Quality Analysis of Reheated Oils by Fourier Transform Infrared Spectroscopy

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Keywords: Fourier transforms infrared, soybean oil, quality analysis

Abstract. Based on the study of Fourier transform infrared (FT-IR) spectroscopy of the unheated and repeated heating soybean oil, the identification method is rapidness for quality analysis of reheated oil measure quickly quality analysis of the cooking oils. The article records the Fourier transform infrared spectrum of the reheated conspecific soybean oil at the different time and thermostat 200° C. The results showed that the unheated and repeated heating soybean oil had basic same infrared spectra in 4000 ~ 500 cm^{-1} and the same absorption peaks at 3008, 2925, 2854, 1745, 1460, 1373, 1163, 723 cm^{-1}, which showed that the cooking oils had the main compositions, The strength of absorption peaks were different showed that the quantities of main compositions were different in different heating time of soybean oils. This method was a simple and fast way for the quality analysis of the cooking oils.

Introduction

Repeatedly used vegetable oil is the main component triglycerides, However, repeated use will bring about changes to physical and chemical destroy, destroy the nutritional value of food, or even produce some hazardous substances, Long-term would cause significant harm to the human body, and even induce cancer[1]. As food safety incidents continue to occur, rapid response analysis means more and more attention. Therefore, it is very important to find a way to quickly and accurately detect the quality of edible oil. The development of modern FT – IR spectrographic technique rendered it easier. In recent years, with the rapid development of the accessory and the stoichiometry, the infrared spectrum plays a more and more important role in the field of rapid detection[2][3]. The application of infrared spectroscopy in the analysis of oil field has become a hot research topic [4]. Bert rapid detection of fatty acid composition of canola, flax, and solin by near infrared spectroscopy [5].Gonzaga analyzed the oxidative stability of edible oils at frying temperatures using near infrared emission spectroscopy [6]. Pereira proposes an analytical method for simultaneous near-infrared spectrometric determination of acidity, refractive index and viscosity in four types of edible vegetable oils (corn, soya, canola and sunflower),and pointed out that a single calibration can be successfully performed for each parameter, without the need for developing a separate model for each vegetable oil type[7]. Yang investigated 10 different kinds of edible oils and fats by Fourier transform mid-infrared, near-infrared and Raman spectroscopy and to compare the performance of these spectroscopic methods for edible oil/fat study [8]. studies show that soybean oil is a natural and reasonable structure of natural edible oil. In this paper, the infrared absorption spectra of soybean oil were determined by Fourier infrared spectroscopy for example, soybean oil was used as an example. Based on the research of the peak shape, peak height can be obtained quickly identify the complex method of hot soybean oil quality [9].

Experimental

Instruments and reagents

WQF-510 type Fourier transforms infrared spectrometer (Beijing Rayleigh Analytical Instruments, Inc.).DTGS detectors, standard 2 cm diameter removable liquid pool, KBr salt tablets.

Samples and sources

(1) Selected a selled-well sample on the market of soybean oil as the basic conditions, quality standards, origin, production methods and other analysis as shown in Table 1.

Table 1 oil sample basic

	Qualiy Standads	Manufaturing	Place ofproduction	Prodution Method
soybean oil	GB1535	2014.10.13	Tianjin	Leaching

(2) The major oil heated to 200 °C, to maintain constant temperature, respectively, in unheated and heated 0, 20, 40, 60min time a sample was taken as sample 0, 1, 2, 3 ,4(such as Figure 1).

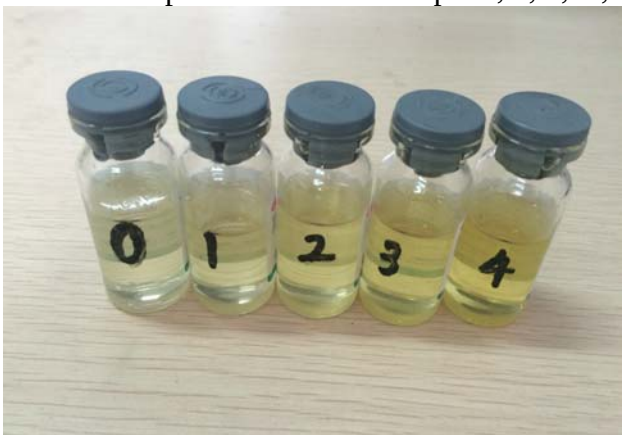

Figure 1 laboratory sample

(0) unheated soybean oil (1) constant temperature of 200°C, heating 0 minutes (2) constant temperature of 200°C, heating 20 minutes (3) constant temperature of 200°C, heating 40 minutes(4) constant temperature of 200°C, heating 60 minutes

