Characterization of Essential oils and hydrosols from senegalese *Eucalyptus camaldulensis* Dehnh.

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ABSTRACT

The volatile oils of *Eucalyptus camaldulensis* leaves harvested in three agro-ecological areas in Senegal were analyzed by GC-FID and GC-MS. The yields ranged from 0.5 to 1.0%. Qualitative and quantitative differences were determined in the composition according to leave sources. The main compounds of Saint-Louis oils were: 1,8-cineole (69.3-73.0%) and limonene (12.4-13.5%) whereas those from Kaolack were characterized by p-cymene (28.4-32.6%), 1,8-cineole (16.8-20.0%), α-pinene (8.7-11.6%) and limonene (7.8-8.3%). While those plants from Dakar revealed high content of β-pinene (25.3-34.4%) and α-eudesmol (12.3-20.6%). During drying of leaves, the proportions of all major compounds (except limonene) increased and were optimal after 2 hours hydrodistillation duration. As in oils, 1,8-cineole was the major compound in hydrosols from Saint-Louis and Kaolack (77.3% and 39.0% respectively), Dakar floral water showed: α-terpineol (20.3%), 1,8-cineole (12.6%), trans-pinocarveol (9.9%), α-eudesmol (9.8%) as major compounds. *E. camaldulensis* from Saint-Louis is a source of essential oils that could be used in pharmaceutical and cosmetic applications.

Key words: *Eucalyptus camaldulensis***,** essential oils, floral waters, 1,8-cineole, β-pinene, p-cymene. .

Introduction

Senegalese climatic conditions allow the development of several wild and cultivated plants including some species known to contain compounds that are greatly requested by food, cosmetic, and pharmaceutical manufacturers. Spices and essential oils from plants are well known for their various beneficial effects on human health. Indeed the use of aromatic plants and spices in food manufacturing or phytotherapy is mostly due to the essential oils which influence their various technological properties or biological activities, such as flavor, antimicrobial, spasmolytic, carminative, hepatoprotective, antiviral, and anticarcinogenic agents (1, 2).

Nowadays, several techniques for essential oils extraction have been developed. These methods include: expression, steam distillation, extraction with volatile solvents, and extraction by supercritical CO_2. The type of extraction process directly influences the quality of the essential oils, and the yields of the extractions. Hydrodistillation is one of the main methods recommended by the standards to have an extract that can be classified as an essential oil. It is the most common and most accessible approach for extracting essential oils.

The Senegalese industry uses several varieties of essential oils. The country import all of these products needed in the diverse economic activities. The market represents 182 T per year and attained around 434 000 US $ in 2014 (3). This observation has supported the establishment of an international project aimed to implement new diversified systems of production of endemic aromatic plants in the perspective of strengthening development and growth of self-supporting local agro-industries.

In order to investigate the Senegalese potentialities in the field of essential oil production by hydrodistillation, a series of trials has been designed with the goal to:

i. explore the biodiversity of Senegalese essential oil bearing plants

ii. evaluate the valorization of different sources of essential oils selected,

iii. establish a pilot plant for hydrodistillation at the University Gaston Berger (Saint-Louis),

iv. estimate the sustainability of this potential activity and finally suggest guidelines for the valorization of essential oils in Senegalese local economy.

In this context a series of investigations have been carried out to study specific resources among which *Eucalyptus calmadulensis* (phase i.). Eucalyptus (Myrtaceae), considered native from Australia, is a widespread plant genus with more than 700 species wildly grown in many parts of the world (4). This tree furnishes one of the most-extensively planted pulpwood. According to Sadio et al. (5), *E. camaldulensis* Dehnh. is a species able to adapt to various climatic and edaphic conditions. The genus has been introduced in Senegal to prevent desertification and to satisfy population’s needs for wood because of its easy adaptability, rapid growth and tolerance to hydric stress (5-7).

Used throughout the world as a traditional herbal remedy, eucalyptus leaves and their essential oils have found various applications in everyday life due to their antiseptic, anti-inflammatory and antipyretic properties (2, 8).The essential oils of *E. camaldulensis* are used in perfumes and as a food flavoring material (9, 10). It has also been proved that *E. camaldulensis* oils have larvicide effects (11) moreover Cheng et al. (12) showed the effectiveness of eucalyptus essential oils against mosquito larvae. Monoterpenes and sesquiterpenes that are the majors constituents of essential oils have repulsive and pharmacologic (antibacterial, antifungal antiviral) activities (13-15). The fight against anopheles with repellent products (essential oils or plant-emitted Volatile Organic Compounds, VOCs) (16) seems to be, at least locally, a good alternative to synthetic formulations whose bio-active constituents lead often to insect resistance and toxicity for man and other living organism.

Some studies focusing on *E. camaldulensis* essential oil composition extracted from plants of different origin, reported a high content of 1,8-cineole: from 43.4% to 69.46% (4, 11, 18 - 20). Nevertheless other indicated low proportions of 1,8-cineole: 2.0-7.6% (21), 9.5% (12).

Aqueous distillate also called floral water or hydrosol is the co-product of hydro-distillation and steam distillation of plant materials. Floral waters contain traces of essential oils and several water soluble components. They are mainly valorized in cosmetic preparations, and care products (22) and also as food flavoring substances (23). Some investigations focused on the constituents of floral water show that their chemical composition is largely dominated by oxygenated lightly water-soluble compounds (24, 25).

E. camaldulensis trees have been listed in the six agro-ecological areas across Senegal. Three of them named, “Niayes”, (Dakar) “Fleuve Sénégal” (Saint-Louis), and “bassin arachidier” (Kaolack) areas have been selected within the field of the present study.

The present original paper reports an investigation focused on the yield, and the chemical composition of the essential oils extracted from leaves of endemic *E. camadulensis* harvested in three agro-ecological areas in Senegal. Since different factors are able to strongly influence yield and composition of essential oils (17), drying conditions and extraction duration have also been taken into account. Beside essential oils, the residual volatile components in aqueous distillates (hydrosols) were also determined.

Experimental

***Eucalyptus camaldulensis* leaves**

The leaves of *Eucalyptus camaldulensis* were harvested in August 2014 (same phenological stades) in three agro-ecological areas of Senegal:

a.“Niayes” area (Dakar) characterized by a very close water table, a mild and humid maritime climate and a strong and relatively constant winds,

b. “Fleuve Sénégal” area (Saint-Louis) characterized by the weakness and the irregularity of the rains with a humid climate

c. “Bassin arachidier” area (Kaolack) characterized by problems of drying up of water points and salinization of the water table.

Identification of species was confirmed in the Plant Biology Department of Cheikh Anta Diop University (Dakar). Voucher specimens of samples were deposited in the herbarium of “Institut Fondamental d’Afrique Noire” (IFAN) of Cheikh Anta Diop University (Dakar) with the references IR1, IS1 and NG1 for Dakar, Saint-Louis and Kaolack origins, respectively.

Leaves drying processing and duration

Fresh leaves collected were washed with tap water and dried at room temperature for 03, 07, 14, and 21 days in the shade. The drying process efficiency was monitored by weighting biomass using a RADWAG electronic balance.

Extraction of Essential oils

For each sample, 100 g of dried leaves were submitted to steam distillation for 2 hours and 4 hours (with 1.5 L water) using a Clevenger-type apparatus. Oil yields have been calculated relative to the fresh matter and the presented results are the mean ± standard deviation of triplicates.

Extraction of the volatile constituents from aqueous distillates

A liquid-liquid extraction method was undertaken to isolate components of aqueous distillates which were recovered after essential oil hydrodistillation. In a separatory funnel, 20 mL of aqueous hydrosols and 4 mL n-hexane were mixed for 5 min. at room temperature. After decantation, the extracts have been dried over anhydrous sodium sulphate and analyzed.

