



UNIVERSITY OF LIFE SCIENCES  
"KING MIHAI I" FROM Timisoara  
**Multidisciplinary Conference on  
Sustainable Development**



21 - 22 May 2026

# Comparative Study of Natural and Commercial Lemon Juices Based on Physicochemical Properties and FT-IR Spectral Analysis

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## Abstract:

Lemon juice is one of the most consumed natural beverages worldwide, due to its high content of vitamin C, phenolic compounds, and aromatic substances. During the processes of extraction, transportation, storage, and packaging, the physicochemical properties of the juice play a crucial role in maintaining its quality and stability.

Physico-chemical analyses represent an important stage in the quality control of food products. In the food industry, the quality of a product is not limited to its organoleptic appearance (taste, smell, texture), but is also defined by physico-chemical parameters such as pH, density, sugar content. The properties of liquids such as viscosity and surface tension are two fundamental parameters that influence fluid behavior, and in the case of lemon juice, they contribute to pulp stability, the degree of homogenization, foaming, as well as the sensory perception of the product. The study of these quantities allows the characterization of lemon juice as a complex, non-ideal fluid, with non-Newtonian behavior in some cases. In this work, 2 types of commercially purchased lemon juice were analyzed and a comparison was made between the results obtained from them and those from natural lemon juice. The study highlights the importance of physico-chemical characterization of juices in order to choose products that have a lower sugar content and that help to properly hydrate the body. For a detailed physicochemical analysis of the sample, FT-IR spectroscopy was employed, and the characteristic spectrum of the lemon used for obtaining the natural juice was recorded and characterized.

## Introduction

The lemon is a citrus fruit belonging to the Rutaceae family, widely cultivated in regions with subtropical and Mediterranean climates. Due to its nutritional value, therapeutic properties, and multiple industrial uses, the lemon occupies an important place both in human nutrition and in the global agricultural economy. Lemon juice is a food product frequently used both in household consumption and in the food industry. Due to its high content of citric acid, vitamin C, and bioactive compounds, lemon juice is appreciated for its organoleptic and functional properties. The aim of this study is to evaluate different types of lemon juice using FT-IR spectroscopy and to correlate the obtained results with those from complementary analytical methods. The research comparatively analyzes commercially available lemon juice and freshly squeezed lemon juice, as well as the FT-IR spectrum of lemon pulp.

## Material and method

- The study material consisted of the analysis of natural lemon juice and commercial lemon juice (Fanta, Frutti Fresh).
- Natural juice is obtained by directly squeezing fresh fruit, without industrial stabilization processes or the addition of additives. For each type of juice we prepared two samples of 100 ml each, one sample being necessary for calculating the density and the other to be able to do the other physico-chemical analyses.
- FT-IR and Raman spectra were recorded using a FT-IR-4100 Jasco, and a Bruker Equinox 55 with a FRA 106S Raman module. Micro-Raman spectra were recorded with a Renishaw Raman system using the 532 and 785 nm lines for excitation.

