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Research Article

Purity Specifications of Constituents of Cinnamon Essential Oil by Fourier Transformed Infrared Spectroscopy Analysis

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ABSTRACT

Three main tools are used to determine the structures of organic molecules. These tools are infrared (IR) spectroscopy, mass spectrometry (MS) and nuclear magnetic resonance (NMR) spectroscopy. Infrared Spectroscopy (IR), Mass Spectrometry (MS) and Nuclear Magnetic Resonance Spectroscopy (NMR). Organic molecules absorb light (infrared, ultraviolet, etc.) at particular wavelengths based on different vibrational modes unique to the specific functional groups and structural features. In the present study, the volatile compounds of Cinnamon (*Cinnamomum zeylanicum*) were detected and identified by Fourier Transformed Infrared Spectroscopy (FTIR) analysis. FTIR allowed us to identify 10 volatile compounds and indicated than the functional groups of the essential oils are CHx, C=C and C=O.

Introduction

Most people either use essential oils for their therapeutic effect or for the fragrance alone but it is also interesting to take note of the chemistry, of which the oils are made up from. Essential oils, like all organic compounds, are made up of hydrocarbon molecules and can further be classified as terpenes, alcohols, esters, aldehydes, ketones and phenols etc. Every single oil normally has more than a hundred components, but this figure can also run into thousands, depending on the oil in question.

When you analyze essential oils with a chromatograph various organic components are found and the primary ones are as follows:

- Terpenehydrocarbons: Monoterpene hydrocarbons, Sesquiterpenes.
- Oxygenated compounds: Phenols, Alcohols.
- Monoterpene alcohols.
- Sesquiterpene alcohols: Aldehydes, Ketones, Esters, Lactones, Coumarins, Ethers, Oxides [1].

The genus *Cinnamomum* comprises several hundred species, which occur in Asia and Australia. These are evergreen trees and shrubs and most of the species are aromatic. *Cinnamomum zeylanicum*, the source of cinnamon bark and leaf oils, is a tree indigenous to Sri Lanka. Many species of cinnamon yield a volatile oil on distillation [2].

Fourier Transformed Infrared Spectroscopy (FTIR) is based on the absorption of infrared radiation by the analyzed material. Through the detection of the characteristic vibrations of the chemical bonds, it makes it possible to carry out the analysis of the chemical functions present in the material [3].

The aim of this work was to clearly describe the functional groups of Cinnamon essential oil in order to better define the field of investigation of this natural product.

Material and methods

Plant Material

For the IX th edition of the French Pharmacopoeia, the drug is made by dry aromatic yellowish brown barks and whose taste is sweet and pungent. Our samples come: from among herbal lists [4].

Isolation of the Essential Oil

Obtaining essential oil was carried out in a Clevenger-type apparatus [5]. A steam distillation was performed by boiling for

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an hour and a half to 200 g of plant material with one litter of water in a two litter flask surmounted by a column of 60 cm length connected to a condenser.

FTIR Analysis

Spectroscopy is based on the study of the interactions between matter and electromagnetic radiation. This radiation consists of a particle beam having an undulating motion. All electromagnetic radiation forms the electromagnetic spectrum. In the spectrum, four regions are discernible: X-rays, ultraviolet (UV), visible and infra-red (IR). The emphasis will be on infrared (IR) spectroscopy because spectrum analysis allows us to follow a reaction process, determine the dosage of a compound, check the purity of a product and identify an unknown. Moreover, it is an inexpensive and easy to use process which makes IR spectroscopy the most widely used spectral method used by chemists. The principle is based on molecular vibrations. The energy emitted as photons can be absorbed by the material causing vibration in the molecules. This vibration changes the angle and the distance between the atoms. When the molecule returns to its original form, energy will be released as heat. The absorption and release of energy by the molecule will be recorded by the apparatus and translated into a band spectrum. The analysis of this spectrum makes it possible to obtain the necessary information on the material analyzed [3]. FTIR is performed with a PERKIN ELMER (universal ATR Sampling Accessory) apparatus, the operating conditions are as follows: technique: ATR, analysis range: 4000- 600 cm -1. The results are directly compared with those of the internal bibliography of the apparatus; 01. Euclidean, 02. PSU / peak, 03. MIX PSU, 04. Peak Match, 05. PEAK / psu, 06. MIX PEAK. In our study we used the Euclidean library. The FTIR analysis was performed at the Regional Police Scientific Laboratory (Constantine, Algeria).

