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Essential Oil Composition of *Syzygium aromaticum* (L.)

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Abstract*—*In Algeria (North Africa) clove is widely used by traditional practitioners in phytotherapy for these different therapeutic properties, even if this plant is not native to North Africa. The objective of the present work is to develop a gas chromatography-mass spectrometry (GC/MS) separation of compounds from clove essential oil (Syzygium aromaticum) The results showed that the essential oil mainly contained about eugenol (80.00 %) followed by eugenyl acetate (5.01 %) and β-caryophyllene (2.9 %).

***Keywords*—** *Essential oil, Syzygium aromaticum, GC / MS.*

I. INTRODUCTION

Essential oils are complex mixtures, they originate from the plant secondary metabolism and are responsible for their characteristic aroma (1). Clove essential oil is extracted from Eugenia caryophyllata (also known as *Syzygium aromaticum*, *Eugenia aromatica*, *Eugenia carophyllus*) of the Myrtaceae family. Although clove oil is a very potent oil that should be used with great care in aromatherapy, it does have wonderful properties from stimulating the mind and lifting depression, to aiding digestion, relieving pain in arthritis and rheumatism, easing respiratory problems and assisting leg ulcers. A native of Indonesia and the Malacca Islands, it is an evergreen tree that grows to about 10 meters (30 feet) tall and has bright green leaves and nail-shaped rose-peach flower buds which turn, upon drying, a deep red brown. The Latin word 'Clavus' means nail shaped, referring to the bud. The therapeutic properties of clove oil are analgesic, antiseptic, antispasmodic, anti-neuralgic, carminative, anti-infectious, disinfectant, insecticide, stimulant, stomachic, uterine and tonic (2).

II. MATIRIALS AND METHODS

A. Plant Material

The samples come from herbalists, the parts of the plant used are; flower buds, free of pedicels and leaves. The plant was taxonomically identified at Department of Natural Sciences, High School Professors Technological Education, Skikda (Algeria) by Dr. Hicham Boughendjioua. Specie name was according to International Plant Name Index (IPNI).

B. Isolation of the Essential Oil

According to the French Pharmacopea, the essential oil of clove *Syzygium aromaticum* (L.) is obtained by steam distillation from leaves, free of pedicels or flower buds. In this extraction system, the plant material is subjected to the action of a vapor stream without prior maceration. The vapors saturated with volatile compounds are condensed and then decanted (3). The obtained essential oil was dried with anhydrous sodium sulphate and stocked at 4 °C for later use.

C. Chromatography Analysis

The GC/MS analysis was performed with an Agilent 7890A GC system 5975C inert XL EI/CI MSD with Triple-Axis Detector. The operating conditions were as follows: the GC was equipped with a capillary column DB-HP-5MS (30 m*0.25 mm), 0.25 µm film thickness was used. The carrier gas flow rate was 1ml He/min, Injected volume was 10 µl. Spilt ratio was 1/20. The column temperature was held at 60ºC, programming 4ºC/min to 180ºC, then 10ºC/min to 260ºC. Detector and evaporator temperature was 260ºC. The components of essential oil were identified by comparing the results of mass-spectra(m/z) of the chemical substances found in the mixtures under study (obtained in the process of chromatography) with the data of mass spectra library NIST. The range of electronic scanning was 35 to 45 Da and the electronic charge of mass-spectra was 70 eV.

III. RESULT AND DISCUSSION

A. Yield and Chemical Constitution of Essential Oil

Clove essential oil has a warm, strong, spicy smell and the oil is colorless to pale yellow with a medium to watery viscosity, miscible with 96 % ethanol, methylene chloride, toluene and oils fat. The essential oil yield was estimated according to the dry vegetal matter by using the following equation: R_{EO} % = m_{EO} / m_S x 100. Where m_{EO} = essential oil mass (g), m_S = dry vegetal matter mass (g) and R_{EO} = essential oil yield (%) (4). The average yield of essential oil extracted from the plant is studied in the range of 0.8 %. This performance is comparable to that obtained for the same species from different countries of Gulf Region had the percentage of yield only about 0.7-0.92 % (w/w) (05).

