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CHEMOTYPE AND ANTIBACTERIAL ACTIVITY OF ALGERIAN POPULATIONS OF *PISTACIA LENTISCUS* L.

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ABSTRACT

The chemical composition of essential oil, isolated from leaves of *Pistacia lentiscus* L. by hydrodistillation, was analysed by GC and GC/MS. A total 58 components representing on average 99.23% of the total oil were identified. This oil is characterized by a high rate of three terpene components. The myrcene with an average (23.53 ± 32.28) is the dominant component. The α-pinene is the second produced with an average of (18.77 ± 13.12) and the limonene is represented with an average of (7.19 ± 15.43). This study has allowed us to highlight the presence of three chemotypes. To test the antibacterial activity of essential oil of *P. lentiscus*, four bacteria are used in this study. The oil showed a low antibacterial activity against Gram-negative and positive bacteria.

Keywords: *Pistacia lentiscus*, Essential oil, Chemotype, Antibacterial activity, Algeria.

INTRODUCTION

The essential oil of *Pistacia lentiscus* has been the subject of several studies [1-5] (Table 1). The chemical composition is very varied, it contains essential oil [6], fatty oil [7], the tannins [8], the flavonoic glycosides [9], anthocyanins [10], the resin "chios mastic" [11] and the triterpenes [12].

The essential oil of this species is rich in monoterpenes, sesquiterpenes and terpene esters [6, 13]. The essential oil of *P. lentiscus* is dominated by α-pinene [2, 14-19]. The dominant component in Greece differs from α-pinene [20]. The populations of Egypt are characterized by the Δ^3-carene [21].

The p-cymene characterizes the populations of Greece [22]. The essential oil of *Pistacia lentiscus* is highly appreciated in traditional medicine [4, 6, 13, 22-25]. It is used in aromatherapy and phytotherapy for its decongestant, and to treat venous problems including hemorrhoids [26]. The fruit oil of lentisk is used externally to treat topical burns or back pain [27]. The Mastic of *Pistacia* was used for the relief of abdominal pain, upset stomach, dyspepsia and peptic ulcer disease [28].

In Algeria the oil is used against bronchitis, asthma, sinusitis, dermatitis (psoriasis and lichen), burns, against the problems of the digestive system (ulcers, parasites). The Lentisk leaves are used to prepare a tea (6, 13, 23-24]. Oil is also highly esteemed in Tunisia for the same indications, in addition of his used for feeding of animals in northern Tunisia [29].

Different studies have been conducted on the biological activity of *P. lentiscus*. These studies have shown the presence of a significant antibacterial activity on certain bacterial strains [4, 14, 22, 25, 30-32]. The aim of this work was to investigate the chemical composition and antibacterial activity of essential oil of *P. lentiscus* growing in Algeria.

MATERIELS AND METHODES

Plant material

Samples of *Pistacia lentiscus* L. were collected in the flowering stage, of 10 localities in eastern Algeria (Figure 1). Aerial parts were collected in October 2014. The air dried materials were subjected to hydrodistillation for 3h using a Clevenger apparatus type. Voucher specimens were deposited in the herbarium of the Department of Ecology and Biology, Setif University, Algeria. The oil obtained was collected and dried over anhydrous sodium sulphate and stored at 4°C in sealed brown vials until use.

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Essential oil analysis

The essential oils were analysed on a Hewlett-Packard gas chromatograph Model 5890, coupled to a Hewlett-Packard model 5971, equipped with a DB5 MS column (30 m X 0.25 mm; 0.25 µm), programming from 50°C (5 min) to 300°C at 5°C/min, with a 5 min hold. Helium was used as the carrier gas (1.0 ml/min); injection in split mode (1:30); injector and detector temperatures, 250 and 280°C, respectively. The mass spectrometer worked in EI mode at 70 eV; electron multiplier, 2500 V; ion source temperature, 180°C; MS data were acquired in the scan mode in the m/z range 33-450. The identification of the components was based on comparison of their mass spectra with those of NIST mass spectral library [33, 34], and those described by Adams, as well as on comparison of their retention indices either with those of authentic compounds or with literature values [35].

Antibacterial activity

One Gram positive bacteria (*Staphylococcus aureus ATCC2592)* and four Gram negative bacteria (*Pseudomonas aeruginosa ATCC 27853, Escherichia coli ATCC 25922, Klebsiella pneumonea ATCC700603* and *Shigella* sp) were used in present study. The bacterial inoculums was prepared from overnight broth culture in physiological saline (0.8 % of NaCl) in order to obtain an optical density ranging from 0.08-01 at 625 nm. Muller-Hinton agar (MH agar) was poured in Petri dishes, solidified and surface dried before inoculation. Sterile discs (6 mm) were placed on inoculated agars, by test bacteria, filled with 10 µl of mother solution and diluted essential oil (1:1, 1:2 and 1:5 v/v of DMSO). DMSO was used as negative control. The antibiotic, Gentamicin, was used as positive control. Then Petri dishes were incubated at 37°C during 18 to 24h aerobically. After incubation, inhibition zone diameters were measured and documented.