Gas chromatography

Oils and extracts from aqueous distillates have been analyzed by gas chromatography fitted with a flame ionization detector (GC-FID) and gas chromatography coupled with a mass spectrometer (GC-MS).

GC-FID: The gas chromatograph fitted with a flame ionization detector (Thermo-Trace, Interscience, Belgium) was equipped with an optima-5-MS Accent capillary column from Agilent (Belgium) (30m long, 0.25mm diameter and 0.50 µm film thickness for a complete resolution of 1,8-cineole and limonene which co-eluted with thinner stationary phases). The oven temperature ranges from 40 to 250°C according to the following program: 40 °C for 3 minutes and then a programmation at 5° C / min until 250°C with a final hold of 5 minutes at this temperature. Helium (He) was used as carrier gas at a flow rate of 1.1ml/min. The injector used in splitless mode was set at 280° C. The detector (FID) temperature was 280°C. The FID runs with compressed air (at a flow of 350 mL/min) and hydrogen (35 mL / min). A make-up gas (N_2) was used with a flow rate of 30 mL/min.

GC-MS: The gas chromatograph (Agilent 6890- USA) equipped with MS (Agilent 5973 NETWORK mass selective detector) in the electron impact mode (70 eV) source and quadrupole temperatures were of 280°C and 150°C respectively. The scanned mass range was fixed at 35 to 350 amu. The column was the same than GC-FID. The oven temperature was programmed as follows: isotherm of 5 min at 40 °C then a progression of 8°C/minute up to 280°C with a final hold of 5 minutes at 280°C. The injector, used in splitless mode, was at

240 °C. 1 µl of each sample was injected. The carrier gas was Helium (He) with a constant flow rate of 1.1 mL/min. The identification of the compounds was made using data of computer library (Wiley 275L) connected to the GC-MS and retention indices of components calculated using retention times of n-alkanes (C7-C30) (26) compared with those of the literature (27, 28). Whenever possible, the identifications were confirmed by comparison of the recorded retention data with those of pure standard compounds such as α-pinene (268070), β-pinene (402753), myrcène (64643), α-phellendrene (W285609), p-cymene (C121452), limonene (62118), 1,8-cineole (C80601), α-terpinolene (586485), γ-terpinene (86478), bornéol (15598), linalool (L2602), α-terpineol (30627), terpinen-4-ol (86477) and β-caryophillene (W225207) from SIGMA ALDRICH (Boornem, Belgium) injected in the same conditions.

Results and Discussion

Essential oil yields

The yield of essential oils extracted for 2 and 4 hours from leaves of *E. camaldulensis* varied from 0.5 to 1% depending on growing site, the drying time and the extraction duration (Table 1 and 2). They increased with the extraction duration. Compared to the results of Cheng et al. (12), Alain et al. (29) and Batish et al. (30) reporting 0.5%, 0.2% and 0.6% oil yields respectively, extractions of plant samples from Dakar and Saint-Louis areas revealed higher recoveries. The essential oil yield of leaves harvested in Saint-Louis was in line with those from Dakar but higher than Kaolack's yield. Gilles et al (31) reported that climate; genotype, growth location and harvesting regime can affect the total essential oil content of plants.

Essential oils chemical composition

Essential oil compositions are listed in Tables 3 and 4. Forty-nine components were identified in essential oils of *E. camaldulensis* leaves collected in Kaolack, forty in those of

Saint-Louis and fifty-seven in those from Dakar representing from 93.2% to 99.4% of the total. Oils from Saint-Louis were very rich in monoterpenes among which oxygenated molecules (mainly 1,8-Cineole) were the most abundant (from 74.6 to 78.7%) followed by hydrocarbon monoterpenes (16.7 - 17.8%). *E. camaldulensis* essential oils from Dakar and Kaolack were dominated by hydrocarbon monoterpenes (38.6 – 53.1% and 58.4 - 63.2% repectively), by oxygenated sesquiterpenes (26.2 – 41.0%) in essential oils from Dakar and by oxygenated monoterpenes (27.2-32.2%), in Kaolack oils. Monoterpenes has various pharmacological properties as antifungals, antibacterials, antioxidants and anticancer (13). In samples from Saint-Louis, 1,8-cineole and limonene were the main constituents, with 69.3-73.0% and 12.4-13.5% respectively. Eucalyptus essential oils of this region refer more closely to data reported for commercial products (32).

The major components of *E. camaldulensis* oils from Kaolack were p-cymene (28.4 - 32.6%), 1,8-cineole (16.8 - 20.0%), α-pinene (8.7 - 11.6%) and limonene (7.8 - 8.3%). Oils from Dakar contained β-pinene (25.3 - 34.4%) and α-eudesmol (12.3 - 20.6%) as major constituents. In all tested oils, other compounds were present in small proportions. 1,8-cineole content of Saint-Louis oils confirms the results of Tsiri et al. (20) (from Greece), Panahi et al. (19) (from Iran) and Lima et al. (33) (from Iran) who reported 1,8-cineole percentages of 29.5 to 44.2%, 54.4 and 47.7% respectively. The low content of 1,8-cineole (1.0 – 4.6%) from Dakar oils is in line with Pappas et al. (34) study (2.7% 1,8-cineole). Grbovic et al. (35) have reported also a low content of 1,8-cineole (1.7 - 2.9%) in *E. camaldulensis* essential oils from five geographical areas in Montenegro. In the current study, only the oils of *E. camaldulensis* from Saint-Louis had high 1,8-cineole proportion in comparison with the 70% in the commercial eucalyptus oils. On the basis of the present results, we conclude that the leaves of *E. camaldulensis* from the area of Saint Louis contain a sufficient quantity of oil that is rich in 1,8-cineole. The latter has a potential beneficial use in therapy as an antiinflammatory and analgesic agent (36) and reduced significantly the blood pressure of both conscious and anesthetized rats by intravenous administration (37). Therefore oil of *E. camaldulensis* from Saint-Louis could be used in pharmaceuticals applications.

The results showed that there are many qualitative similarities between eucalyptus oils studied although the contents of some corresponding compounds were different. Kaolack and Saint-Louis oils had the same major components: 1,8-cineole, p-cymene, limonene and α-pinene. 1,8-cineole was higher in Saint-Louis samples (69.3-73.0%). Among the three agro-ecological areas, the "fleuve Senegal" area characterized by a humid climate was the most favorable area for growing eucalyptus able to produce essential oils that met the standards requirements. Furthermore, the difference in composition is most likely related to the difference in climates in the three agro-ecological areas. It was noted that plant origin influences strongly the chemical composition which can be attributed to abiotic and biotic factors (17).

Effect of drying on the essential oil composition

The chemical composition of essential oils from leaves after 3, 7, 14, and 21 days of drying is shown in Tables 2 and 3. The proportion of major compounds of Saint-Louis and Kaolack's oils, 1,8-cineole and p-cymene increased during drying. Likewise, the major constituent of Dakar's oils, β-pinene reached a maximum after 7 days of drying for both extraction times. α-pinene increased during drying of leaves in all oils contrary to limonene whose proportion decreased. It appears from these results that drying had a positive effect on 1,8-cineole and α-pinene percentages. The same behavior has also been reported by Zrira et al. (38) According to Fathi and Sefidkon (39), oven drying at 50°C led to higher 1,8-cineole content then shade and sun drying.