Results and discussion

Determination of the functional groups present using FTIR

Fourier transformed infrared spectroscopy is one of the most widely employed techniques for functional groups identification. **Figures 01** to **02** showed the infrared spectra and the characteristic bands observed in Cinnamon essential oil in the range of 4000-600 cm^{-1}:

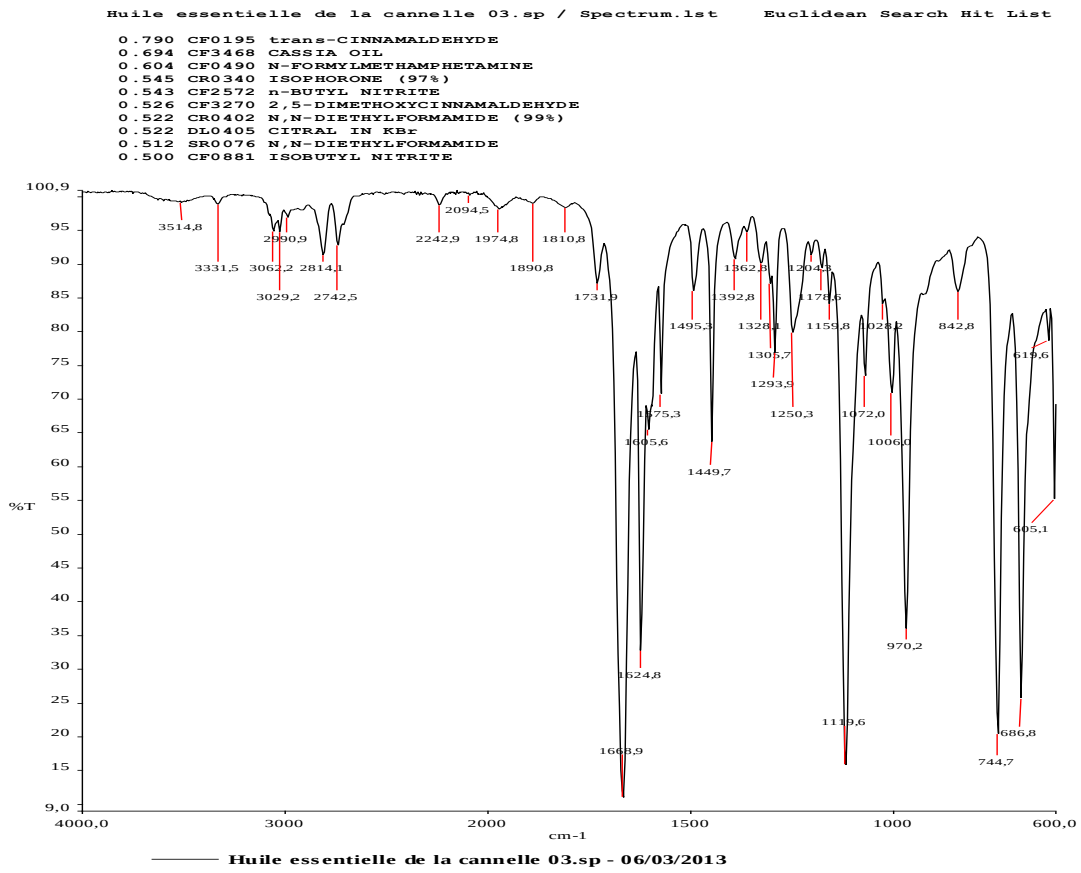

Figure 1: FTIR of Cinnamon essential oil.