Configuration of the sample

Took a suitable amount of soybean oil samples in the KBr salt central, waited for seconds, closed to another piece of KBr salt tablet, slightly twitched salt tablets, to make the sample form homogeneous liquid membrane.

Experimental Methods

With F-510-type Fourier transform infrared spectrometer scanned, warmed up for 20 minutes and stabilized, it used standard 2cm removable liquid pool in diameter sample, started scan (basic process shown in Figure 1): infrared radiation emitted by the light source, after interferometer into an interference pattern, after the sample is obtained by the interference pattern containing the sample information, by the computer collection, and subjected to fast Fourier transform, absorption intensity variations obtained wave number infrared spectrum, scanned infrared absorption spectrum, scanned range 4000 cm-1 ~ 400 cm-1, resolution: 1 cm-1, accumulated 32 times the number of scans, save trace, printed extracts data spectrum, plotted with Origin.

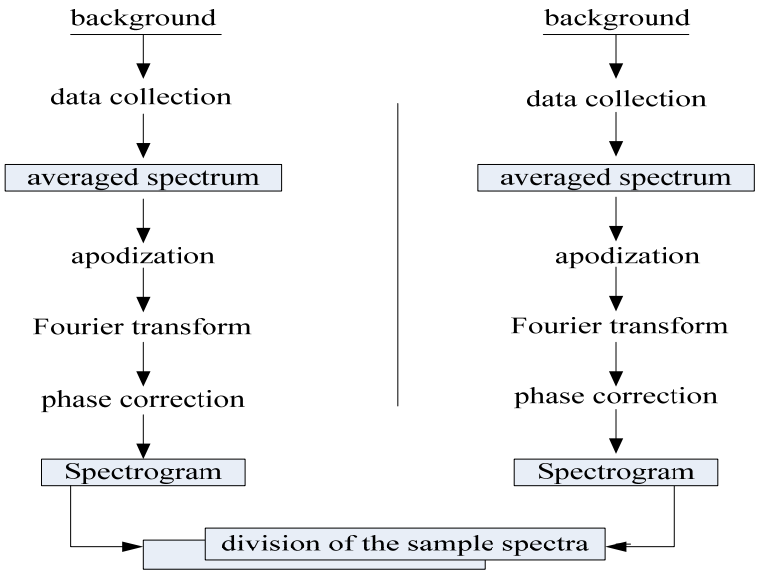

Figure 2 FT-IR analysis flow chart scanning

Results and Discussion

Figure 1 gives the laboratory sample, As can be seen, The color of the soyabean oil progressively deep as the heating time increases. Figure 1 gives the infrared spectra of soybean oil in different heating time. From Fig3 we note that The infrared absorption spectra of unheated and repeated heating soyabean oil in the range of 4000 to500 cm-1 were almost the same. Its basically behave in: The unsaturated carbon C - H expansion vibration peak at 3008 cm-1, The saturated carbon C - H expansion vibration peak at2925 and 2854 cm^{-1}, the C = O stretching vibration peak at 1745 cm^{-1}. The bending vibration of methylene peaks at 1460、1373 cm-1. the C- O stretching vibration peak in triglycerides at 1745 cm-1.the Carbon chain frame vibration peak at 723 cm-1.The unheated and repeated heating soyabean oil had basic same absorption peaks at 3008，2925，2854，1745，1460，1373，1163，723 cm^{-1}, (He et al.,2011)which showed that the different heating time of soybean oil had the main compositions .

