclogermacrene was the major volatile compound of both samples.

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