

Oil Analysis

Analysis of this oil sample was conducted in the Chemical Engineering laboratories at the University of Tennessee Chattanooga by REDACTED

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Experimental Method

The liquid oil sample was characterized on a Bruker Alpha fourier transform infrared spectroscope (FTIR) equipped with attenuated total reflectance (ATR) capabilities over a wavelength range of 400-4000 cm^{-1} at room temperature to determine the surface functional groups in the sample and thereby identify the oil type. FTIR spectra were reported based on five consecutive runs for reliability. Motor oil and three different varieties of commercial edible oil (e.g., Great Value vegetable oil, Publix brand vegetable oil, and Golden Chef vegetable oil) were also characterized using the same conditions for comparison. Finally, the FTIR spectrum of oil sample was compared with the four other commonly used oils analyzed, literature reports, and spectral libraries available in literature to identify the oil type.¹

Results and Discussion

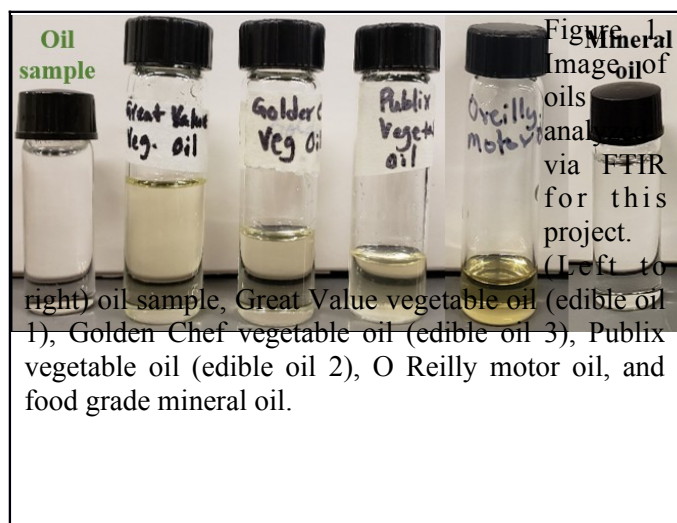


Figure 1. Mineral oil of oils analyzed via FTIR for this project. (Left to right) oil sample, Great Value vegetable oil (edible oil 1), Golden Chef vegetable oil (edible oil 3), Publix vegetable oil (edible oil 2), O Reilly motor oil, and food grade mineral oil.

Figure 1 shows the oil sample and the four other common oils characterized. The oil sample was transparent, but had an odor. The major peaks in FTIR spectrum of the oil sample (Figure 2a) and their attributed chemical bonds are highlighted in Table 1. Two sharp FTIR peaks observed at 2919 cm^{-1} and 2851 cm^{-1} with a shoulder at 2939 cm^{-1} were attributed to the CH_2 aliphatic bend.^{2,3} The spectrum contained a weak peak at 1651 cm^{-1} , characteristic of $\text{C}=\text{C}$ aromatic stretch.³ The transmittance at 1458 cm^{-1} were due to contributions from the CH_2 and CH_3 bending modes while methyl bending vibrations induced the peak at 1374 cm^{-1} .³ A broad peak was observed at 1308 cm^{-1} due to ester linkages and the peak at 719 cm^{-1} corresponded to the aromatic C-H out-of-plane bending vibrations.³ The peaks at 2361 cm^{-1} and 2340 cm^{-1} are due to CO_2 . The FTIR profile matched with literature data and spectral profiles of petroleum based oils such as motor oil, crude oil, diesel, or kerosene.^{2,4,5,6,7}

Table 1. Summary of FTIR analysis for the oil sample

No.	Wavelength of major FTIR peaks (cm^{-1})	Corresponding chemical bond

1	2919 and 2851; shoulder at 2939	CH ₂ aliphatic bend
2	1651	C=C aromatic stretch
3	1458	CH ₂ and CH ₃ bending
4	1374	Methyl bending
5	1308	Ester C-O bond
6	719	C-H out-of-plane bend