Effect of distillation duration on the essential oils composition

E. camaldulensis leaves from Dakar, Kaolack and Saint-Louis were distilled for duration of 2 and 4 hours. The results showed that the percentages of some monoterpones such as 1,8-cineole, p-cymene, β-pinene and α-pinene were higher in the oils after 2 hours hydrodistillation. The opposite was observed with limonene and sesquiterpene relative percentages.

Aqueous distillate composition

Among the identified products, the major components quantified in Saint-Louis floral water was 1,8-cineole (77.3%) and α-terpineol (3.6%) in Kaolack sample, 1,8-cineole (39.0%), followed by terpinen-4-ol (8.5%), α-terpineol (8.2%) trans-pinocarveol (6.4%). Dakar floral water had as major constituents: α-terpineol (20.3%) and 1,8-cineole (12.6%), trans-pinocarveol (9.9%). α-eudesmol (9.9%). spathulenol (6.9%), terpinen-4-ol (6.8%) and cis-piperitol (4.9%) were also present at relatively high percentages (Table 5).

The results gathered herein confirm the previous work on chemical composition of floral waters made by several authors such as Śmigielski et al. (24); Labadie and Edris (22). 1,8-cineole was the major compound in floral water of Saint-Louis and Kaolack. Many compounds such as terpinen-4-ol, α-terpineol, trans-pinocarveol and cryptone found at lower concentrations in the essential oils, were present in floral waters at high concentrations. Presence of other oxygenated compounds in floral waters, such as 5-methylfurfural, 6-methyl-5-hepten-2-one, 2.4-heptadienal, verbenone, cis-jasmone which are not found in essential oils, was also noted in our study. This suggests that during extraction many hydrophilic oxygenated molecules remained in the floral water

As shown, floral water of *E. camaldulensis* from Saint-Louis and Kaolack contained a high proportion of 1,8-cineole. This opens up an opportunity to exploit this floral water for cosmetics, medicinal and/or pharmacological applications.

Conclusion

In the present work, we conducted a study of both quantitative and qualitative variability of *Eucalyptus camaldulensis* essential oils from Senegal taking into account sampling locations, drying time and extraction duration. The essential oil yields of *E. camaldulensis* from "fleuve Sénégal" agro-ecological area (Saint-Louis) were quantitatively interesting. However this study shows that chemical profiles of essential oils from Saint-Louis, Dakar and Kaolack were different qualitatively and quantitatively. We have also noted that the concentrations of the different major compounds varied with drying time and with the extraction duration. Both essential oils and aqueous distillates of *E. camaldulensis* from Saint-Louis show a high amount of 1,8-cineole. This makes them good candidates for use in pharmaceutical and cosmetic industries. Further studies are in progress to produce Eucalyptus oils of very good quality in Senegal, using a semi-industrial distillation unit. This could contribute to reduce imports of the essential oil and meet demand of the food and cosmetic local industries.

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Table 1: Essential oil yields (%) of *E. camaldulensis* leaves from Saint-Louis, Kaolack and Dakar using Clevenger for 2 hours

Areas	Drying time			
	03 days	07 days	14 days	21 days
Dakar	0.8 ± **0.2**	0.8 ± **0.1**	0.7 ± **0.1**	0.6 ± **0.1**
Kaolack	0.5 ± **0.1**	0.5 ± **0.1**	0.5 ± **0.1**	0.5 ± **0.1**
Saint-Louis	1.0 ± **0.2**	1.0 ± **0.1**	0.9 ± **0.1**	0.9 ± **0.1**

Table 2: Essential oil yields (%) of *E. camaldulensis* leaves from Saint-Louis, Kaolack and Dakar using Clevenger for 4 hours

Areas	Drying time			
	03 days	07 days	14 days	21 days
Dakar	1.0 ± **0.1**	1.0 ± **0.1**	0.9 ± **0.1**	0.9 ± **0.1**
Kaolack	0.6 ± **0.1**	0.6 ± **0.2**	0.6 ± **0.2**	0.5 ± **0.1**
Saint-Louis	1.0 ± **0.1**	1.0 ± **0.1**	1.0 ± **0.1**	0.9 ± **0.1**

Table 3: Chemical composition of *E. camaldulensis* essential oils from Dakar, Kaolack and Saint-Louis after 02 hours of distillation

RI	Component Name	Relative percentage (%)											
		03 days			07 days			14 days			21 days		
		DK	KL	SL	DK	KL	SL	DK	KL	SL	DK	KL	SL
928	α-thujene	0.3 ±**0.0**	0.2 ± **0.0**	-	0.4 ±**0.0**	0.2 ± **0.0**	-	0.3 ±**0.0**	0.1 ± **0.0**	-	0.4 ±**0.0**	0.1 ± **0.0**	-
936	α-pinene	6.0 ±**0.6**	9.1 ±**1.1**	2.1 ± **0.2**	6.4 ±**0.4**	10.5±**0.8**	2.2 ± **0.0**	6.5 ±**0.1**	9.8 ±**0.6**	2.3 ± **0.2**	7.2 ±**0.8**	11.2±**0.3**	2.3 ± **0.3**
953	camphene	0.1 ±**0.0**	0.1 ± **0.0**	0.1 ± **0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.1 ± **0.0**
982	β-pinene	30.7 ±**1.9**	0.3 ± **0.1**	0.1 ± **0.0**	31.3±**2.0**	0.4 ±**0.0**	0.1 ±**0.0**	31.3±**0.4**	0.4 ±**0.1**	0.1 ±**0.0**	34.4 ±**2.2**	0.4 ±**0.1**	0.1 ± **0.0**
988	myrcene	0.6 ±**0.0**	0.5 ±**0.1**	0.2 ± **0.0**	0.6 ±**0.0**	0.6 ±**0.0**	0.2 ±**0.0**	0.6 ±**0.0**	0.6 ±**0.0**	0.2 ±**0.0**	0.6 ±**0.1**	0.6 ±**0.1**	0.2 ±**0.0**
1008	α-phellandrene	0.1 ±**0.0**	6.6 ±**1.3**	0.1± **0.0**	0.1 ±**0.0**	7.0 ±**0.5**	0.1 ±**0.0**	0.1 ±**0.0**	5.1 ±**0.9**	0.1 ±**0.0**	0.1 ±**0.0**	6.1 ±**0.3**	0.1 ± **0.0**
1019	α-terpinene	tr	0.6 ±**0.1**	-	tr	0.7 ±**0.1**	-	tr	0.5 ±**0.1**	-		0.6 ±**0.1**	tr
1027	p-cymene	2.6 ±**0.1**	31.6 ±**0.3**	1.0 ± **0.0**	2.6 ±**0.2**	31.1±**1.6**	0.9 ±**0.0**	2.5 ±**0.1**	32.1±**2.8**	0.9 ±**0.0**	2.9 ±**0.2**	32.6 ±**1.6**	0.9 ± **0.1**
1032	limonene	5.0 ±**0.2**	8.0 ±**0.4**	12.6±**0.4**	5.0 ±**0.4**	7.9 ±**0.5**	12.6±**0.6**	4.8 ±**0.1**	8.0 ±**0.7**	12.6 ±**0.5**	5.3 ±**0.4**	8.1 ±**0.6**	12.4 ±**0.9**
1033	β-phellandrene	2.4 ±**0.1**	1.0 ±**0.1**	-	2.3 ±**0.1**	1.0 ±**0.1**	-	2.2 ±**0.1**	1.0 ±**0.1**	-	2.0 ±**0.1**	1.2 ±**0.1**	-
1036	1,8-cineole	3.3 ±**0.1**	18.7 ±**0.4**	71.7±**1.6**	3.4 ±**0.2**	19.0±**1.0**	72.2±**0.1**	3.2 ±**0.2**	20.0±**1.7**	73.0 ±**0.9**	4.1 ±**0.4**	19.8±**1.4**	72.5±**0.5**