Statistical analysis

Data were first subjected to Principal Components Analysis (PCA) to examine the relationships among the terpenes compounds and identify the possible structure of the population. Cluster analysis (UPGMA) was carried out on the original variables and on the Manhattan distance matrix to seek for hierarchical associations among the populations. The cluster analyses were carried out using Statistica v10 software.

RESULTS

The essential oil analysis of *Pistacia lentiscus* by GC-GC/MS has led to the identification of 58 components representing on average 99.23% of the total oil. The relative abundance of the components of these essential oils is represented in order of their appearances (Table 2).

The chemical composition is dominated by the presence of three terpene components; the myrcene with an average of (23.53 ± 32.28) is the dominant component. The highest rate is observed in Merouaha station (73.38%) and the lowest was recorded at the station Ait Idriss (0.9%). The α-pinene is the second produced with an average of (18.77 ± 13.12); the highest rate was observed in Ait Anane station (34.35%). The limonene is represented with an average of (7.19 ± 15.43), the highest rate is observed at Souk Lethnine station (50.81%).

The chemical composition of *P. lentiscus* contains other constituents with variable rates. From these results, we note the presence of heterogeneity in the chemical composition of essential oils of our populations. The composition of the essential oil of the populations shows notable differences. The concentration of identified components shows great inter-population variability. The three-dimensional spatial projection of populations based on three main axes from the ACP (Figure 2) shows the presence of three population groups: the first group formed by the populations of Derguina, Ain Smara and Merouaha, are characterized by a very high rate of myrcene. The populations of Ait Idriss, Kherrata, Bouakrez, Ait Anane, Amoucha and Constantine, form the second group, which is characterized by the presence of α-pinene mainly, while the population of Souk lethnine is isolated from other populations by the presence of limonene with a rate of 50.81%.

The UPGMA cluster analysis, based on the distance of the linkage, confirms the separation of our populations, in three distinct clades and confirms the results of the ACP (Figure 3). This separation indicates the presence of differences in the chemical composition of essential oils. The first clustration separates the group of populations of Derguina, Ain Smara and Merouaha, from the rest of the populations. In the second group, the population of Souk lethnine rich in limonene is isolated from the rest of the populations; the third cluster includes the remaining populations. These clustrations resulting from the UPGMA, indicates the presence of subdivisions based on chemical composition. The chemical particularity of each group comes from the genetic structure of populations, and who has given birth to Chemotypic individualisations. Chemotype to mycene characterizes the populations of Ain Smara, Derguina and Merouaha. The population of Souk lethnine has developed the chemotype to limonene-α-pinene. The chemotype to α-pinene is divided into two sub-chemotypes, the first to (α-pinene-β-pinene), localizes in (Kherrata, Bouakrez and Ait Idriss) regions, and the second sub-chemotype to (α-pinene-sabinene), is localized in the regions of Amoucha, Ait Anane and Constantine.

To compare the chemical composition of our populations to those of literature, we conducted a multivariate statistical analysis (UPGMA) that has divided the populations into two distinct clades (Figure 4). The observation of several population groups means that we have to do to heterogeneous subsets. The clades are composed of a amalgam of populations, the first clade is divided into two groups. The first group is formed mainly by populations of Algeria centre, characterized in β-caryophylene and δ-cadinene. In the second group we find our populations Derguina, Ain Smara and Merouaha, characterized by the chemotype at myrcene.

The second clade, divided in turn into two groups, the first includes the populations of Greece, Morocco, Iceland and the Turky. The second brings together the rest of our populations (Constantine, Ait Anane, Bouakrez, Ait Idriss, Amoucha and Kherrata), characterized by the chemotypes to α-pinène and limonene. This separation is mainly explained by the impact of environmental conditions, because the populations studied are spread over various regions of the Mediterranean.

The antibacterial activity of essential oils of *Pistacia lentiscus* is evaluated by the disc method. The effects of essential oils on the bacteria tested are expressed in mm, by measuring the diameter of the inhibition halos after 24 hours of incubation at 37°C (Table 3).

The bacterium *Pseudomonas aeruginosa* is resistant to the oil of the populations of Bouakrez, Ait Idriss, Souk Lethnine and Derguina; while it is very insensitive to the oil of Marouaha population, with a diameter of inhibition (8 mm). *Staphylococcus aureus* has low sensitivity to the action of the essential oil of the populations; it is resistant to the oil of Derguina population. The essential oil of all populations has a low activity against the bacteria, *Escherichia coli*, *Shigella* sp. and *Klebsiella pneumonea*. The strains Gram (-) are less sensitive or resistant to the essential oil of *Pistacia lentiscus*, by strains against Gram (+) are more sensitive.