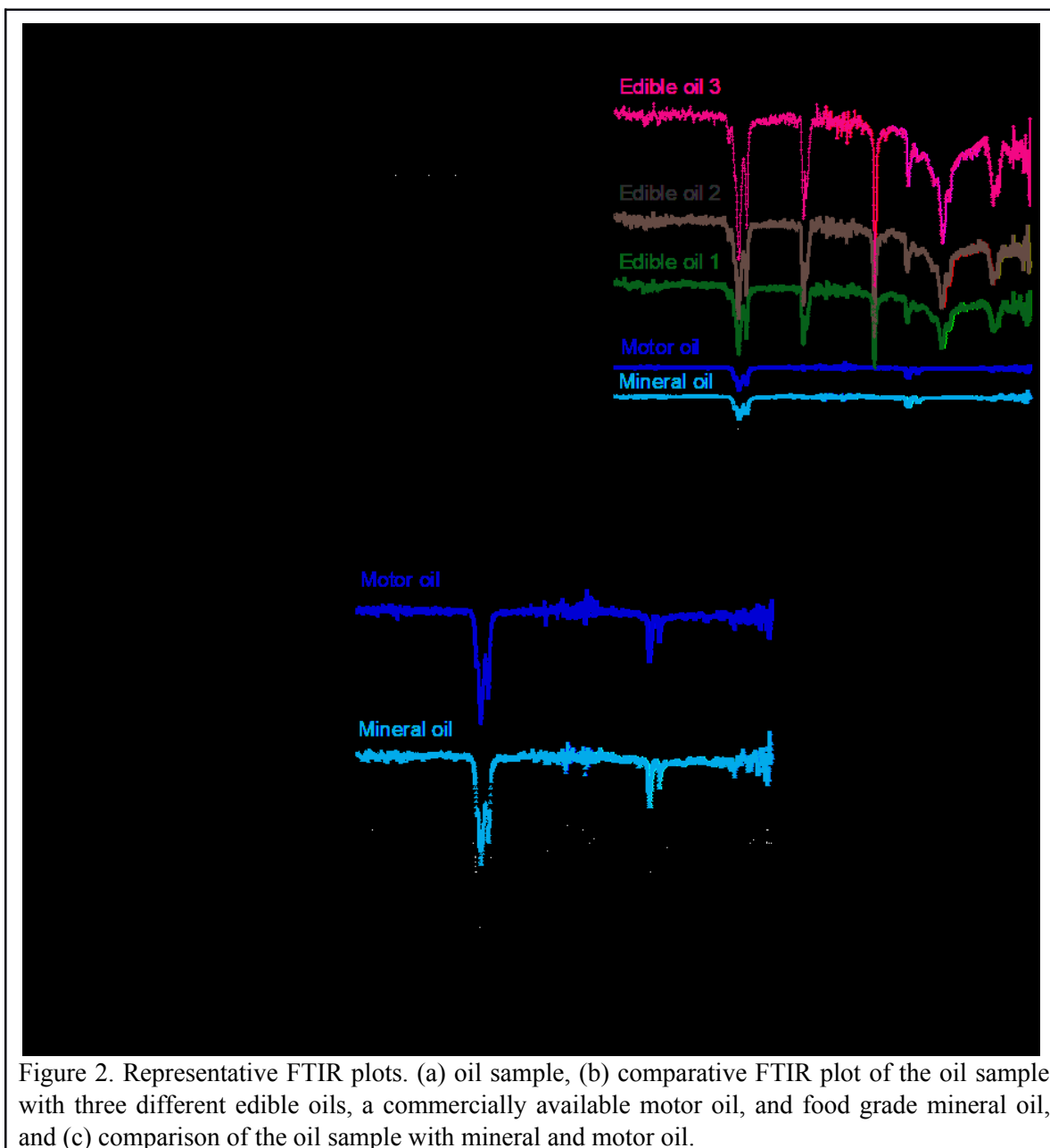


Figure 2. Representative FTIR plots. (a) oil sample, (b) comparative FTIR plot of the oil sample with three different edible oils, a commercially available motor oil, and food grade mineral oil, and (c) comparison of the oil sample with mineral and motor oil.

In the next step, a comparison of this spectrum was made with different edible oils, mineral oil, and motor oil (Figure 2b). A strong peak was observed at 1742 cm⁻¹, characteristic of saturated C=O stretch of aldehydes for the edible oils.⁸ This characteristic peak was also present in all oils derived from

plant and fatty acid or triglyceride sources, based on a detailed literature review.^{9,10} This peak was absent in the FTIR spectrum of the oil sample. In addition, two prominent peaks were observed at 1162 cm⁻¹ and 1098 cm⁻¹ corresponding to C-O ester linkage for edible oils as compared to one ester peak for the oil sample. The fingerprint region of the edible oils showed broad peaks from 719 cm⁻¹ – 668 cm⁻¹, markedly different from the spectrum of the oil sample. Therefore, the spectrum of the oil did not match with edible oil or hydrogenated edible oil. The data confirmed that the analyzed oil sample was not an edible oil or ghee.

The FTIR spectrum of oil sample matched with petroleum derived oils such as mineral oil and motor oil as shown in Figure 2c. Motor oil is not a clear liquid, unlike the provided oil sample. A closer match was observed with mineral oil, which is also a transparent colorless liquid obtained as a by-product of crude refining for the production of gasoline or diesel. The results strongly suggest that the oil sample is mineral oil.

Conclusion

Our detailed analysis based on FTIR suggest that this oil sample does not belong to the class of edible oils or oils derived from fatty acids, triglycerides, and plant sources. The FTIR profile indicate a petroleum derived product, particularly mineral oil. Further analysis such as gas chromatography mass spectrometry, solvent extraction, and nuclear magnetic resonance could be used to confirm these results.