The major constituents of essential oil of *Syzygium aromaticum* were eugenol (80.00 %) followed by eugenyl acetate (5.01 %) and β-caryophyllene (2.9 %) (Table I and Figure 1).

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TABLE I. Chemical constituents of the essential oil from *Syzygium aromaticum*.

No.	Compounds	Retention time (min)	Area %
1.	α-Pinene	6.146	0.05
2.	β-Phellandrene	7.606	0.75
3.	β-Pinene	8.906	0.49
4.	α-Phellandrene	9.974	0.40
5.	α-Terpinene	10.198	0.25
6.	m-Cymene	11.577	0.04
7.	Limonene	12.668	0.30
8.	Eucalyptol	13.909	0.50
9.	γ-Terpinene	14.594	0.70
10.	Linalool	15.080	0.75
11.	**Eugenol**	**21.784**	**80.00**
12.	Benzyl acetate	21.808	0.30
13.	4-Terpineol	22.121	0.22
14.	**β-Caryophyllene**	**23.547**	**2.27**
15.	α-Cubebene	23.901	0.30
16.	α-Guaiene	24.026	0.71
17.	**Eugenyl acetate**	**25.924**	**5.01**
18.	Globulol	28.330	0.40
19.	Cubenol	30.725	0.57
20.	Elixene	32.660	0.43
21.	α-Cadinol	36.750	0.57
22.	Germacrene D	37.045	0.60
23.	(+)-Cycloisosativen	44.761	0.45
24.	Nerolidyl acetate	45.107	0.25
25.	α-Farnesene	50.001	0.99
	Total		**97.30**

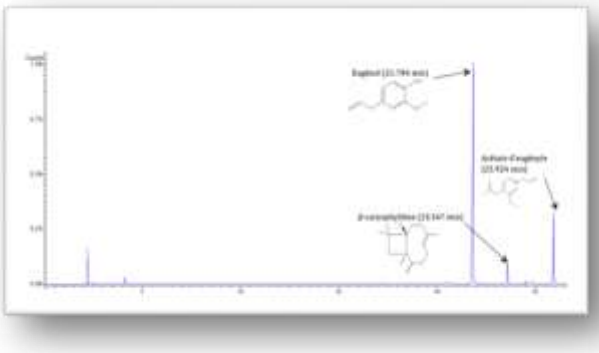

Fig. 1. Typical (GC/MS) chromatogram of Clove essential oil.

According to the literature, the major constituent of clove oil is eugenol up to 70-80 % (06-07). Eugenol and volatile components are contributed to the aroma of clove oil (08-09). The other main constituents found in clove oil are eugenyl acetate and β-caryophyllene (10-11). The other minor constituents include methyl salicylate, chavicol, α-copaene, α-amorphene and caryophyllene oxide (07-12).

Clove oil is comprised of many different compounds, with the primary ingredients being eugenol (49–87%), β-caryophyllene (4–21%), and eugenyl acetate (0.5–21%). Smaller amounts of α-humulene are also present, as well as trace amounts (<1%) of 25–35 other constituents. Figure 2 shows the chemical structures of the primary components of clove oil. Several factors govern the relative quantities of the different constituents in clove oil, including plant genetics, climate, soil and cultivation techniques, the part of the plant extracted, and the extraction method (13).

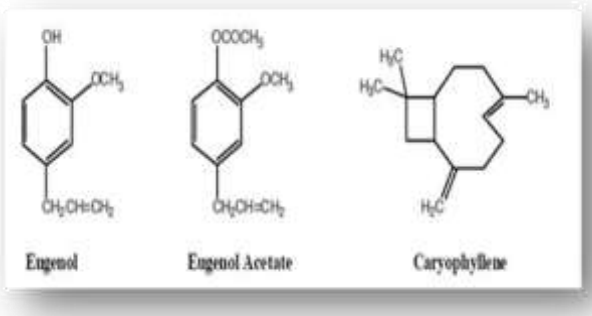

Fig. 2. The major constituents of Clove essential oil.