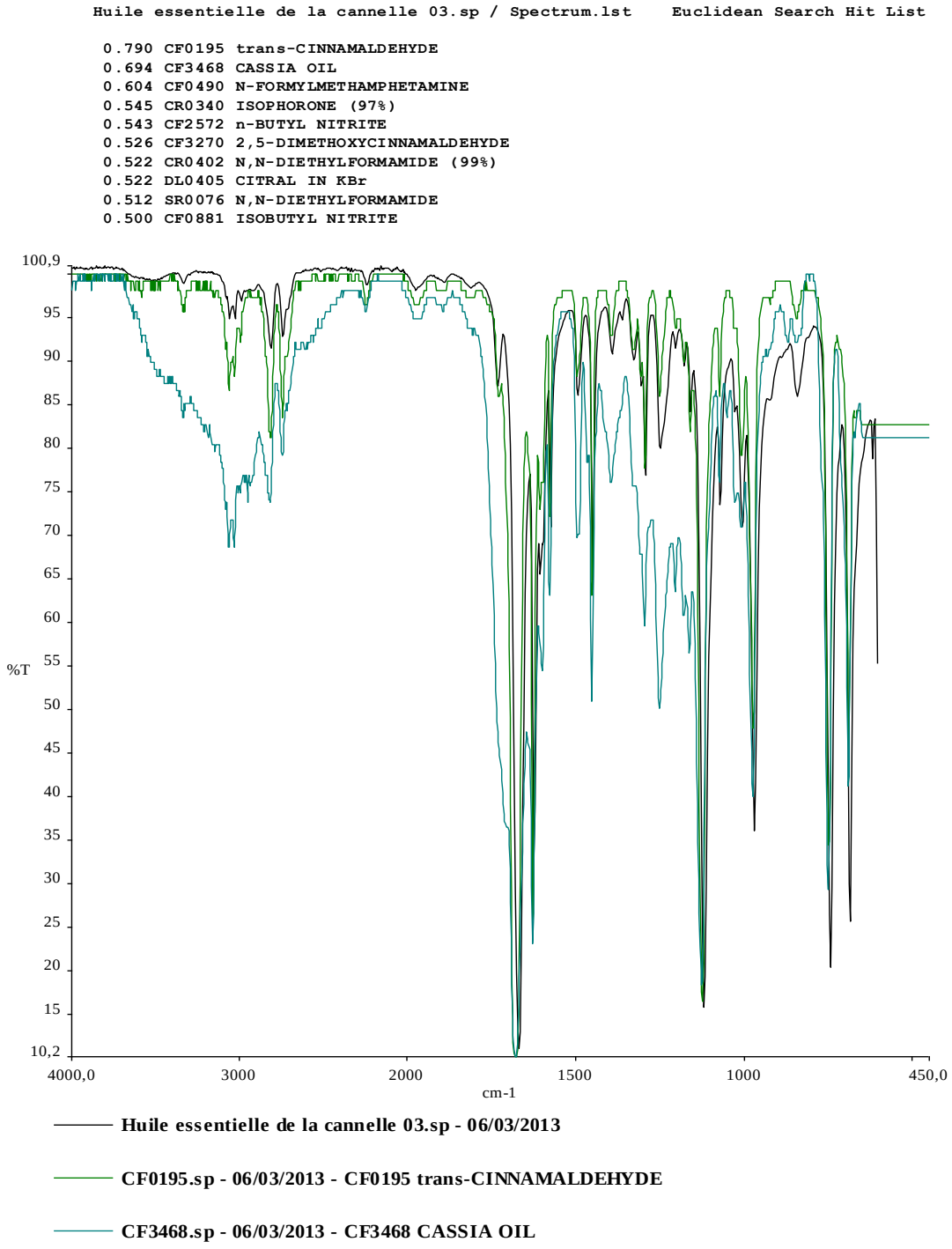

Figure 2: FTIR of Cinnamon essential oil compared to the bibliography.

Table 1: Links present in Cinnamon essential oil.

