Study of The Organoleptic and Physicochemical Properties of Cinnamon Essential Oil (Cinnamomum zeylanicum).

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ABSTRACT
Essential oils must meet characteristics imposed by the laws of producing and exporting countries and by importing countries. These criteria are defined in international standards ISO (International Organization for Standardization) or French AFNOR (French Association of Normalization). Thus the organoleptic and physical properties such as coloration, odor, refraction, solubility, flash point, but also chemical properties such as acid and ester indices are controlled. About that, our study comes to determine some organoleptic and physicochemical properties of cinnamon essential oil (Cinnamomum zeylanicum) a medicinal plant (spice) widely marketed in Algerian public markets. The evaluation of the essential oil yield extracted by hydrodistillation is: 1.5%. The qualitative and quantitative analysis (GC/MS) of the essential oil identified 60 compounds that represent: Cinnamic aldehyde (81.529%), Eugenol (2.915%), p-Cineole (2.914%), Camphene (2.124%), α-Pipene (1.482%), Hydrocinnamic aldehyde (1.218%), α-Terpineol (1.041%) totaling approximately 93.223%. The density is: 1,050 ± 0,005. The measurement of the calculated refractive index and reduced to 20 °C is of low refraction to light: 1.6020 ± 0.007. The boiling and evaporation index are: (185-196 °C).

Keywords: Cinnamon, Cinnamomum zeylanicum, essential oil, chemical composition, density, refractive index, boiling and evaporation index.

INTRODUCTION
Cinnamomum Zeylanicum is a very popular spice and very useful substances in medicines and food, said to be originated from the island Sri Lanka, southeast of India. The plant is also playing an important role in aromatherapy due to its chemical constituent and also its aroma and scent. It contains cinnamaldehyde, an aromatic compound that have a very pleasant smell that can relax and soothe the mind and body, and also eugenol that have a strong aromatic odor and a spicy, pungent taste. The essential oil of the bark is described in the European
Pharmacopoeia 2009, the oil mainly contains cinnamaldehyde (55-76%), eugenol (5-18%) and saffrole (up to 2%) [1].

Essential oils possess many biological activities. They have organoleptic properties: (appearance, color, odor, flavor) and physicochemical properties: (chromatographic profile, density, refractive index and melt index). The methods used to determine the physicochemical indices are those indicated by the French Standards Association (AFNOR) Code of Standards. The purpose of the present work was to determine the organoleptic and physicochemical properties of Cinnamon essential oil. And relate them with their chemical composition, for further application in food and pharmaceutical industries as natural valuable products [2].

The purpose of the present work is to determine the organoleptic and physicochemical properties of Cinnamon essential oil, and relate them with their chemical composition, for further application in food and pharmaceutical industries as natural valuable products.

MATERIAL AND METHODS

Plant material
For the IXth edition of the French pharmacopoeia, the drug of the Cinnamon consists of dry barks yellowish brown, aromatic and whose taste is sweetish and pungent, our samples come from herbalists, the material is easy to get since cinnamon is commonly used as spices in Algerien cooking. The plant was identified by Dr. Hicham Boughendjioa at the Department of Natural Sciences, High School Professors Technological Education, Skikda (Algeria). The voucher specimen under the plant’s name was deposited in the herbarium.

Extraction of the essential oil (Hydrodistillation)
The simple hydrodistillation consists in directly immersing the plant material to be treated (intact or possibly ground) in the water which is then brought to a boil. The heterogeneous vapors are condensed on a cold surface and the essential oil separates by difference in density [3].

Essential oil was obtained in a Clevenger type device [4]. Distillation was carried out by boiling, for an hour and a half, 200 g of fresh plant material with one liter of water in a two-liter flask surmounted by a 60 cm long column connected to a condenser. The yield of essential oil is expressed by the volume of oil (in milliliter) obtained for the mass 100 g of dry vegetable matter. The essential oil was stored at 4 °C in the dark in the presence of anhydrous sodium sulfate.

Measurement of relative density at 20 °C
The relative density of the essential oil is defined as the ratio of the mass of a certain volume of oil at 20 °C. and the equal mass of volume of distilled water at 20 °C. This size is dimensionless and its symbol is $d_{20}^{20}$. The density is measured using a pycnometer of volume: 5 ml at the temperature of 20 °C (Standard NF T 75 - 111) [5].