DISCUSSION

The data presented here are not in agreement with those from Algeria [5, 36, 37], of Tunisia [3] and Morocco [2, 5]. Our chemical results of *P. lentiscus* oil differ considerably from those Ait Said *et al.*, [38], who give as principal components in the samples from the center of Algeria, δ-cadinene, β-caryophyllene, α-pinene and cubebol. The percentage of myrcene in our essential oil revealed a similarity to that described by Lamiri et al., [39]. In the Mediterranean region, several chemical compositions of oil of *P. lentiscus* were observed [2, 22, 40-41]. The myrcene, main component of our essential oil was found in populations of Algeria [5], Morocco [15], France [40], Spain [42], Italy [40] and Australia [16].

On the other hand, the α-pinene with a highest content was observed in Ait Anan population, is the second major product in the essential oil of the stations studied. This compound is also the major in essential oils of Algeria [5, 17, 36], Morocco [2], the Tunisia [3], Greece [4], Italy [22, 43], Spain [1] and France [40]. The Limonene is predominant in the population of souk lethnine; it is mainly present in the oils of the populations of France and Algeria [5, 38, 40], Iceland [4], Tunisia [44].

Essential oils of *P. lentiscus* are characterized by the presence of monoterpene major compounds. Previous studies show qualitative and quantitative differences in chemical composition, so different chemotypes were observed. It appears that environmental factors (geography, temperature, nutrients, etc.), play an important role in the chemical composition of the species. The genetic characteristics of the plant may also influence the occurrence of chemotypes.

The chemotype to myrcene, is reported in Morocco [39], France [45], Spain [42], Italy [40] and Algeria [5]. On the other hand, the chemotype to α-pinene was identified in Morocco [2], Algeria [5, 36], Tunisia [3], Greece [4], Italy [22, 43], Spain [1] and France [45]. While the chemotype to terpinen-4-ol was mainly present in the oils from Morocco [2], Algeria [43], Turkey [20, 46] and France [45]. Other chemotypes were also reported: to longifolene from Algeria [36]; limonene from France and Algeria [5, 36]; α-caryophellene from Algeria [5] and Italy [19]. Egyptian oil contained a chemotype to Δ^3-carene [19]. The strains Gram (-) are less sensitive or resistant to the essential oil of *Pistacia lentiscus*, by strains against Gram (+) are more sensitive, while the work of Bonsignore and Cottiglia, [47] show that *Pistacia lentiscus* has no activity against Gram (-) and Gram (+). Tassou and Nychas, [48] and Shelef *et al*, [49] noted that the Gram (+) bacteria is more sensitive to essential oil as Gram (-). The essential oil of *P. lentiscus* has bacteriostatic activity [50]. The high resistance of bacteria Gram (-) has been attributed to the existence of an outer phospholipid membrane, almost impermeable to lipophilic compounds [51].

The essential oils rich in α-pinene, show a potential antibacterial activity [30, 52]; while Magiatis *et al.*, [50] and Delazar *et al.*, [53] show the opposite. The antimicrobial activities of the essential oil of *Pistacia lentiscus* are difficult to correlate with a specific compound because of their complexity and variability. Nevertheless, some researchers have reported that there is a relationship between the chemical composition (chemotype) and the antimicrobial activity [31].

CONCLUSION

This study is a contribution to the understanding of *P. Lentiscus*, from the perspective chemical composition and antibacterial activity. Analysis of the chemical composition of essential oils by GC-GC/MS showed a great variability in the chemical composition of essential oils of *P. lentiscus* populations. This composition is characterized by the presence of major compounds, the myrcene, the α-pinene and limonene.

This study has allowed us to highlight the presence of three chemotypes. The populations of Ain Smara, Derguina and Merouaha contain the chemotype to mycene, while the population of Souk-lethnine has favored the development of chemotype in limonene; the chemotype to α-pinene characterizes the rest of populations. The evaluation of the antibacterial activity of our oils was performed on five bacterial strains with gentamicin as control negatif. Our oils have a low antibacterial activity.