1060	γ-terpinene	tr	0.6 ±**0.1**	0.4 ± **0.0**	tr	0.6 ±**0.0**	0.4 ±**0.0**	tr	0.5 ±**0.1**	0.4 ±**0.1**	tr	0.6 ±**0.0**	0.4± **0.0**
1088	α-terpinolene	0.1 ±**0.0**	0.5 ±**0.1**	0.2 ± **0.0**	0.1 ±**0.0**	0.5 ±**0.0**	0.2 ±**0.1**	0.1 ±**0.0**	0.4 ±**0.0**	0.2 ±**0.0**	0.1 ±**0.0**	0.5 ±**0.0**	0.2 ± **0.0**
1103	linalool	0.1 ±**0.0**	0.5 ±**0.0**	0.1 ± **0.0**		0.5 ±**0.0**	0.1 ±**0.0**	-	0.5 ±**0.1**	0.1 ±**0.0**		0.5 ±**0.0**	0.1 ± **0.0**
1125	fenchol « exo »	0.2 ±**0.0**	0.1 ±**0.0**	0.1 ± **0.0**	0.2 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.2 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.2 ±**0.0**	-	0.1 ± **0.0**
1128	α-campholenal	0.2 ±**0.0**	0.2 ±**0.0**	-	0.2 ±**0.0**	0.3 ±**0.0**	-	0.1 ±**0.0**	0.2 ±**0.0**	-	0.2 ±**0.0**	0.2 ±**0.0**	-
1145	trans-pinocarveol	0.8 ±**0.1**	1.3 ±**0.3**	0.2 ± **0.0**	0.9 ±**0.1**	1.2 ±**0.4**	0.2 ±**0.0**	0.9 ±**0.2**	1.1 ±**0.4**	0.2 ±**0.0**	1.3 ±**0.1**	1.10±**0.4**	0.2 ± **0.0**
1169	pinocarvone	0.4 ±**0.0**	0.4 ±**0.1**	0.1 ± **0.0**	0.4 ±**0.0**	0.3 ±**0.1**	Tr	0.4 ±**0.0**	0.3 ±**0.1**	0.1 ±**0.0**	0.6 ±**0.1**	tr	0.1 ± **0.0**
1183	borneol	0.1 ±**0.0**	0.3 ±**0.1**	0.5 ± **0.0**	0.1 ±**0.0**	0.3 ±**0.1**	0.5 ±**0.1**	0.1 ±**0.0**	0.3 ±**0.1**	0.4 ±**0.1**	0.1 ±**0.0**	0.3 ±**0.1**	0.4 ± **0.1**
1186	terpinene-4-ol	1.0 ±**0.1**	2.3 ±**0.3**	0.6 ± **0.0**	1.0 ±**0.1**	1.9 ±**0.3**	0.7 ±**0.0**	0.9 ±**0.1**	2.0 ±**0.4**	0.6 ±**0.0**	1.1 ±**0.1**	1.9 ±**0.3**	0.6 ± **0.1**
1189	P-cymen-8-ol	0.2 ±**0.0**	0.4 ±**0.1**	0.1 ± **0.0**	0.2 ±**0.0**	0.4 ±**0.1**	0.1 ±**0.0**	0.2 ±**0.0**	0.4 ±**0.1**	0.1 ±**0.0**	0.3 ±**0.0**	0.4 ±**0.1**	0.1 ± **0.0**
1192	α-terpineol	0.6 ±**0.1**	0.5 ±**0.1**	0.7 ± **0.1**	0.6 ±**0.1**	0.4 ±**0.1**	0.70±**0.1**	0.5 ±**0.1**	0.4 ±**0.2**	0.7 ±**0.1**	0.8 ±**0.1**	0.5 ±**0.1**	0.7 ± **0.1**
1199	trans-p-mentha-1-(7)-8-dien-2-ol	1.1 ±**0.1**	0.8 ±**0.1**	1.9 ± **0.1**	1.0 ±**0.0**	0.7 ±**0.2**	1.9 ±**0.2**	1.0 ±**0.1**	0.7 ±**0.2**	1.8 ±**0.2**	1.2 ±**0.1**	0.7 ±**0.1**	1.8 ± **0.2**
1206	myrtenol	1.3 ±**0.1**	1.2 ±**0.2**	-	1.4 ±**0.1**	1.0 ±**0.3**	-	1.4 ±**0.2**	1.0 ±**0.3**	-	1.8 ±**0.0**	1.1 ±**0.3**	-
1222	trans-carveol	0.1 ±**0.0**	0.2±**0.1**	0.2±**0.0**	0.1 ±**0.0**	0.2 ±**0.1**	0.2 ±**0.0**	0.1 ±**0.0**	0.2 ±**0.1**	0.2 ±**0.0**	0.2 ±**0.0**	0.2±**0.1**	0.2 ± **0.0**
1233	cis-carveol	-	0.3±**0.0**	1.1±**0.1**	-	0.3 ±**0.0**	1.1 ±**0.2**	-	0.3±**0.0**	1.1 ±**0.2**	-	0.3±**0.0**	1.1 ± **0.3**

1236	cis-p-mentha-1-(7)-8-dien-2-ol	-	-	0.1**±0.0**	-	-	0.1 **±0.0**	-	-	0.1 **±0.0**	-	-	0.1 ± **0.0**
1245	cuminal	-	0.5 **±0.1**	-	-	0.4 **±0.1**	-	-	0.4 **±0.1**	-	-	0.4 **±0.1**	-
1248	carvone	0.1 **±0.0**	0.2 **±0.0**	0.1**±0.0**	0.1 **±0.0**	0.2 **±0.0**	0.1 **±0.0**	0.1 **±0.0**	0.2 **±0.0**	0.1 **±0.0**	0.2 **±0.0**	0.2 **±0.0**	0.1 ± **0.0**
1255	carvotanacetone	-	0.6 **±0.1**	-	-	0.6 **±0.1**	-	-	0.6 **±0.1**	-	-	0.6 **±0.1**	-
1260	piperitone	-	1.6 **±0.4**	0.1**±0.0**	-	1.4 **±0.4**	0.1 **±0.0**	-	1.4 **±0.5**	0.1 **±0.0**	-	1.3 **±0.3**	0.1 ± **0.0**
1285	phellandral	0.2 **±0.0**	0.1 **±0.0**	-	0.2 **±0.0**	0.1 **±0.0**	-	0.2 **±0.0**	0.1 **±0.0**	-	0.2 **±0.0**	-	-
1292	thymol	-	0.7 **±0.0**	-	0.1 **±0.0**	0.7 **±0.2**	-	0.1 **±0.0**	1.1 **±0.3**	-	0.1 **±0.0**	0.6 **±0.2**	-
1297	carvacrol	0.1 **±0.0**	1.0 **±0.1**	0.1**±0.0**	0.1**±0.0**	1.0 **±0.2**	0.1 **±0.0**	0.1 **±0.0**	0.9 **±0.2**	tr	0.1 **±0.0**	0.8 **±0.1**	0.1 ± **0.1**
1339	bicycloelemene	0.5 **±0.1**	-	-	0.5 **±0.1**	-	-	0.4 **±0.1**	-	-	0.2 **±0.0**	-	-
1380	α-copaene	-	-	-	tr	-	-	Tr	-	-	tr	-	-
1385	α-elemene	0.2 **±0.0**	-	-	0.2 **±0.0**	-	-	0.2 **±0.0**	-	-	0.2 **±0.0**	-	-
1396	β-elemene	0.3 **±0.0**	-	-	0.3 **±0.0**	-	-	0.2 **±0.0**	-	-	0.2 **±0.0**	-	-
1419	α-gurgunene	0.1 **±0.0**	0.1 **±0.0**	-	0.1 **±0.0**	0.1 **±0.0**	-	0.1 **±0.0**	0.1 **±0.0**	-	0.1 **±0.0**	0.1 **±0.0**	-
1430	β-caryophyllene	0.5 **±0.0**	-	-	0.5 **±0.0**	-	-	0.5 **±0.0**	-	-	0.3 **±0.0**	-	-
1440	β-gurjunene	0.1 **±0.0**	-	-	0.1 **±0.1**	-	-	0.1**±0.0**	-	-	0.1 **±0.0**	-	-

