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Original Article

Vibrational Study for the Lemon and Tangerine Fruit Using FT-IR Spectroscopy

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Abstract

The analyze of food products is one of the actual preocupations which is why the development of some quick and accurate ways of determining the aditives and toxic substances in foods is neeeded. FT-IR spectroscopy is a sample, rapid and accurate method to detect a natural product in food industry. The main objective of the present study was to investigate the detailed physico-chemical characteristics of the pulps of commonly cultivated species of citrus fruits. The FT-IR spectra of lemon and tangerine fruit have been obtained and the principal vibrational band was assignment and analysis according to the available literature.

Keywords: *lemon fruit, tangerine fruit, FT-IR (Fourier transform – infrared).*

1. Introduction

The *Citrus sinensis* (Orange), *Citrus paradisi* (Grapefruit), *Citrus limon* (Lemon), *Citrus reticulata* (tangerine), *Citrus grandis* (shaddock), *Citrus aurantium* (sour orange), *Citrus medica* (Citron) and *Citrus aurantifolia* (lime) is genus Citrus belonging to the Rutaceae or Rue family.

Citrus fruit are grown throughout the world and are highly appreciated for their numerous benefits for human health.

These fruits are a primary source of vitamin C [1] and the high amounts of available bioactive compounds in citrus fruit, such as citric acids, carotenoids, minerals are considered responsible for the numerous health benefits.

Many therapeutic properties have been attributed to citrus fruits, such as anticancer, antiviral and antioxidant [2]. The citrus fruits are mainly processed to produce juice and the waste of this industry such as pulps, seeds and peels which represent about 50% of the raw processed fruit are a potential source of valuable by-products.

Citric acid is a natural compound present in all animal and vegetable material and without this acid living cells could not function.

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A source for citric acid is found naturally in several fruits like citrus fruits: lemon, oranges, and tangerine.

Citric acid (2-Hydroxypropane- 1,2,3-tricarboxylic acid) is produced synthetically in the form of lemon salt (E 330 in Europe) and it is the most widely used acid in the food industry from to produce non-natural juice.

Food aditives is a substances used in the making of some food production for improving their quality or for allowing other advanced processing technologies to be applied.

Because, the acid citric in naturally form is very important for human body having medical properties is necessary experimental studies.

Therefore the aims of this work was to analyzed and to make a comparison between a molecular structures of lemon and tangerine pulps of fruits, using vibrational spectroscopic techniques (FT-IR).

This study can be used to make a difference between natural and non-natural juices.

The application of FT-IR has been reported for the analysis of food matrices [3], correlated with rich information on the use of this technique and its great potential in various research fields [4].

It is well known that it Hirria et. al. (2016) reported a study where the vibrational spectral techniques in connection with chemometric methodologies was used as a fast and direct analytical approach to classify citrus cultivars by the measurements on their juice [5].

In other study the phenomenon, Gamal et al. (2011) used FT-IR spectroscopy for determining sugars, pectin and organic acid contents in same natural and synthetic products, as jam [6].

FT- IR offer several advantages in the context of current research and using this techniques we can obtain detailed information about of molecular vibrations.

This is the reason why this is very often used in food industry IR spectroscopy is based on the absorption of radiation in the 400 – 4000 cm^{-1} range which excites molecular vibrations.

2. Material and Method

Mature fruit samples of each of the two citrus species, lemon and tangerine, were purchased from the local market of Romania.

The fruits were washed with tap water, and then the pulps was dried at 40 ^{0}C for 24 h. Samples of dried citrus were crushed using a commercial blender.

The sample from FT-IR spectrum was obtained from 0,005g of citrus fruits used as such without further purification.

Fourier Transform Infrared (FT-IR) spectra were performed in the absorbance with a spectrophotometer FT-IR-4100 Jasco, using KBr pellet technique.

Spectral resolution was set at 4 cm^{-1} and all spectra were acquired over 256 scans. The spectral data were analyzed using Origin 6.0 software.

3. Results and Discussions

The vibrational fundamentals from the FT-Raman spectra from pulps of lemon and tangerine fruit presented in Fig. 1, were analyzed by comparing these modes with those from the literature.

The intense absorption peak around 3367 cm^{-1} indicates the existence of free and intermolecular bonded hydroxyl groups.

The OH stretching vibrations occur within a broad range of frequencies indicating the presence of “free” hydroxyl groups and bonded OH bands of carboxylic acids.

The peaks observed at 2930 cm^{-1} can be assigned to stretching asymmetric vibration of CH group.

The stretching vibrations of –COOH and –$COOCH_3$ are attributed to the very strong peak at 1727 cm^{-1} from lemon spectra and very weak peak at tangerine spectra [7]

The medium strong band at 1632 cm^{-1} were assigned to the deformation C-OH of carboxyl and this attribution is available just for mandarin spectrum.

The same attribution have the medium band at 1415 cm^{-1} (tangerine) and 1403 cm^{-1}(lemon). The C-O of aliphatic acid groups are attributed to the peak from 1257 cm^{-1}.