Measurement of the refractive index
The measurements were carried out using a Prisma-CETI convex refractometer. When the determination is carried out at a temperature other than 20 °C, the correction is carried out at 20 °C using the formula (Standard NF T 75 - 112) [6]:

$$ I_{20} = I_t + 0.00045 (T - 20 ^\circ C) $$

$I_{20} =$ Index at 20 °C.

$I_t =$ Temperature or ambient temperature.

$T =$ Ambient temperature.
**Melting point determination**

The principle is based on the heating of a capillary tube containing a test portion of the essential oil in a heating and the notation of the melting temperature (AOCS, 1997. In Soares et al., 2009) [7].

**Chromatographic analysis**

The GC/MS analysis was performed using a Hewlett Packard 5973-6800 system operating in EI mode (70 eV) equipped with a split/splitless injector (250 °C), a split ratio 1/50, using a fused silica HP-5 MS capillary column (30 m × 0.25 mm (i.d.), film thickness: 0.25 μm. The temperature program for the HP-5 MS column was from 60°C to 280°C at a rate of 2 °C/min. Helium was used as a carrier gas at a flow rate of 0.5 ml/min. Injection volume of the sample was 0.2 μl. The identification of the components was conducted in an IS system managing a library of spectrum wiley7n.l. The GC/MS analysis was performed at the Scientific and Technological Scientific Research Center on Physico Chemical Analysis (CRAPC), Bab ezzouar (Algiers, Algeria).

**RESULTS AND DISCUSSION**

**Yield**

Essential oil from cinnamon has higher density than water so it will sink at the bottom of the separatory funnel. The essential oil yield was estimated according to the dry vegetal matter by using the following equation: $R_{EO} \% = \frac{m_{EO}}{m_S} \times 100$. Where $m_{EO}$ = essential oil mass (g), $m_S$ = dry vegetal matter mass (g) and $R_{EO}$ = essential oil yield (%). The results obtained indicate that the extraction yield of the essential oil by hydrodistillation is 1.5%. Cinnamon bark contains 1-2% essential oil, including 70% cinnamic aldehyde with a small amount of eugenol [8].

**Organoleptic properties**

The following table (Table n°1) shows the characteristics of the essential oil obtained (color, odor, flavor, solubility) in the species studied.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Color</th>
<th>Odour</th>
<th>Flavor</th>
<th>Solubility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cinnamon</td>
<td>Clear liquid, yellowish color</td>
<td>Odour and spicy taste</td>
<td>Burning, sweet and aromatic</td>
<td>Liposoluble, soluble in alcohol and in glacial acetic acid</td>
</tr>
</tbody>
</table>

According to Koroch et al., 2007 [9] the appearance profile of cinnamon bark oil from Madagascar with cinnamon bark oils (*Cinnamomum zeylanicum*) and cassia (*Cinnamomum cassia*) in the US Market are as follows (Table n°2):

<table>
<thead>
<tr>
<th>Origin</th>
<th>Aroma</th>
<th>Color</th>
<th>Ethanol solubility (ml EtOH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malagasy</td>
<td>Mildly sweet, weak and less rich aroma</td>
<td>Pale yellow</td>
<td>Not soluble z</td>
</tr>
</tbody>
</table>

**Table n°2. The appearance profile for some kinds of cinnamon bark.**
Study of The Organoleptic and Physicochemical Properties of Cinnamon Essential Oil (*Cinnamomum zeylanicum*)

**Commercial 1**  
Sweet, characteristic of cinnamon, strong, rich and pleasant aroma  
Yellow  
1.7

**Commercial 2**  
Sweet, characteristic of cinnamon, strong, rich and pleasant aroma  
Yellow  
1.7

**Cassia commercial 3**  
Burning sensation  
Dark orange  
1.4

**FCC y**  
Odor of cinnamon  
Yellow  
3.0

*z 1 mL of oil in 1 mL of EtOH (70%)  
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**Physicochemical properties**

**Chemical composition**

Qualitative and quantitative analysis by Gas Chromatography coupled with Mass Spectrometry (GC/MS) of the essential oil identified 60 compounds representing a total of 99.938%. The essential oil of *Cinnamomum zeylanicum* consists mainly of: Cinnamic aldehyde (81.529%), Eugenol (2.915%), p-Cineole (2.914%), Camphene (2.124%), α-pipene (1.482%), Hydrocinnamic aldehyde (1.218%), α-Terpineol (1.041%) totaling approximately 93.223% (Table n°3 and Figure n°1).