1448	calarene	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-	tr	-	-
1452	aromadendrene	0.5 ±**0.0**	-	0.3±**0.0**	0.5 ±**0.0**	-	0.3 ±**0.0**	0.5 ±**0.0**	-	0.2 ±**0.0**	0.4±**0.0**	-	0.3 ± **0.0**
1458	α-humulene	0.1 ±**0.0**	0.1 ±**0.0**	-	0.1 ±**0.0**	0.1 ±**0.0**	-	0.1 ±**0.0**	0.1 ±**0.0**	-	0.1 ±**0.0**	0.1 ±**0.0**	-
1469	alloaromadendrene	0.4 ±**0.0**	tr	-	0.4 ±**0.2**	0.1 ±**0.0**	-	0.4 ±**0.0**	-	-	0.3 ±**0.0**	-	-
1474	γ-gurjunene	0.8 ±**0.1**	-	0.1 ±**0.0**	0.8 ±**0.0**	-	0.1 ±**0.0**	0.8 ±**0.0**	-	0.1 ±**0.01**	0.7 ±**0.1**	-	0.1 ± **0.0**
1487	germacrene D	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-	tr	-	
1496	ledene	0.1 ±**0.0**	0.3±**0.0**	0.1±**0.0**	0.1 ±**0.0**	0.5 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.5 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.3 ±**0.1**	0.1 ±**0.0**
1503	bicyclogermacrene	0.8 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.7 ±**0.0**	0.2 ±**0.0**	0.1 ±**0.0**	0.7 ±**0.0**	0.2 ±**0.0**	0.1 ±**0.0**	0.6 ±**0.1**	0.1 ±**0.0**	0.1 ±**0.0**
1523	δ-cadinene	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-
1526	cis-calamenene	0.1±**0.0**	-	-	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-
1556	elemol	1.3 ±**0.1**	-	-	1.3 ±**0.2**	-	-	1.4 ±**0.2**	-	-	1.0 ±**0.1**	-	-
1576	spathunelol	0.1 ±**0.0**	0.3 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.3 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.3 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.3 ±**0.1**	0.1± **0.0**
1585	globulol	0.3 ±**0.1**	0.1 ±**0.0**	0.1 ±**0.0**	0.3 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.4 ±**0.0**	0.1±**0.0**	tr	0.3 ±**0.0**	0.1 ±**0.0**	0.1 ± **0.0**
1591	epiglobulol	7.3 ±**0.7**	tr	-	6.9 ±**0.5**	tr	-	7.2 ±**0.1**	tr	-	6.5 ±**0.8**	tr	
1598	viridiflorol	1.8 ±**0.2**	1.8 ±**0.2**	0.4 ±**0.1**	1.8 ±**0.1**	2.0 ±**0.0**	0.4 ±**0.0**	1.8 ±**0.0**	2.2 ±**0.1**	0.4 ±**0.0**	1.6 ±**0.2**	1.5 ±**0.4**	0.4 ± **0.0**
1621	10-epi-γ-eudesmol	0.7 ±**0.1**	0.1 ±**0.0**	0.1±**0.0**	0.9 ±**0.1**	0.2 ±**0.0**	0.1 ±**0.0**	0.8 ±**0.2**	0.2 ±**0.0**	tr	0.5 ±**0.1**	0.1 ±**0.0**	tr

1645	γ-eudesmol	4.6 ±**0.1**	-	0.5 ±**0.1**	4.6 ±**0.5**	-	0.5 ±**0.0**	4.7 ±**0.2**	-	0.4 ±**0.0**	3.5 ±**0.6**	-	0.5 ± **0.0**
1649	isospathulenol	0.1 ±**0.0**	-	0.1 ±**0.0**	0.1 ±**0.0**	-	0.1 ±**0.0**	0.1±**0.0**	-	0.1 ±**0.0**	0.1 ±**0.0**	-	0.1 ± **0.0**
1653	hinesol	0.3 ±**0.0**	-	0.1±**0.0**	0.3 ±**0.0**	-	0.1 ±**0.0**	0.3 ±**0.0**	-	0.1 ±**0.0**	0.2 ±**0.0**	-	0.1 ± **0.0**
1660	β-eudesmol	0.1 ±**0.0**	tr	-	0.1 ±**0.0**	tr	-	0.1±**0.0**	0.1 ±**0.0**	-	0.1 ±**0.0**	tr	
1668	α-eudesmol	16.0 ±**1.1**	-	2.7±**0.5**	15.4±**1.7**	-	2.4 ±**0.2**	**15.8±0.8**	0.1 ±**0.0**	2.2 ±**0.1**	12.3 ±**1.8**	-	2.5 ± **0.2**
Hydrocarbon Monoterpenes		**47.9**	**59.1**	**16.8**	**48.9**	**60.6**	**16.8**	**48.5**	**58.6**	**16.9**	**53.1**	**62.1**	**16.7**
Oxygenated Monoterpenes		**9.8**	**31.9**	**77.7**	**10.0**	**31.0**	**78.2**	**9.5**	**32.2**	**78.7**	**12.5**	**30.9**	**78.3**
Hydrocarbon sesquiterpenes		**4.8**	**0.6**	**0.6**	**4.7**	**1.0**	**0.6**	**4.5**	**0.9**	**0.5**	**3.5**	**0.6**	**0.6**
Oxygenated sesquiterpenes		**32.6**	**2.3**	**4.1**	**31.8**	**2.6**	**3.8**	**32.7**	**3.0**	**3.3**	**26.2**	**2.0**	**3.8**

RI= Rétention Index, DK= Dakar, KL= Kaolack, SL= Saint-Louis, Tr= trace < 0.1%

Table 4: Chemical composition of *E. camaldulensis* essential oils from Dakar, Kaolack and Saint-Louis after 4 hours of distillation