The stretching CC, CO and CCO of sugar, was observed in both species at very strong peak at 1053 cm^{-1} [6] and because the band of tangerine is more intense compared with the band characteristic of lemon, we can affirm that tangerines contain more sugar than lemons.

In the both variants of the spectrum the rocking CH_3 of pectin are attributed to the very weak peak at 930 cm^{-1} and the bans at 594 cm^{-1} were assigned to the CH_2 group deformation.

The additional peak at 625 cm^{-1} can be assigned to bending modes of aromatic compounds [8]. It is well indicated from the FT-IR spectrum of tangerine and lemon pulp that carboxyl group are present in abundance.

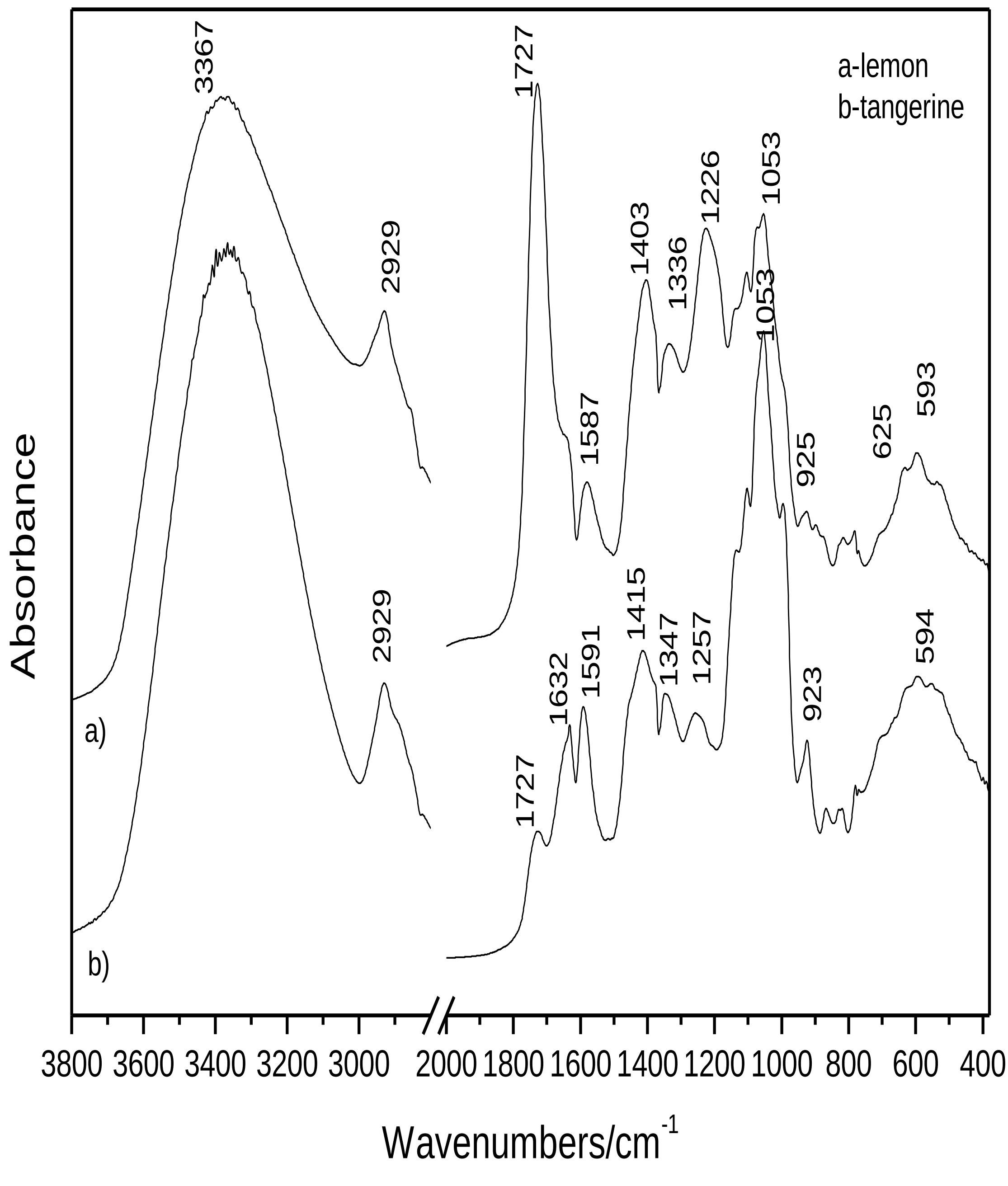

Figure 1. FT-Raman spectra from pulps of lemon (a) and tangerine fruit (b)

4. Conclusions

The discrimination between a principal bands of two citrus was performed using FT-IR data records. Each variety was identified on the basis of different spectral information spread along the selected spectral range of 1400- 700 cm^{-1}. The major changes were observed in the spectral ranges where the stretching OH, CH asymmetric, deformation OH is located. Using vibrational spectroscopy, it was proven that we can identify key molecular components in the samples studied and their molecular structure for the correct classification in food industry.

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