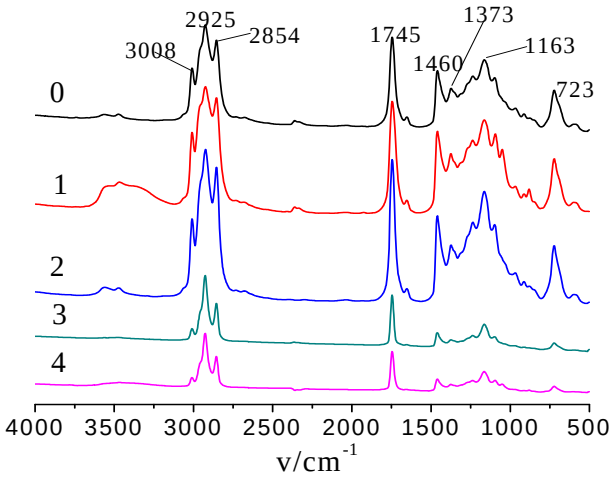

Fig 3 IR spectra of soybean oil at different heating time

(1) unheated soybean oil (1) constant temperature of 200°C, heating 0 minutes (2) constant temperature of 200°C, heating 20 minutes (3) constant temperature of 200°C, heating 40 minutes(4) constant temperature of 200°C, heating 60 minutes

From table 2, although the infrared absorption spectra of soybean oil are basically the same, the relative intensity of their characteristic absorption peaks is different.3008 cm-1 for the unsaturated carbon of the C-H stretching vibration, heated thermostat 200 °C for 30 minutes with the absorbance maximum for soybean oil, sample 1 was heated to 200°C soybean oil, unheated sample 0, followed by soybean oil sample 4 was heated for 60 minutes minimum soybean oil, soybean oil described in the content of unsaturated fatty acids in a short time and with increasing oil temperature increased, but after prolonged heating decreased.2925cm-1 and 2854 cm-1 is a saturated carbon of C-H stretching vibration, samples 0,1,2, high content, indicating that these three samples higher saturated fatty acid content.1460 cm-1 and 1373 cm-1 for the bending vibration peak of a methylene group,1,2 absorbance value larger than other samples, these two samples described high oil content methylene, i.e. a long carbon chain fatty acids, both the 723 cm-1 carbon chain skeleton relatively strong vibration peaks also illustrates this point.1163 cm-1 is that the C-O stretching vibration peak triglycerides, 1,2 absorbance value larger than other samples, indicating that the two samples high triglyceride content. Integrated Table 2, the relative intensity of the absorption peak of the sample 3 and 4 is much smaller than the sample 0, indicating that after the repeated heating of unsaturated fatty acids contained therein, the content of saturated fatty acids and triglycerides in the composition are reduced.

Table 2 Characteristics of each sample in an infrared absorption intensity of spectral absorption peaks (expressed as absorbance)

	Samples 0	Samples 1	Samples 2	Samples 3	Samples 4
A_{3008}	0.877	1.135	1.138	0.373	0.311
A_{2925}	1.374	1.661	1.937	0.986	0.820
A_{2854}	1.198	1.533	1.733	0.663	0.550
A_{1745}	1.233	1.491	1.821	0.0760	0.610
A_{1460}	0.846	1.147	1.175	0.327	0.292
A_{1373}	0.642	0.886	0.836	0.246	0.230
A_{1163}	0.971	1.278	1.454	0.423	0.379
A_{723}	0.620	0.831	0.829	0.208	0.208

NOTE A3008 represents the wave number of 3008 cm-1 absorption peak absorbance

Conclusion

The infrared absorption spectrum of repeated heating soybean oil is very similar to unheated soybean oil, and they are the same characterized by the number of peaks, peak and peak shape. The strength of absorption peaks were different showed that the quantities of main compositions were different in different heating time of soybean oils, This shows that the main composition of the soybean oil after repeated heating has not changed. The strength of absorption peaks were different showed that the quantities of main compositions were different in different heating time of soybean oils, Therefore, by using Fourier infrared spectrometry cooking oil infrared absorption spectrum, based on the research of the peak shape, peak height can be obtained quickly identify the complex method of hot soybean oil quality.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (Grant nos. 61405136 and 61178067), and the Natural Science Foundation for Young Scientists of Shanxi Province (Grant no. 2013021010-4). and College students innovation and entrepreneurship training program of

Taiyuan University of Science and Technology in 2015(Grant nos. xj2015001),and Taiyuan University of Science and Technology graduate student science and technology innovation in 2014(Grant nos.20145009).

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