Compound	Present links in essential oil	Theoretical frequency of the band (cm^{-1})	Presence of the banding the spectrum
Alkane	CHx deformation	1500-1400	Yes
Unsaturated	C=C *stretching*	1600-1500	Yes
Aldehyde	C=O *stretching*	1710-1700	Yes

In an earlier work developed by Boughendjioua (2014) [06], the chemical composition of the essential oil of *Cinnamomum zeylanicum* detected by GC–MS allowed us to identify 60 compounds and indicated that the main compounds constituting the volatile oil were mainly Cinnamic aldehyde (81.52%), Eugénol (2.91%), p-Cineole (2.91%), Camphene (2.12%), α-pipene (1.48%), Hydrocinnamic aldehyde (1.21%) and α-Terpineol (1. 04%). Among the ten compounds revealed by FTIR: (1). Trans-cinnamaldehyde, (2). Cassia oil, (3). N-formylmethamphetamine, (4). Isophorone (97%), (5). N-butyl nitrite, (6). 2,5-dimethoxycinnamaldehyde, (7). N,n-diethylformamide (99%), (8). Citral in KBr, (9). N,n-diethylformamide, (10). Isobutyl nitrite.

On the other hand, the complete and detailed study of a spectrum is an operation rarely practiced in current interpretation because of the complexity of the analysis. It is therefore often limited to the identification of functional groups through the location of the different bands on the spectrum. The spectrum presents characteristic bands at 1500-1400 cm^{-1} corresponding to CHx deformation, the signals which appeared between 1600-1500 cm^{-1} corresponding to C=C *stretching*, and 1710-1700 cm^{-1} are caused by stretching vibrations of C=O groups (**Table 01** and **Figure 03**). For aldehyde C=O stretch with characteristic absorption (cm-1); 1740 - 1690 (s), the carbonyl stretching absorption is one of the strongest IR absorptions, and is very useful in structure determination as one can determine both the number of carbonyl groups (assuming peaks do not overlap) but also an estimation of which types [07].

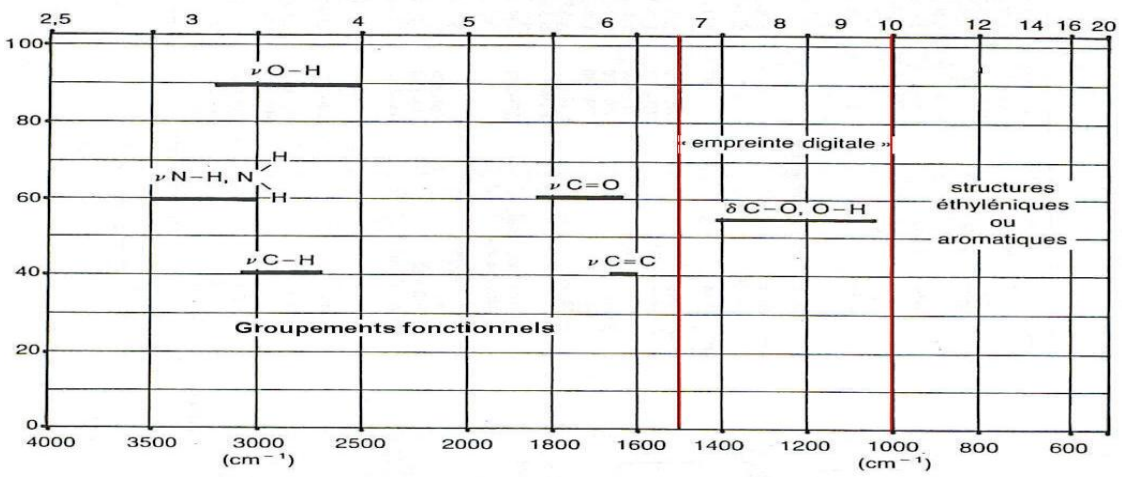

Figure 3: Graphs of IR spectroscopy.

Conclusion

Infrared spectroscopy provides incredibly powerful assurance of identity and purity. The ingredients obtained from this study indicate that the essential oil of Cinnamon (*Cinnamomum zeylanicum*) can be fully utilized for the manufacture of perfumery products, antimicrobial and antiseptic agents or even in petrochemical industry or alkenes serve as a feedstock for the petrochemical industry because they can participate in a wide variety of reactions, prominently polymerization and alkylation, on the other hand aldehydes sound of great importance in industry, formaldehyde and acetaldehyde, have complicated behavior because of their tendency to oligomerize or polymerize. They also tend to hydrate, forming the geminal diol.

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