		Relative percentage (%)											
		03 days			07 days			14 days			21days		
RI	Component Name	DK	KL	SL	DK	KL	**SL**	DK	KL	SL	DK	KL	SL
928	α-thujene	0.2 ±0.1	0.1 ± 0.0	-	0.3 ±0.0	0.1 ± 0.0	-	0.2 ± 0.1	0.1 ± 0.0	-	0.3 ± 0.1	0.1 ± 0.0	-
936	α-pinene	4.5 ±1.0	8.7 ± 1.2	2.1 ± 0.1	5.2 ±0.6	10.0±1.8	2.3 ± 0.3	4.5 ±0.7	11.6 ±1.0	2.3 ± 0.0	5.3 ±1.0	11.4 ±0.5	2.4 ± 0.2
953	camphene	0.1±0.0	0.1 ± 0.0	0.1±0.0	0.1 ±0.0	0.1 ±0.0	0.1 ±0.0	0.1 ±0.0	0.1 ±0.0	0.1±0.0	0.1 ±0.0	0.1 ±0.0	0.1± 0.0
982	β-pinene	26.8±0.6	0.5 ± 0.1	0.1 ±0.0	26.9±0.4	0.4 ±0.0	0.1 ±0.0	25.3 ±0.7	0.3 ±0.0	0.1 ±0 .0	27.7±2.3	0.3 ±0.0	0.1 ± 0.0
988	myrcene	0.5 ±0.1	0.6 ± 0.1	0.2 ±0.0	0.5 ±0.0	0.6 ±0.1	0.2 ±0.0	0.5 ±0.1	0.6 ±0.1	0.2 ± 0.0	0.5 ±0.0	0.5 ±0.0	0.2± 0.0
1008	α-phellandrene	0.1 ±0.0	8.2 ± 0.9	0.1 ±0 .0	0.1 ±0.0	9.3 ±0.6	0.1 ±0.0	0.1 ±0.0	8.3 ±1.9	0.1 ± 0.0	0.1 ±0.0	7.2 ±0.9	0.1 ± 0.0
1019	α-terpinene	tr	0.8 ± 0.2	tr	tr	0.8 ±0.2	tr	tr	1.0 ±0.1	tr	-	0.8 ±0.1	tr
1027	p-cymene	2.2 ±0.2	28.4±1.4	1.0 ±0 .0	2.1 ±0.0	28.7±1.6	1.0 ±0.1	2.0 ±0.1	30.7±2.8	1.0 ± 0.0	2.4 ±0.2	30.8 ±2.8	1.0 ± 0.1
1032	limonene	4.4 ±0.4	8.3 ± 0.7	13.5±0.2	4.2 ±0.2	8.1 ±0.4	12.5±0.8	4.0 ±0.4	7.8 ±0.6	12.7±0.5	4.5 ±0.2	7.9 ±0.5	12.5± 1.1
1033	β-phellandrene	2.0 ±0.4	1.3 ± 0.0	-	2.1 ±0.1	1.2 ±0.1	-	1.8 ±0.2	1.3 ±0.2	-	1.7 ±0.2	1.1 ±0.1	-
1036	1,8-cineole	2.6 ±0.2	16.8±1.1	69.3±0.8	2.5 ±0.0	17.2±0.2	69.4±1.1	2.5 ±0.1	17.2±1.1	70.4±0.7	3.1±0.3	17.3 ±1.0	70.6 ±0.8

1060	γ-terpinene	0.1 ±**0.0**	0.8 ±**0.1**	0.5 ± **0.0**	0.1 ±**0.0**	0.8 ±**0.1**	0.4 ± **0.1**	tr	0.8 ±**0.0**	0.4 ± **0.0**	tr	0.7 ±**0.1**	0.4 ± **0.0**
1088	α-terpinolene	0.1 ±**0.1**	0.6 ±**0.1**	0.2 ± **0.0**	0.1 ±**0.0**	0.6 ±**0.1**	0.2 ± **0.1**	0.1 ±**0.1**	0.6 ±**0.1**	0.2 ± **0.0**	0.1 ±**0.0**	0.5 ±**0.1**	0.2 ± **0.0**
1103	linalool	0.1 ±**0.0**	0.5 ±**0.1**	0.1 ± **0.0**	-	0.5 ±**0.1**	0.1 ± **0.0**	-	0.5±**0.0**	0.1 ± **0.0**	-	0.5 ±**0.1**	0.1 ± **0.0**
1125	fenchol « exo »	0.2 ±**0.0**	0.1 ±**0.0**	0.1 ± **0.0**	0.2 ±**0.0**	0.1 ±**0.0**	0.1 ± **0.0**	0.2 ±**0.0**	0.1±**0.0**	0.1 ± **0.0**	0.2 ±**0.0**	0.1 ±**0.0**	0.1 ± **0.0**
1128	α-campholenal	0.1 ±**0.0**	0.3 ±**0.0**	-	0.1 ±**0.0**	0.2 ±**0.1**	-	0.1 ±**0.0**	0.2±**0.0**	-	0.1 ±**0.0**	0.2 ±**0.0**	-
1145	trans-pinocarveol	0.6 ±**0.1**	1.0 ±**0.2**	0.2 ± **0.0**	0.6 ±**0.0**	1.0 ±**0.3**	0.2 ± **0.0**	0.7 ±**0.1**	1.0 ±**0.4**	0.2 ± **0.0**	0.9 ±**0.2**	1.0 ±**0.3**	0.2 ± **0.0**
1169	pinocarvone	0.3 ±**0.1**	0.3 ±**0.0**	tr	0.3 ±**0.0**	0.3 ±**0.1**	0.1 ± **0.0**	0.3 ±**0.0**	0.3 ±**0.1**	tr	0.4 ±**0.1**	0.3 ±**0.1**	tr
1183	bornéol	0.1 ±**0.0**	0.3 ±**0.0**	0.4 ±**0.0**	0.1 ±**0.0**	0.2 ±**0.1**	0.4 ± **0.1**	0.1 ±**0.0**	0.2±**0.1**	0.4± **0.1**	0.1 ±**0.0**	0.2 ±**0.1**	0.4 ± **0.1**
1186	terpinene-4-ol	0.8±**0.1**	2.0 ±**0.1**	0.6 ±**0.1**	0.8 ±**0.0**	1.8 ±**0.2**	0.6 ± **0.0**	0.8 ±**0.1**	1.8±**0.4**	0.6± **0.1**	0.9 ±**0.1**	1.8 ±**0.3**	0.6 ± **0.1**
1189	P-cymen-8-ol	0.1 ±**0.0**	0.4 ±**0.1**	0.1 ±**0.0**	0.1 ±**0.0**	0.3 ±**0.1**	0.1 ± **0.0**	0.1 ±**0.0**	0.3±**0.1**	0.1± **0.0**	0.2 ±**0.1**	0.4 ±**0.1**	0.1 ± **0.0**
1193	α-terpineol	0.4 ±**0.1**	0.4 ±**0.2**	0.6 ± **0.1**	0.4 ±**0.1**	0.4 ±**0.1**	0.7 ± **0.1**	0.4 ±**0.1**	0.4±**0.2**	0.6 ± **0.1**	0.6 ±**0.2**	0.4 ±**0.1**	0.7 ± **0.2**
1199	trans-p-mentha-1-(7)-8-dien-2-ol	1.0 ±**0.1**	0.8 ±**0.1**	1.7±**0.1**	0.9 ±**0.1**	0.7 ±**0.1**	1.8 ± **0.1**	1.0 ±**0.2**	0.7±**0.2**	1.7± **0.2**	1.2 ±**0.2**	0.7 ±**0.2**	1.7 ± **0.3**
1202	myrtenol	1.0 ±**0.2**	0.1 ±**0.0**	-	1.0 ±**0.2**	1.00 **0.2**	-	1.1 ±**0.2**	1.1±**0.4**	-	1.4 ±**0.3**	1.2 ±**0.4**	-
1222	trans-carveol	0.1 ±**0.0**	0.2 ±**0.0**	0.2 ±**0.0**	0.1 ±**0.0**	0.2 ±**0.0**	0.2 ± **0.0**	0.1 ±**0.0**	0.2±**0.0**	0.2± **0.0**	0.1 ±**0.0**	0.2 ±**0.1**	0.2 ± **0.1**
1233	cis-carveol	-	0.4 ±**0.1**	0.9 ±**0.1**	-	0.3 ±**0.1**	1.1 ± **0.2**	-	0.3±**0.2**	1.0 ± **0.2**	-	0.3 ±**0.1**	1.1 ± **0.3**

