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A Review on Detection of Adulterants in Edible Oil Using FTIR-ATR Spectroscopy

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Abstract

Food adulteration is one of the primary concern in these days. It not only reduces the value of nutrients in a particular food but also cause severe side-effects on the human health. Edible oil is used in most of the food items directly or indirectly to add calories, essential fats and vitamins to the food. Throughout the world different edible oils are being used in different regions, to mention a few, sunflower oil, coconut oil, corn oil, olive oil, groundnut oil etc. In this article we briefly review on the different adulterants being used in these oils. In particular, we report on their spectroscopic signatures by using FTIR-ATR spectroscopy.

Introduction

A food Something which provides nutrients. Nutrients are substance which provides energy for activity and to do all the functions of body. Nutrients are required to our body in a a specific amount compounds such as free fatty acid. One of the essential ingredients that we used in our day-to-day life is oil. Edible oils consist of about 96% triglycerides composed of different fatty acids. Some other compounds or groups of compounds such as free fatty acid, phospholipids, and other antioxidants also be found. Adulteration of vegetable oil is define as addition of cheaper inferior harmful substances to oil. The variety of edible oils are Sunflower oil, coconut oil, olive oil, groundnut and corn oil etc. But it has been liable to adulteration by adulterants like thermally deteriorated oil, animal fats, argemone oil, paraffin etc. Society demands for quality and safety of oils and food products which surely appropriate analytical tools for quick and accurate analysis of them. Many methods are there for checking the oil quality. Analytical techniques used for the detection of oil quality are viscosity index, chromatographic techniques, atomic emission spectroscopy, fourier transform infrared spectroscopy etc. In this review we concentrate on Fourier transform infrared spectroscopy (FTIR),

which is common and available apparatus in quality control laboratory which is inexpensive non-destructive and environment protecting technique. FTIR- transform infrared Spectroscopy is technique used to obtain and infrared spectrum of absorption or emission of a solid, liquid or gas. It collects high resolution spectral data over a wide spectral range which measures intensity over a narrow range of a wavelength at a time. Fingerprints of authentic commodities may be considered to represent their overall chemical composition and therefore have the potential to detect the adulteration. This method to be with chemometric tools. Chemometric treatments on FTIR-ATR oil samples. This is fastest technique for analysis of samples without usage of any reagents.[3]

FTIR-ATR spectroscopy and chemometric for authentication of fats and oils

Sample preparation:

FTIR is one of the vibrational spectroscopy, in which sample analysis will be based on interaction between functional groups by electromagnetic radiation. sample preparation is done by collecting a different edible oils. The thermal stability of the edible oils from 30℃-170℃. A set of pure samples of different edible oils were collected. In another set the pure oils are adulterated by adding another vegetable oils and by other adulterants. A pair of sodium chloride plates is taken and clean these 2 NaCl plates with chloroform and dry them with tissue.one drop of oil sample onto a NaCl plate by using a dropper and sandwich it using the other NaCl plate without an air bubbles. Then place NaCl plates into the sample holder. Then these different samples were studied and compared by spectral analysis of FTIR-ATR spectroscopy.

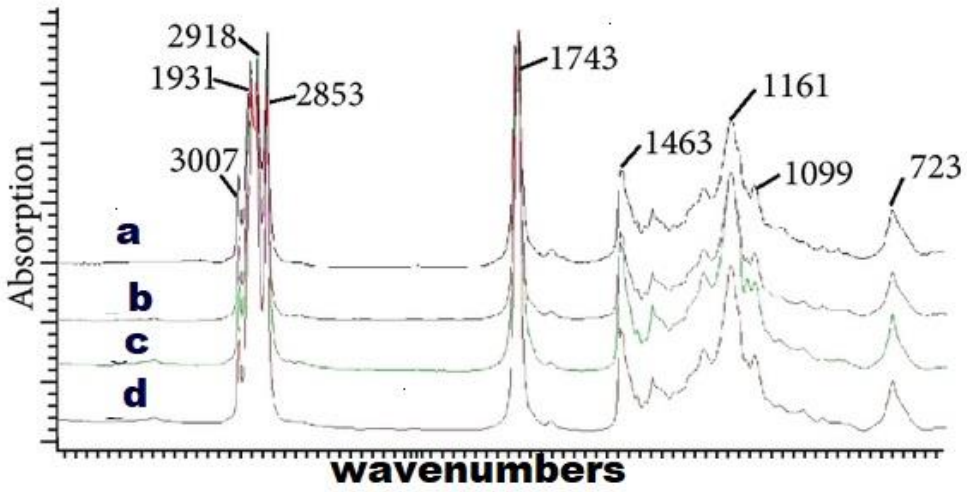
Method and Measurements:

FTIR-spectroscopy measures IR region ranging from 14000cm^{-1}-50cm^{-1} in electromagnetic radiation spectrum. The theory that it works is that the bond between different elements absorb light at different frequency. The sample which absorbs IR light radiation at different wave length is measured to detect the molecular and structural composition of the material. The main device that is present in the FTIR spectrometer is interferometer which identifies the samples by sending an optical signal which is having all IR frequencies. The interferometer that consists of a beam splitter, one movable mirror and another fixed mirror. The IR radiation that is sending through the source through the colimeter to the beam splitter. The half of the light is reflected and half of the light is transmitted by the beam splitter. The transmitted light and the reflected light strike the fixed mirror and the movable mirror respectively. The two lights reflected back by the mirrors and 2 beams of light recombine with each other at the beam splitter and which undergo constructive and destructive interference as the changes in the position of moving mirror to produce interference pattern. The light beam is passed through the sample, some radiation is absorbed by the sample and some passes through it. The resulting signal at the detector is a spectrum representing a molecular finger

print of the sample. FTIR combined with ATR and chemometric software. ATR is the attenuated total reflection which works on the property of total internal reflection. To collect the infrared spectrum in ATR mode the sample is placed on the surface of the crystal which is having greater refractive index. By using the property of TIR it gives an evanescent wave.

The detection of the adulterants in the virgin walnut oil (VWO). The spectrum obtained from FTIR using HATR crystal with DGTS detector. The measurements of oils sample is done by putting the sample directly on crystal surface at controlled room temperature. By the resolution of the $4cm^{-1}$, 40 scans are collected in the IR region of $4000\text{-}650cm^{-1}$. The sample spectra is displayed as the average spectra but it is collected in the triplicate. After every sample scanning the crystal was cleaned with hexane twice and acetone and then dry with a clean tissue for the data of each spectrum.

Results and discussion:



IR spectra of soybean oil (SO), pure tea seed oil (PO), sunflower oil (SFO), and virgin walnut oil (VWO) at IR region of 4000–650 cm^{-1}. (A) VWO, (B) SO, (C) PO, and (D) SFO.

It is very difficult to detect adulterants in oils and fats physically. Because, some of the oils and fats may have similar chemical composition. So, IR spectroscopy is very important in identification of the molecular structure and absorption bands of the particular functional groups. Most of the peaks and shoulders of the spectrum are characteristic of the specific functional groups of different oils and fats. FTIR spectroscopy allows one to differentiate authentic oils which is adulterated with others because of fingerprint technique. We can also observe adulteration by studying the spectral changes. The figure exhibits IR spectra of SO, PO, VWO and SFO at the region of $4000\text{-}650cm^{-1}$. The spectrum of VWO, SO, PO and SFO, there is some difference to VWO with respect to the spectra of SO, PO and SFO at the frequency of $3007cm^{-1}$. $2854cm^{-1}$ due to symmetrical and assymmetrical strectching vibration of $-CH_2-$. $1463cm^{-1}$ because of $-CH_2$ bending

and 1098cm^{-1} of C−O and 722cm^{-1} of cis −CH=CH− bending vibrations. The frequency regions are observed. The spectral variation is seen in the above frequency regions between VWO and SO, PO and SFO (Edible oils). Hence it is shows that the VWO was adulterated by vegetable oils (SO, PO and SFO).[7]

Conclusions:

The adulteration of oils and fats is the most serious issue in the society. So many techniques are there to detect the adulteration in the oils and fats. The most useful technique is FTIR-ATR spectroscopy. FTIR-ATR combine with chemometrics give a specific analysis of the edible oils. It is very simple and sensitive analytical tool and quick data accession tool. FTIR is much suitable analytical tool for the authentication of oils and fats because of its simplicity and their user friendly, no usage of reagents and inexpensive analytical processes. FTIR spectroscopy of wave analysis is a wonderful technique for the authentication of oils and fats. Due to the fingerprint analysis nature of FTIR-ATR it is emerging as a powerful technique in the authentication analysis of oils and fats as mentioned in this review. Nowadays it is the most standardized method used in the quality control laboratories.

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