References

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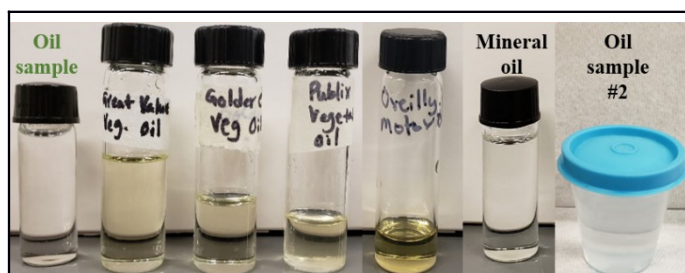


Figure 1. Image of oils analyzed via FTIR for this project. (Left to right) oil sample, Great Value vegetable oil (edible oil 1), Golden Chef vegetable oil (edible oil 3), Publix vegetable oil (edible oil 2), O Reilly motor oil, food grade mineral oil, and oil sample 2.

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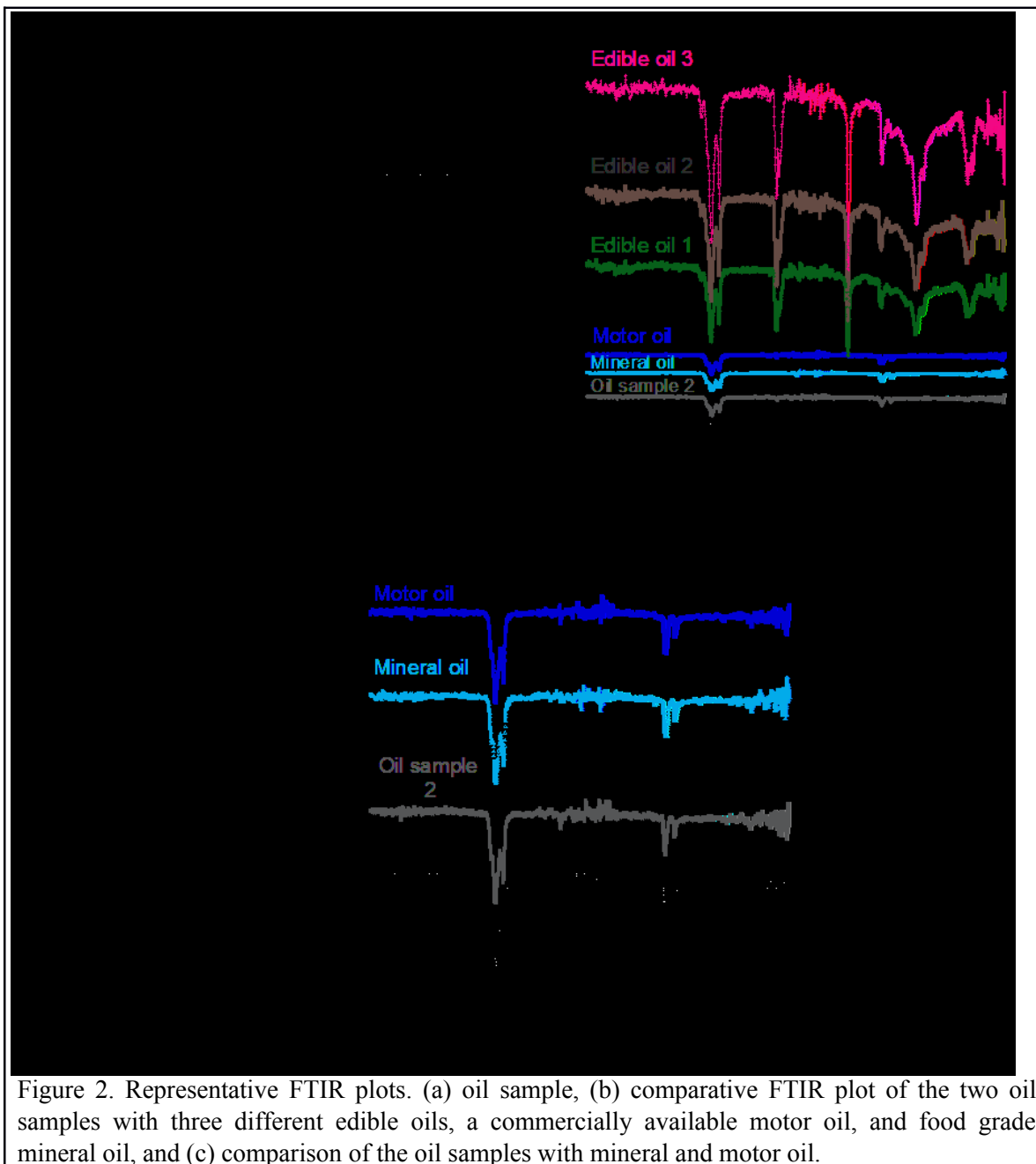


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