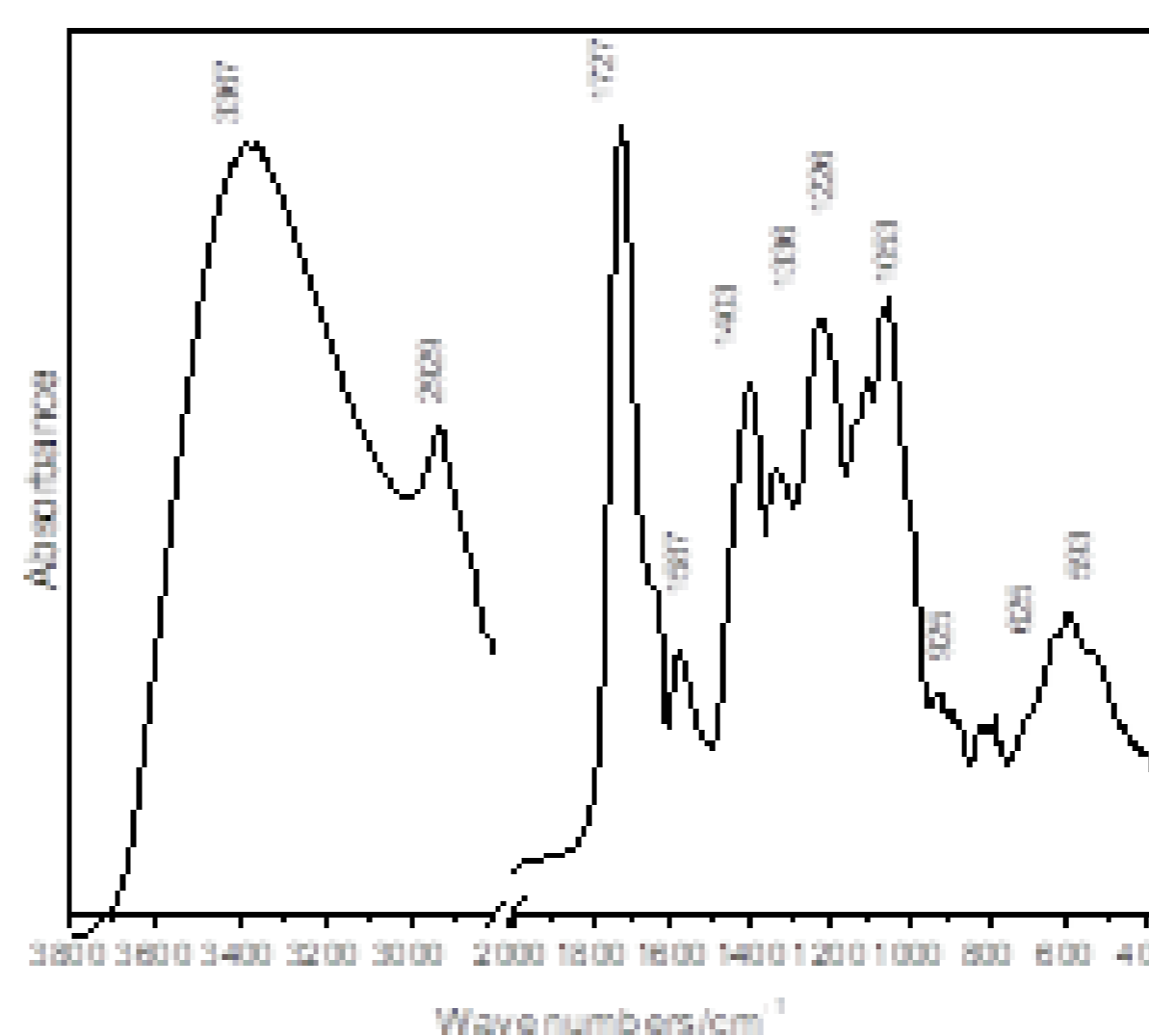


Figure 1 presents the FT-IR spectra of dried a pulp samples obtained from lemon pulp fruits. Analyzing the FT-IR spectrum, it can be observed that dried lemon pulp mainly contains hydroxylated compounds, carbohydrates, fibers, and organic acids, which are typical characteristics of plant biomass derived from citrus fruits.

Lemon Juices	Sugar content (°Brix)
Natural lemon juices	3
Fanta	10
Frutti Fresh	7



Lemon Juices	Refractive index
Natural lemon juices	1.335
Fanta	1.348
Frutti Fresh	1.341

The sugar concentration, expressed in degrees Brix, was determined using a portable refractometer. As can be observed, natural lemon juice has the lowest °Brix values, which explains its intensely sour taste. Fanta shows the highest °Brix values due to its high added sugar content, while Frutti Fresh presents intermediate values, offering a balance between sweet and sour taste.

Natural lemon juice shows values of  $n \approx 1.335$ , being close to the value of water but slightly higher due to the presence of natural sugars and organic acids. Fanta shows higher values,  $n \approx 1.348$ , which reflects its high sugar content. In the case of Frutti Fresh, the values are intermediate,  $n \approx 1.341$ , corresponding to a moderate content of soluble sugars. All juices have higher values than water because they contain sugars, acids, and other dissolved substances.

## Conclusions



- The comparison between natural juice and commercially available juice shows a clear compromise between nutritional quality and stability.
- Natural lemon juice provides superior benefits in terms of vitamin and antioxidant content, but it has a short shelf life.
- Industrial juice is more practical and safer for long-term consumption, but it may undergo significant nutrient losses during the production process