1236	cis-p-mentha-1-(7)-8-dien-2-ol	-	0.1 ±**0.0**	0.1 ±**0.0**	-	0.1 ±**0.0**	0.1 ± **0.0**	-	0.1±**0.0**	0.1 ± **0.0**	-	0.1 ±**0.0**	0.1 ± **0.0**
1245	cuminal	-	0.4 ± **0.1**	0.1 ±**0.0**	-	0.4 ±**0.0**	0.1 ± **0.0**	-	0.4±**0.1**	0.1± **0.0**	-	0.4 ±**0.1**	0.1 ± **0.0**
1248	carvone	-	0.2 ±**0.0**	-	-	0.2 ±**0.0**	-	-	0.2 ±**0.0**	-	-	0.2 ±**0.0**	-
1255	carvotanacetone	-	0.6 ±**0.0**	-	-	0.6 ±**0.1**	-	-	0.6 ±**0.1**	-	-	0.7 ±**0.1**	-
1260	piperitone	-	1.3 ±**0.3**	0.1 ±**0.0**	-	1.2 ±**0.3**	0.1 ± **0.0**	-	1.2 ±**0.5**	0.1 ± **0.0**	-	1.3 ±**0.4**	0.1 ± **0.0**
1285	phéllandral	0.2 ±**0.0**	-	-	0.2 ±**0.0**	-	-	0.2 ±**0.0**	-	-	0.2 ±**0.0**	-	-
1292	thymol	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-
1297	carvacrol	0.1 ±**0.0**	1.0 ±**0.2**	0.1 ±**0.0**	0.1 ±**0.0**	0.9 ±**0.1**	0.1 ± **0.0**	0.1 ±**0.0**	0.9 ±**0.3**	0.1± **0.0**	0.1 ±**0.0**	1.0 ±**0.2**	0.1 ± **0.0**
1339	bicycloelemène	0.6 ±**0.4**	-	-	0.9 ±**0.1**	-	-	0.7 ±**0.1**	-	-	0.3 ±**0.2**	-	-
1380	α-copaène	0.1 ±**0.0**	-	-	0.1±**0.0**	0.1 ±**0.0**	-	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-
1385	α-elemene	0.3 ±**0.0**	-	0.1 ±**0.0**	0.3±**0.0**	-	0.1 ± **0.0**	0.3 ±**0.0**	-	-	0.3 ±**0.0**	-	0.1 ± **0.0**
1396	β-elemène	0.3 ±**0.0**	0.2 ±**0.1**	-	0.3 ±**0.0**	0.2 ±**0.0**	-	0.3 ±**0.0**	0.2±**0.0**	-	0.3 ±**0.0**	0.2 ±**0.0**	-
1419	α-gurgunene	0.1 ±**0.0**	0.2 ±**0.0**	-	0.1 ±**0.0**	0.1 ±**0.1**	-	0.1 ±**0.0**	0.2 ±**0.1**	-	0.1 ±**0.0**	0.2 ±**0.0**	-
1433	β-caryophyllene	0.7 ±**0.1**	-	-	0.7 ±**0.0**	-	-	0.7 ±**0.0**	-	-	0.6 ±**0.1**	-	-
1440	β-gurjunène	0.1 ±**0.0**	-		0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-

1448	calarene	0.1 ±**0.0**	-	-	0.1±**0.0**	-	-	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-
1452	aromadendrene	0.8 ±**0.1**	1.5 ± **0.1**	0.4 ±**0.0**	0.7 ±**0.0**	1.4 ±**0.2**	0.41±**0.1**	0.8 ±**0.0**	1.3±**0.1**	0.4± **0.0**	0.7 ±**0.0**	1.3 ±**0.1**	0.4 ± **0.1**
1458	α-humulene	0.1 ±**0.0**	0.1±0.0	-	0.1±**0.0**	0.1 ±**0.0**	-	0.1 ±**0.0**	0.1±**0.0**	-	0.1 ±**0.0**	0.1 ±**0.0**	-
1469	alloaromadendrène	0.5 ±**0.0**	0.1 ± **0.0**	-	0.5±**0.0**	0.1 ±**0.0**	-	0.5 ±**0.0**	0.1±**0.0**	-	0.5 ±**0.0**	0.1 ±**0.0**	-
1474	γ-gurjunene	1.1 ±**0.1**	0.3 ± **0.0**	0.1 ±**0.0**	1.1±**0.1**	0.3 ±**0.1**	0.1 ± **0.0**	1.2 ±**0.0**	0.3 ±**0.0**	0.1± **0.0**	1.1 ±**0.1**	0.3 ±**0.0**	0.1 ± **0.0**
1487	germacrène D	0.1 ±**0.0**	-	-	0.2±**0.0**	-	-	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-
1496	ledène	0.1 ±**0.0**	0.5 ± **0.0**	0.2 ±**0.0**	0.1 ±**0.0**	0.5 ±**0.1**	0.2 ± **0.0**	0.1 ±**0.0**	0.5±**0.0**	0.2± **0.0**	0.1 ±**0.0**	0.5 ±**0.0**	0.1 ± **0.0**
1503	bicyclogermacrène	1.1 ±**0.0**	0.3 ± **0.0**	0.2 ±**0.0**	1.1±**0.1**	0.3 ±**0.0**	0.2 ± **0.0**	1.1 ±**0.0**	0.3 ±**0.0**	0.2 ± **0.0**	1.0 ±**0.1**	0.3 ±**0.0**	0.2 ± **0.0**
1508	γ-cadinene	0.6 ±**0.2**	-	0.1 ±**0.0**	0.7 ±**0.0**	-	-	0.7 ±**0.0**	0.1 ±**0.0**	-	0.5 ±**0.1**	tr	0.1 ± **0.0**
1523	δ-cadinene	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	0.1± **0.0**	0.1 ±**0.0**	-	tr
1526	cis-calamenene	0.1 ±**0.0**	-	-	0.2 ±**0.0**	-	-	0.1 ±**0.0**	-	-	0.1 ±**0.0**	-	-
1556	elemol	1.4 ±**0.1**	-	-	1.6 ±**0.2**	-	-	1.4 ±**0.1**	-	-	1.3 ±**0.1**	-	-
1576	spathunelol	0.1 ±**0.0**	0.5 ± **0.0**	0.2 ±**0.1**	0.1 ±**0.0**	0.4 ±**0.1**	0.2 ± **0.0**	0.1 ±**0.0**	0.4 ±**0.0**	0.2± **0.0**	0.1 ±**0.0**	0.4 ±**0.0**	0.2 ± **0.0**
1585	globulol	0.4 ±**0.1**	0.2 ± **0.0**	0.1 ±**0.0**	0.4 ±**0.1**	0.1 ±**0.0**	0.1 ± **0.0**	0.4 ±**0.1**	0.1±**0.0**	0.1 ± **0.0**	0.4 ±**0.1**	0.1 ±**0.0**	0.1 ± **0.0**
1591	epiglobulol	7.9 ±**0.1**	**-**	-	7.4 ±**0.3**	-	-	8.2 ±**0.3**	-	-	7.9 ±**0.4**	-	-
1598	viridiflorol	2.0 ±**0.2**	2.9 ± **0.2**	0.6 ±**0.1**	1.9 ±**0.1**	2.5 ±**0.3**	0.6 ± **0.1**	2.0 ±**0.1**	2.5 ±**0.1**	-	2.0 ±**0.1**	2.3 ±**0.3**	-