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Table 1. Chemical composition of essential oil of *Pistacia lentiscus*

Populations	Authors	α-pinene	Camphene	Ssabinene	β-pinene	Myrcene	α-phellandrene	Δ3-Carene	limonene	β-Phellandrene	γ-terpinene	terpinen-4-ol	α-terpineol	Caryophyllene-E	α-humulene	γ-muurolene	germacrene D	α-muurolene	β-bisabolene	γ-cadinene	Λ-cadinene	Caryophyllene ox	α-cadinol	β-caryophyllene	cubebol	p-cymene	β-myrcene
S1	**A**	-	1.3	-	-	-	-	-	-	-	-	-	-	-	1.1	-	-	-	-	-	-	-	-	24.2	-	-	-
S2	**B**	4.2	1	-	1.9	-	-	-	10.6	-	-	29.9	11.6	-	-	-	-	-	-	-	-	-	-	3.2	-	-	-
S3	**C**	11.4	0.7	0.7	1.4	-	0.8	-	9.2	-	2.4	7	2.1	-	-	-	1.8	-	-	-	1.7	1.1	-	-	-	5	-
S4		15	0.7	2.8	4.2	-	0.7	-	10.8	-	2	4.1	1.5	-	-	-	2	-	-	-	0.9	0.7	-	-	-	2.1	-
S5		6.5	-	4.6	2	-	-	-	6.2	-	2.1	6.9	2.8	-	1.1	0.8	9.3	-	-	1	2.3	-	-	-	-	-	1.2
S6	**D**	2.9	-	-	2.2	39.2	-	-	10.3	-	-	1.6	-	-	2.6	-	4.3	2.7	-	-	2.5	-	-	-	-	-	-
S7	**E**	24.3	2.3	-	12.6	2.1	1.2	-	7.6	-	4.5	7	4.9	-	-	-	-	-	-	-	-	-	-	3.2	-	-	-
S8	**F**	-	6.1	-	13.2	-	1.3	-	2.6	8.9	2.8	-	1.1	-	3.1	1.4	8.5	2.5	-	2.5	4.6	1.1	-	22.2	-	-	-
S9		-	-	-	-	-	-	-	-	-	-	-	-	-	4	6.9	7.4	8.4	-	-	12.3	-	-	13.5	-	-	-
S10	**G**	7.5	2.1	6.2	1.1	-	-	-	8.1	-	6	19.3	-	-	-	-	-	-	-	-	-	10.3	-	1.7	-	-	2.3
S11		38.5	2.5	3.1	4.2	-	-	-	9.8	-	1.4	-	-	-	-	1.1	-	-	-	-	-	-	-	-	-	1.5	11.5
S12		11.9	1.4	4.9	6.1	-	-	1.7	4	-	-	39.3	-	-	-	-	-	-	-	-	-	1	-	4.7	-	1.5	2.6
S13	**H**	16.8	4	5.7	4.3	1.2	-	-	-	8.9	5.5	-	-	-	-	-	3.30	-	-	-	2.1	-	-	1.9	-	-	-
S14	**I**	6.3	-	5.8	2.4	3.90	1.5	-	-	3.7	-	1	-	-	2.4	2.9	19.9	1.6	1.1	8.7	4.2	-	-	6.6	-	-	-
S15	J	1	-	-	-	1.3	-	65.3	4.6	-	-	-	-	-	-	-	-	-	3.4	-	-	4.1	-	-	-	-	-
S16	**K**	9.5	1	1.4	3.3	1.1	3.2	2.8	19.1	-	-	1.5	2.1	-	-	-	-	-	-	-	-	-	-	1.1	-	-	-
S17	**L**	5.5	3.2	-	5.1	-	3.8	-	-	-	4.1	6.4	3	-	-	-	-	-	-	-	1.8	-	-	-	-	1.6	15.2
S18	**M**	8.5	-	0.9	2.2	-	2.7	-	1.2	-	2.4	6.4	5	-	1	-	4.8	1	-	-	2.43	-	-	6.49	-	-	14.5
S19	**N**	-	-	-	-	-	-	-	-	-	-	-	-	14.7	3.5	3.6	18.6	2.9	1.6	1.04	11.1	-	5.4	-	-	-	-
S20	**O**	20.4	3.6	2.5	3.5	-	-	-	3	2.9	-	14.2	1.9	-	-	-	-	-	-	-	1.1	-	-	1.3	-	14.8	18.3
S21		19.2	2.3	1.2	5.5	-	-	-	3.8	3.8	1.3	15.1	3.2	-	-	-	1.7	-	-	-	1.1	-	-	2.3	-	9.9	19.4