**Table n° 3.** Chemical composition of the essential oil of Cinnamon (Main constituents).

<table>
<thead>
<tr>
<th>No</th>
<th>Compound</th>
<th>Retention time</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>α.-Pipene</td>
<td>10.252</td>
<td>1.482</td>
</tr>
<tr>
<td>02</td>
<td>p-Cineole</td>
<td>16.513</td>
<td>2.914</td>
</tr>
<tr>
<td>03</td>
<td>Hydrocinnamic aldehyde</td>
<td>26.066</td>
<td>1.218</td>
</tr>
<tr>
<td>04</td>
<td>α.-Terpineol</td>
<td>28.088</td>
<td>1.041</td>
</tr>
<tr>
<td>05</td>
<td>Cinnamic aldehyde</td>
<td>36.418</td>
<td>81.529</td>
</tr>
<tr>
<td>06</td>
<td>Camphène</td>
<td>45.300</td>
<td>2.124</td>
</tr>
<tr>
<td>07</td>
<td>Eugénol</td>
<td>45.494</td>
<td>2.915</td>
</tr>
</tbody>
</table>
The first research on the composition of the essential oil of the bark of Ceylon cinnamon was made by Blanchet in 1833. Sometime later, Dumas and Peligot (1834 and 1835) indicate that the main constituent of this species is the "Cinnamaldehyde" or "Cinnamic Aldehyde" (Figure n°2) [10, 11].

Other compounds were identified in 1892 and 1902 by Schimmel chemists, in particular Walbaum and Hüthing, note that the eugenol content in the essential oil of the leaves is greater than that of the bark [10], they identified several compounds by the preparation of chemical derivatives (chemical reactions) [11].

On the other hand, Valnet, (1990) [12] determined that the bark of Cannelium Ceylon (Cinnamomum zeylanicum) is very rich in essential oil, 1-pinene, cineol, phellandrene, furfurol, cymene, linalool, sugar, mucilage, tannin, starch, mannite .. The essential oil of bark is itself composed of 65 to 75% cinnamic aldehyde, 4 to 10% eugenol, carbides and terpenic alcohols.

According to Wright, (1995) [13] the approximate chemical composition of cinnamon bark essential oil is: cinnamaldehyde (trans form) (76%), Eugenol (4%), cinnamyl acetate (5%), 1-linalool (2%), β-caryophyllene (3%), α-terpineol (0.7%), coumarin (0.7%), 1,8-cineole (0.6%), Terpinene 4-ol (0.4%).

The analysis of cinnamon bark volatile oil showed the presence of 13 components accounting for 100% of the total amount. (E)-cinnamaldehyde (97.9%) was found as the major component along with d-cadinene (0.9%), a-copaene (0.8%) and a-amorphene (0.5%) [14]. Kazemi and Mokhtariniya (2016) [15], report that he volatile constituents of the bark of cinnamon (Cinnamomum zeylanicum) were investigated. Analysis of the volatile fraction by GC-MS is described. Twenty one components have been identified, of which the major constituents were found to be cinnamic aldehyde (52.3%) followed by α-copaene (11.42%).
δ-cadinene (6.25%), styrene benzene, ethenyle-(CAS) (5.5%) and cyclohexane, 1-methyl-3-(1-methylet) (5.2%).

Our results concerning the chemical profile of the essential oil of *Cinnamomum zeylanicum* are consistent with those of Khanfri, (2012) [8] which showed that cinnamon essential oil analyzed by GC-MS revealed the presence of 37 dominant components, are characterized by the high concentration of: cinnamic E-aldehyde (63.23%), camphene (19.74%), a-pinene (14.53%) and 1,8-cineol (6.52%).

![Figure n°2: The major constituents of Cinnamon essential oil.](image)

**Density**
The density of an essential oil is a very important criterion for evaluating the quality of an essential oil in different areas of life (cosmetics, pharmacy, food industry, chemical, etc.). It can easily give insight into the naturalness of the product as well as attempts at fraud and alteration.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Density (found)</th>
<th>Density (AFNOR NF T. 75-202)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cinnamon</td>
<td>1.050±0.005</td>
<td>1.045 à 1.063</td>
</tr>
</tbody>
</table>

From the result (Table n°4) of the obtained density, it can be said that the oil conforms to international standards. (According to the French Association of Standardization).