The results show that the essential oil of clove bud, which was cultivated in the Mediterranean region of Turkey, obtained from steam-distillation method and analyze by GC and GC-MS, mainly contained about 87.00% eugenol, 8.01% eugenyl acetate and 3.56% β-Caryophyllene. The chemical composition of the Turkish clove bud oil was comparable to those of trees naturally grown in their native regions (13).

Essential oil obtained by hydrodistillation from fresh leaves and dry buds of *Syzigium caryophyllatum* were analyzed by Gas Chromatography Mass Spectrometry (GC-MS). Thirty-eight components were identified in the leaf oil. The main components were eugenol (74.3%), eucalyptol (5.8%), caryophyllene (3.85%) and a-cadinol (2.43%). Thirty-one components were identified in bud oil with the main components being eugenol (49.7%), caryophyllene (18.9%), benzene,1-ethyl-3-nitro (11.1%) and benzoic acid,3-(1-methylethyl) (8.9%). The clove oil from Bangladesh was found to be comparable in terms of its eugenol content (14).

A review of published results reveals a great variability in the chemical composition of clove essential oils. The purpose of this study is to compare the bud, leaf and stem essential oil compositions from *Syzygium aromaticum* and then to evaluate the correlation of the results with anatomic and geographical origins of the essential oil. The oils were analyzed by GC and ten constituents were identified from the whole. The major constituent in bud, leaf and stem oils was eugenol, with increasing percentages from bud (72.08 - 82.36%) to leaf (75.04 - 83.58%) and stem (87.52 - 96.65%). In the clove bud essential oil eugenyl acetate is the second major component (8.6 - 21.3%) while detected in considerably lower amount in the leaf (0 - 1.45%) and stem (0.07 - 2.53%), in leaf essential oil, the second main compounds were β-caryophyllene (11.65 - 19.53%) and α-humulene (1.38 - 2.17%), less represented in bud essential oils (2.76 - 8.64% and 0.34 - 1.04% respectively) and in stem essential oils (1.66 - 9.7% and 0.22 - 1.31% respectively) (15).

The chemical composition of essential oils from clove (*Eugenia caryophylata*) provided from Amboina Island was investigated. Essential oil from bud, leaf and stem clove oil, was obtained from steam distillation method, and its chemical composition was determined by GC and GC-MS. The result indicated that the essential oils mainly had about 81.13 - 84.44 % eugenol, 11.60 - 15.02 % eugenyl acetate and 3.45 - 4.60 % β-caryophyllene in the oil from bud, 81.06 - 86.04 % eugenol,

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11.95 - 16.16 % β-caryophyllene and 2.02 - 3.05% eugenyl acetate in oil from leaf, 97.20 - 98.83% eugenol in oil from stem, thus only one main component (16).

In clove oil, a different number of chemical compounds was identified: the most in the commercial oil (20 components), and the least in cold and hot extracts, 14 and 13 components, respectively. Monoterpenes constituted the main components of these oils and in the commercial oil and after maceration they amounted to 78% and, after hot extraction, 82%. Eugenol was the most important part of this group of compounds, which made up 62% of the whole composition while, in the remaining extracts, it comprised approximately 55%. However, eugenol acetate was present in considerable amounts (23.5% and 27.5%) only in extracts. The sesquiterpene-type compounds constituted around 20% of the commercial oil and maceration obtained compositions, while 16% of the composition of the extract obtained as the result of extraction in the Soxhlet apparatus. In this group of compounds, b-caryophyllene was observed in the highest amounts (16% and 13%). On the other hand, monoterpenes, which were mostly represented by eucalyptol, were present only in the commercial oil (17).

IV. CONCLUSION

In order to take stock of trends in the Algerian market of imported medicinal plants and their organizational dynamics, this study aims to update the chemical composition clove essential oil commercialize. The results obtained show that the essential oil consists mainly of eugenol (80.00%) followed by eugenyl acetate (5.01%) and β-caryophyllene (2.9%). The richness of this essential oil in eugenol makes it an oil for various purposes; antimicrobial and antioxidant.

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