Table 1. Continued

Populations	Authors	α-pinene	Camphene	Sabinene	β-pinene	Myrcene	α-phellandrene	Δ3-Carene	imonene	β-Phellandrene	γ-terpinene	terpinen-4-ol	α-terpineol	Caryophyllene-E	α-humulene	γ-muurolene	Germacrene D	α-muurolene	β-bisabolene	γ-cadinene	Δ-cadinene	Caryophyllene ox	α-cadinol	β-caryophyllene	Cubebol	p-cymene	β-myrcene
S22	**O**	14.8	1.1	3.7	2.6	-	4.9	-	-	3.1	6.6	19.7	2.6	-	-	-	5.1	-	-	-	2.7	-	-	1.7	-	1.6	10.4
S23		21.6	1.9	3.9	4.3	-	10.8	-	1.8	5.4	5.2	19.8	1.8	-	-	-	2.1	-	-	-	1.5	-	-	1.2	-	2.2	1.4
S24		22.7	1.6	8.1	3.6	-	-	-	2.2	2.4	-	28.3	2.7	-	-	-	-	-	-	-	-	-	-	-	-	16.2	-
S25		63.3	-	-	3.3	-	-	-	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25
S26	**P**	28	-	-	4	39	-	-	11	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S27	**Q**	1.3	0.1	-	1.9	-	-	-	0.4	-	0.3	0.9	0.4	-	3.5	5.2	3.9	2.6	3.6	2.6	9.9	10.2	2.6	15.9	2.7	0.1	-
S28	**R**	1.3	0.1	-	1.8	-	-	-	0.4	-	0.3	0.7	0.3	-	3.4	5.2	3.7	3.02	3.8	2.6	10.5	9.9	3	14.3	2.8	0.2	-
S29		0.3	0.1	-	0.4	-	-	-	0.2	-	0.1	0.4	0.1	-	2.5	4.4	1.9	3.3	9.8	1.5	13.6	6.6	2.6	8.7	13.8	0.1	-
S30		0.4	0.1	-	0.5	-	-	-	0.2	-	0.1	0.3	0.1	-	2.3	4.5	2	3.2	9.3	1.7	12.2	7	3.1	7.9	12.2	0.1	-
S31		0.6	0.1	-	0.9	-	-	-	0.2	-	0.2	0.3	0.2	-	2.2	4	1.5	3	8.5	3.1	11.2	8	2.8	6.5	12.7	0.1	-
S32		0.2	0.1	-	1	-	-	-	0.5	-	0.4	0.5	0. 2	-	3.1	5.4	1.6	4.1	9.4	2.8	15.	4.6	1.8	8.1	10.5	0.2	-
S33		0.6	0.4	-	1.4	-	-	-	0.7	-	0.7	0.9	0.4	-	2.1	4.2	2.3	2.8	4.8	4.4	10.3	5.9	3.3	8.1	7.1	0.4	-
S34		0.8	0.2	-	2.1	-	-	-	0.5	-	0.4	0.7	0.3	-	3.1	4.8	3.2	2.82	3.6	3.8	8.8	10	3.2	14	3.3	0.2	-
S35		0.3	0.1	-	0.6	-	-	-	0.3	-	0.2	0.5	0.1	-	3.2	4.1	3.6	3.5	8.5	2	13.2	6.4	3.2	11.4	9.6	0.1	-
S36		1.5	0.2	-	1.6	-	-	-	0.4	-	0.3	0.7	0.1	-	3.3	4.1	4.2	2.7	4.1	2.3	9.2	7.9	2.2	16	4.3	0.2	-
S37		8.2	1.2	-	3	-	-	-	1	-	0.6	2.1	0.4	-	2.5	4.8	3.2	3.5	4.5	2.3	11.9	4.7	1.6	14.4	4.6	1.2	-
S38		7.1	1.3	-	2.8	-	-	-	1	-	0.6	2.1	0.5	-	2.6	4.5	3	3.9	4.3	2.1	11.2	5.2	1.9	13.3	4.4	1.2	-
S39		7	1.2	-	5.4	-	-	-	3. »	-	0.7	3.9	0.6	-	2.7	3.7	4.1	2.3	4	1.8	8.1	4.5	1.7	14.4	4	2	-
S40		6.9	1.1	-	3.1	-	-	-	1.2	-	0.6	1.9	0.5	-	2	4.5	3.8	3.7	4.4	2.6	11.6	4.7	2.1	13.2	4	1.2	-
S41		7.1	1.5	-	2.2	-	-	-	0.9	-	0.8	2.2	0.6	-	3	4.2	1.7	4	4.1	1.5	10	6.4	1.7	12.6	4.7	1.4	-

S1, S13, S16, S17 (Tunisia); S2 (Turkey); S3, S4, S5 (Iceland); S6, S7, S10, S11, S12 5Morocco); S7, S8 (Sardinia); S14, S19 (Italy); S15 (Egypt); S18, 20-12 (Greece); S26 (Austria); S27-S41 (Algeria); A= Bachrouch *et al.*, 2010b; B= Duru *et al.*, 2002; C= Chryssavgi *et al.*, 2007; D= Amhamdi *et al.*, 2009; E= Derwich *et al.*, 2010; F= Congiu *et al.*, 2001; G= Zrira *et al.*, 2003; H= Ben Douissa *et al.*, 2004; I= Quartu *et al.*, 2012; J= Aboutabl *et al.*, 1991; K= Bachrouch *et al.*, 2010a; L= Djenane *et al.*, 2011; M= Mans *et al.*, 1991; N= Lo Presti *et al.*, 2008; O= Barra *et al.*, 2007; P= Koutsoudaki *et al.*, 2005; Q= Grant-Wyllie *et al.*, 1990; R= Ait Said, 2011.