1621	10-epi-γ-eudesmol	1.0 ±**0.1**	0.2 ± **0.0**	0.1 ±**0.0**	0.8 ±**0.2**	0.2 ±**0.0**	0.1 ± **0.0**	1.0 ±**0.1**	0.2 ±**0.0**	0.1± **0.0**	0.3 ±**0.0**	0.2 ±**0.0**	0.1 ± **0.0**
1645	γ-eudesmol	6.1 ±**0.7**	0.4 ± **0.0**	0.8 ±**0.1**	6.4 ±**0.1**	0.3 ±**0.0**	0.9 ± **0.1**	6.5 ±**0.4**	-	0.8 ± **0.1**	5.7 ±**1.0**	-	0.7 ± **0.1**
1649	isospathulenol	0.2 ±**0.0**	-	0.1 ±**0.0**	0.2 ±**0.0**	-	0.1 ± **0.0**	0.2 ±**0.0**	-	0.1± **0.0**	0.1 ±**0.0**	-	0.1 ± **0.0**
1653	hinesol	0.4 ±**0.0**	0.1 ±**0.0**	0.1 ±**0.0**	0.3 ±**0.0**	0.1 ±**0.0**	0.1 ± **0.0**	0.4 ±**0.0**	0.1±**0.0**	0.1± **0.0**	0.3 ±**0.0**	0.1 ±**0.0**	0.1± **0.0**
1660	β-eudesmol	0.1 ±**0.1**	-	-	0.1 ±**0.0**	-	-	0.2 ±**0.0**	-	-	0.2 ±**0.0**	-	-
1668	α-eudesmol	19.2 ±**0.7**	0.1 ±**0.0**	3.8 ±**0.6**	19.3±**0.1**	tr	4.1 ± **0.5**	20.6±**0.7**	tr	3.7± **0.4**	18.0 ±**2.3**	tr	3.4 ± **0.3**
Hydrocarbon Monoterpenes		**41.0**	**58.4**	**17.8**	**41.7**	**60.7**	**16.9**	**38.6**	**63.2**	**17.1**	**42.7**	**61.4**	**17.0**
Oxygenated Monoterpenes		**7.8**	**27.2**	**74.6**	**7.5**	**27.6**	**75.2**	**7.8**	**27.7**	**75.8**	**9.6**	**28.3**	**76.2**
Hydrocarbon Sesquiterpenes		**6.9**	**3.2**	**1.1**	**7.4**	**3.1**	**1.0**	**7.2**	**3.1**	**1.0**	**6.2**	**3.0**	**1.0**
Oxygenated Sesquiterpenes		**38.8**	**4.4**	**5.8**	**38.5**	**3.6**	**6.2**	**41.0**	**3.3**	**5.1**	**36.3**	**3.1**	**4.7**

RI= Retention Index, DK= Dakar, KL= Kaolack, SL= Saint-Louis, Tr= trace < 0.1%

Table 5: Chemical composition of the aqueous distillates of *E. camaldulensis* from Dakar, Kaolack and Saint-Louis

RI	Component Name	Relative percentage (%)		
		DK	KL	SL
961	5-methylfurfural	0.1± **0.0**	-	-
987	6-methyl-5-hepten-2-one	0.2± **0.0**	0.1 ± **0.0**	0.1 ± **0.0**
1009	2,4-heptadienal	0.2 ± **0.0**	0.1 ± **0.0**	-
1034	1,8-cineole	12.6± **0.1**	39.0± **0.3**	77.3 ± **0.9**
1044	benzene acetaldehyde	0.2± **0.0**	0.1 ± **0.0**	-
1087	trans-linolool oxide furanoid	0.2± **0.0**	0.1± **0.0**	0.1 ± **0.0**
1090	p-cresol	0.3± **0.0**	0.2± **0.0**	0.1± **0.0**
1096	cis-linalool oxid furanoide	0.4± **0.0**	0.3± **0.0**	0.1± **0.0**
1101	linalool	0.2± **0.0**	0.1± **0.0**	
1123	fenchol	1.2± **0.0**	0.4± **0.1**	0.2± **0.0**
1127	cis-p-menth-2en-1-ol	0.7± **0.1**	0.2± **0.0**	-
1138	trans-p-mentha-2.8-dien-1-ol	0.3± **0.0**	0.2± **0.0**	0.1± **0.0**
1144	nopinone	3.7 ± **0.1**	-	-
1146	trans-pinocarveol	9.9± **0.1**	6.4 ± **0.1**	0.9± **0.1**
1153	cis-β-terpineol	-	0.1 ± **0.0**	0.3± **0.0**
1167	pinocarvone	3.0± **0.0**	1.6± **0.0**	0.1± **0.0**
1173	δ-terpineneol	0.2 ± **0.0**	0.5± **0.0**	0.4± **0.0**
1174	bornéol	1.3 ± **0.1**	0.9± **0.0**	0.2± **0.0**
1182	terpinene-4ol	6.8± **0.1**	8.5± **0.1**	1.9± **0.1**
1184	p-cymen-8ol	1.1 ± **0.0**	1.8± **0.0**	1.6 ± **0.1**

1188	cryptone	2.9 ± **0.1**	2.4 ± **0.1**	-
1191	α-terpineol	20.3 ± **0.1**	8.2 ± **0.2**	3.6 ± **0.1**
1203	cis-piperitol	4.9 ± **0.1**	2.7 ± **0.1**	-
1206	myrtenol	0.5 ± **0.0**	0.3 ± **0.1**	0.1± **0.0**
1214	verbenone	1.7 ± **0.0**	0.1 ± **0.0**	0.2± **0.0**
1221	trans-carveol	1.5 ± **0.1**	1.1 ± **0.0**	0.9 ± **0.0**
1230	cis-carveol	0.7 ± **0.0**	2.9 ± **0.0**	2.2± **0.1**
1233	cis-p-mentha-1-(7)-8-dien-2-ol	0.4± **0.0**	0.4 ± **0.0**	3.3 ± **0.2**
1242	cuminal	0.1 ± **0.0**	2.3 ± **0.1**	-
1247	carvone	1.0 ± **0.0**	0.7 ± **0.0**	0.3 ± **0.0**
1258	piperitone	0.2 ± **0.0**	9.5 ± **0.3**	0.5 ± **0.0**
1277	peryl aldehyde	-	0.2 ± **0.0**	0.1± **0.0**
1283	phéllandral	0.4 ± **0.0**	0.1 ± **0.0**	-
1288	tymol	-	0.2± **0.1**	0.1± **0.0**
1291	p-cymen-7ol	-	0.3 ± **0.1**	0.1 ± **0.0**
1302	peryl alcohol	0.9 ± **0.0**	4.9 ± **0.2**	0.2 ± **0.0**
1309	carvacrol	1.0 ± **0.0**	0.1 ± **0.0**	0.1 ± **0.0**
1339	exo-2-hydroxycineole acetate	0.4± **0.0**	0.1 ± **0.0**	-
1394	cis-jasmone	0.1± **0.0**	0.3 ± **0.0**	-
1540	dihyroactinidiolide	1.1± **0.1**	-	-
1554	elemol	0.2± **0.0**	-	-
1588	spathunelol	6.9 ± **0.2**	0.1 ± **0.0**	0.2 ± **0.0**
1597	globulol	0.9 ± **0.0**	1.5 ± **0.1**	0.3 ± **0.0**
1634	10-epe-γ-eudesmol	0.2 ± **0.0**	0.2 ± **0.0**	0.1 ± **0.0**
1642	γ-eudesmol	0.1± **0.0**	0.1± **0.0**	0.8 ± **0.0**

1645	isospathulenol	0.3 ± **0.0**	-	0.1 ± **0.0**
1651	hinesol	0.5± **0.0**	-	-
1655	β-eudesmol	0.2 ± **0.0**	0.4± **0.0**	0.1 ± **0.0**
1668	α-eudesmol	9.8 ± **0.7**	0.1 ± **0.0**	3.1 ± **0.0**

RI= Rétention Index, DK= Dakar, KL= Kaolack, SL= Saint-Louis