Our results are different to those found by Koroch *et al.*, 2007 [9] for density of cinnamon bark oil from Madagascar with cinnamon bark oils (*Cinnamomum zeylanicum*) and cassia (*Cinnamomum cassia*) in the US Market and who are as follows (Table n°5):

<table>
<thead>
<tr>
<th>Origin</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malagasy</td>
<td>0.949</td>
</tr>
<tr>
<td>Commercial 1</td>
<td>1.019</td>
</tr>
<tr>
<td>Commercial 2</td>
<td>1.026</td>
</tr>
<tr>
<td>Cassia commercial 3</td>
<td>1.058</td>
</tr>
<tr>
<td>FCC y</td>
<td>1.010–1.03</td>
</tr>
</tbody>
</table>

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**Refractive Index**
The refractive indices were calculated and brought to 20 °C using an Abbot refractometer and are shown in the table below (Table n°6).
Table n°6. Value of the refractive index at 20 °C (mean ± standard deviation) of the Cinnamon essential oil.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Refractive index (found)</th>
<th>Refractive index (AFNOR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cinnamon</td>
<td>1.6020±0.007</td>
<td>1.6020 à 1,6060</td>
</tr>
</tbody>
</table>

The refractive index is the ratio between the celerity of light in the vacuum and the celerity of light in the medium under consideration. This report indicates the ability of the essential oil to reflect light. The refractive index of the sample corresponds to the AFNOR standards. It indicates its low refraction to light.

Our results are close to those found by Koroch et al., 2007 [9] for refractive index of cinnamon bark oil from Madagascar with cinnamon bark oils (Cinnamomum zeylanicum) and cassia (Cinnamomum cassia) in the US Market and who are as follows (Table n°7):

Table n°7. Refractive index for some kinds of cinnamon bark.

<table>
<thead>
<tr>
<th>Origin</th>
<th>Refractive index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malagasy</td>
<td>1.5301</td>
</tr>
<tr>
<td>Commercial 1</td>
<td>1.5817</td>
</tr>
<tr>
<td>Commercial 2</td>
<td>1.5909</td>
</tr>
<tr>
<td>Cassia commercial 3</td>
<td>1.6119</td>
</tr>
<tr>
<td>FCC y</td>
<td>1.573–1.591</td>
</tr>
</tbody>
</table>

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Melt Index
The melt index is usually found directly on the majority essential oil compounds after separation and not on the oil itself. Therefore, a separation of the major components of the oil is indispensable and indicated to determine this index (Table n°8).

Table n°8. Value of the melting index of the Cinnamon essential oil.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Boiling temperature (found)</th>
<th>Evaporation T ° (found)</th>
<th>Melting Index (literature)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cinnamon</td>
<td>185</td>
<td>196</td>
<td>Cuminaldehyde 236</td>
</tr>
</tbody>
</table>

CONCLUSION
Essential oils have become in recent years a matter of considerable economic importance, with a constantly growing market whose fields of application are directly related to human consumption. This is why essential oils are more and more controlled in order to verify the presence of certain natural toxic compounds, their natural or non-natural origin, their source and the presence of certain active compounds and even though the plant biomass a very promising source for the future, very little works has been done on the study of the organoleptic and physicochemical properties of aromatic fractions of cinnamon. Due to its chromatographic profile, the essential oil extracted by hydrodistillation of this plant has organoleptic and physicochemical properties very appreciated in perfumery and will be very coveted in the sector of the food, pharmaceutical and cosmetic industry.

CONFLICT OF INTEREST
Authors have declared that no competing interests exist.
REFERENCES

1. Saleeza ABS. Extraction of essential oil from *Cinnamomum zeylanicum* by various methods as a perfume oil, Thesis submitted to the Faculty of Chemical and Natural Resources Engineering in Partial Fulfillment of the Requirements for the Degree of Bachelor of Engineering in Chemical engineering, Faculty of Chemical & Natural Resources Engineering Universiti Malaysia Pahang, February. 2013; page 2.