Table 2. Chemical composition of *Pistacia lentiscus*

Populations	KI	Constantine	Derguina	Ait Idriss	Ain Smara	Ait Anane	Merouaha	Bouakrez	Souk Lethnine	Kherrata	Amoucha	Avereage	SD
Total (%)		99,27	98,4	99,29	98,68	99,57	99,36	99,53	99,24	99,23	99,52		
Tricyclene	922	0,49	-	1,24	-	0,67	0,1	1,17	0,33	0,25	0,17	0,44	0,45
α-thujene	926	0,35	-	0,34	-	0,19	-	0,13	-	-	0,2	0,12	0,14
α-pinene	933	20,08	2,45	28,91	1,23	34,35	1,88	23,38	14,09	33,59	27,7	18,77	13,12
Camphene	949	1,69	-	4,09	0,12	2,81	0,33	4,72	1,64	1,29	0,81	1,75	1,64
Sabinene	972	7,74	-	11,75	0,11	3,86	0,42	4,01	0,33	0,5	13,75	4,25	5,14
β-pinene	977	1,53	0,29	9,94	0,51	4,6	0,6	14,88	7,7	21,18	1,52	6,27	7,16
Myrcene	989	1,18	71,96	0,9	64,03	1,58	73,78	3,09	5,7	12,21	0,91	23,53	32,28
α-phellandrene	1006	14,71	0,18	2,34	0,12	6,77	-	0,25	0,14	0,44	0,35	2,53	4,76
Δ^3-carene	1007	1,9	0,15	-	0,18	-	0,11	-	-	-	0,1	0,24	0,59
α-terpinene	1017	-	-	3,19	-	1,84	-	1,55	0,28	0,31	2,68	0,98	1,23
Ortho-cymene	1025	1,81	0,07	1,45	-	0,84	0,11	0,22	-	0,12	0,76	0,54	0,65
Limonene	1030	5,62	0,25	3,88	0,51	3,63	0,23	2,08	50,81	3,04	1,85	7,19	15,43
β-phellandrene	1031	4,17	0,46	3,74	0,57	2,82	0,53	2,75	-	3,77	1,59	2,04	1,59
β-ocimene-(Z)	1036	-	0,11	-	0,16	1,11	-	0,16	2,11	0,52	-	0,42	0,69
β-ocimene-(E)	1047	-	-	-	-	3,73	-	-	-	-	-	0,37	1,18
Pentyl isobutanoate	1057	0,07	0,35	0,15	0,54	-	0,51	0,01	-	-	-	0,16	0,22
γ-terpinene	1058	2,4	0,05	4,97	0,15	2,64	0,08	2,68	0,43	0,4	4,26	1,81	1,84
Terpinolene	1085	1,07	0,15	1,4	0,2	0,86	0,25	0,81	0,76	0,5	1,1	0,71	0,42
Nonanone-2-	1091	0,87	0,12	0,19	0,2	0,28	0,27	0,17	-	-	-	0,21	0,26
Linalool	1100	0,17	0,32	-	0,21	0	0	0,23	-	0,18	-	0,11	0,12
Isopentyl isovalerate	1105	-	0,15	0,3	-	0,14	0,2	0,1	-	-	0,16	0,11	0,1
Menth-2-En-1-ol-cis	1126	0,19	-	0,21	-	0,27	-	-	-	0,09	0,23	0,1	0,11
Terpinen-4ol	1183	4,84	0,17	8,4	0,38	5,01	0,43	3,72	0,58	0,51	11,73	3,58	3,99
α-terpineol	1198	0,99	0,08	1,19	0,68	1,28	0,4	1,22	0,89	1,64	1,13	0,95	0,46
Isoamyl hexanoate	1251	-	0,19	0,12	0,35	0,09	0,25	0,09	-	-	-	0,11	0,12
Bornyl acetate	1286	0,4	-	1,49	-	0,77	-	1,3	1,16	0,06	-	0,52	0,61
Undecanone-2	1294	0,54	0,29	1,18	0,53	0,51	0,34	0,52	0,43	0,31	0,2	0,48	0,27
δ-terpinyl acetate	1315	-	-	0,24	0,55	-	0,1	-	-	0,58	-	0,15	0,23
α-cubebene	1349	0,16	-	-	3,09	-	0,06	0,09	-	-	-	0,34	0,97
β-copaene	1379	0,11	-	-	0,31	0,12	0,06	0,21	-	0,29	0,19	0,13	0,12
β-bourbonene	1388	-	-	0,21	0,1	0,07	-	0,41	-	0,12	0,1	0,1	0,13
β-elemene	1392	1,09	0,32	0,19	0,9	0,55	0,77	0,9	0,27	0,56	0,93	0,65	0,32
caryophyllene-(E)	1425	6,6	9,51	3,31	3,3	2,41	3,11	5,9	1,73	2,59	3,07	4,15	2,42
α-copaene	1435	0,69	-	-	0,43	0,52	0,43	0,83	0,14	0,17	0,47	0,41	0,27
Methyl butyl-benzoate	1443	-	0,38	0,21	0,14	0,17	0,14	0,36	-	-	0,28	0,17	0,14
δ-elemene	1449	-	-	-	-	0,37	-	-	-	-	-	0,04	0,12
Isoamyl octanoate	1450	-	0,47	-	0,15	0,09	-	0,09	-	-	0,33	0,11	0,16
Muurola-4(14)5-diene	1454	0,25	-	-	0,54	0,3	0,25	0,41	0,38	-	0,26	0,24	0,19
α-humulene	1461	1,31	1,1	0,31	0,83	0,97	0,7	1,23	0,46	0,58	1,2	0,87	0,35
Aromadendrene--allo	1466	0,4	-	-	0,24	0,39	0,2	0,45	0,17	0,17	0,5	0,25	0,18
Cadina-1(6)-4-diene	1477	0,21	0,07	-	0,24	0,25	0,18	0,45	-	0,09	0,11	0,16	0,14
α-muurolol	1480	0,26	0,35	-	0,26	-	0,33	0,5	0,3	0,24	0,22	0,24	0,15
Germacrene-D	1487	7,34	1,12	1,52	7,4	6,49	4,07	6,02	5,05	7,28	14,31	6,06	3,7
α-muurolene	1498	1,26	0,44	-	0,61	0,93	0,6	1,16	0,16	0,33	1	0,65	0,43
γ-muurolene	1503	1,03	0,12	-	0,74	0,9	0,73	1,3	0,22	0,35	0,75	0,61	0,42
α-farnesene<(E, E)	1506	0,23	0,41	0,27	0,45	-	0,14	0,52	-	0,61	-	0,26	0,23
γ-cadinene	1519	0,22	0,16	-	0,12	0,19	0,18	0,34	-	0,12	0,15	0,15	0,1
δ-cadinene	1522	2,89	0,85	0,38	2,1	2,1	2,3	3,12	0,6	1,02	1,8	1,71	0,96
Zonarene	1528	0,25	0,18	-	0,25	0,22	0,23	0,48	0,05	0,12	0,1	0,19	0,13
Germacrene-B	1566	-	0,23	-	0,27	-	0,14	0,6	0,04	0,24	0,18	0,17	0,18
Caryophyllene oxide	1590	0,09	0,46	0,29	-	0,04	0,09	0,55	-	-	-	0,15	0,21

Cubenol-1-epi	1635	0,36	0,22	-	0,64	0,35	0,47	1,07	0,21	0,47	0,3	0,41	0,29
α-cadinol	1650	0,69	1,48	0,41	1,19	0,42	1,06	0,95	1,14	1,13	0,72	0,92	0,35
Muurola-3,5-diene	1652	0,07	0,14	-	0,24	0,21	0,09	0,32	-	0,07	0,24	0,14	0,11
α-muurolol-epi	1654	0,45	0,82	0,1	1,12	-	1,21	1,63	-	0,83	0,56	0,67	0,55
α-cadinol-epi	1664	0,5	0,49	0,12	0,84	0,86	-	-	0,94	0,36	0,22	0,43	0,36
α-bisabolol	1692	-	0,76	0,36	0,36	-	0,35	0,29	-	-	0,33	0,24	0,25
Benzyl benzoate	1777	-	0,53	-	0,49	-	0,55	0,11	-	-	-	0,17	0,25

Table 3. Antibacterial activity of essential oils of *Pistacia lentiscus*

		Ait Anane				Bouakrez				Ait Idriss			
Dilution	A	1	0.5	0.2	0.1	1	0.5	0.2	0.1	1	0.5	0.2	0.1
Pseudomonas aeruginosa ATCC27853	22	10	11	14	13	0	0	0	0	0	0	0	0
Staphylococcus aureus ATCC25923	18	19	18	13	9	8	7	8	7	9	8	8	8
Escherichia coli ATCC25922	25	21	13	12	10	20	12	11	13	11	10	10	9
Shigella sp	30	13	12	11	10	9	8	9	10	12	9	8	7
Klebsiella pneumonea ATCC700603	23	10	9	9	7	8	8	8	7	0	7	8	8
	A	Souk Lethnine				Derguina				Merouaha			
Pseudomonas aeruginosa ATCC27853	22	0	0	0	0	0	0	0	0	0	8	8	8
Staphylococcus aureus ATCC25923	18	11	7	8	7	0	0	0	0	9	9	9	10
Escherichia coli ATCC25922	25	10	10	8	11	8	8	0	0	9	12	12	7
Shigella sp	30	14	9	9	7	7	9	0	9	9	0	8	9
Klebsiella pneumonea ATCC700603	23	0	9	0	9	7	9	0	7	0	0	8	9
A= Gentamicine													

Figure 1. Stations sampled of *Pistacia lentiscus*.

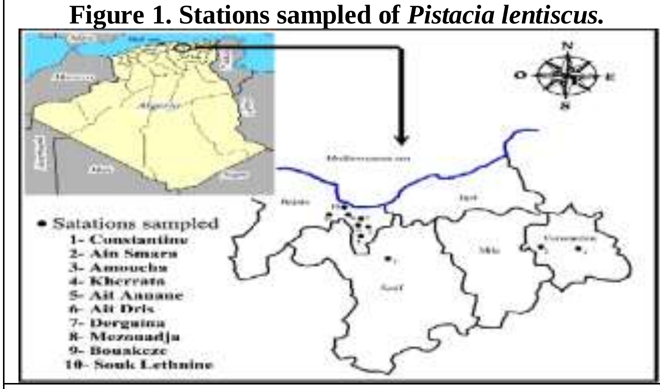


Figure 2. Spatial projection of population *Pistacia lentiscus*

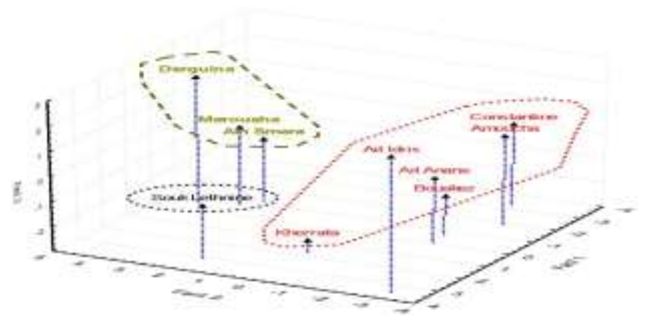


Figure 3. UPGMA cluster and chemotypes of *Pistacia lentiscus*.

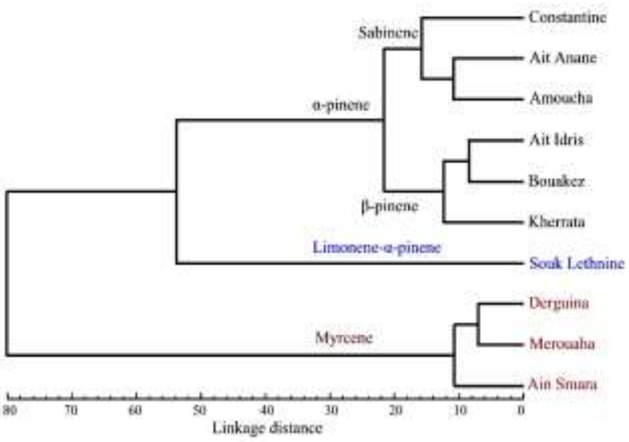
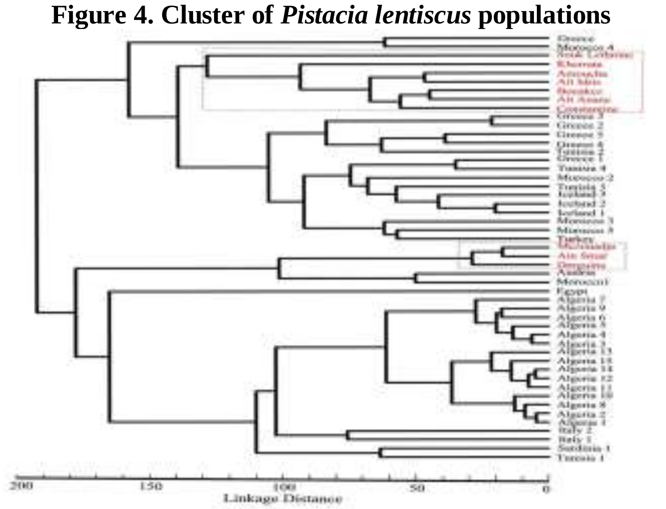


Figure 4. Cluster of *Pistacia lentiscus* populations



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CONFLICT OF INTEREST: NIL

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