Detection of Edible Oil Adulteration Using Mir Spectroscopy and Pca.

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Abstract-*Edible oils are a commonly used cooking ingredient around the world. The availability of edible oils has led to adulteration. The industries have a demand to provide a simple solution for detecting oil adulteration. A method using Mid Infrared spectroscopy and PCA was developed to classify adulteration of edible oils with palm oil. Samples of unadulterated and adulterated edible oil with different ratios are collected using Mid Infrared spectrometer. Principal component analysis was done on Mid infrared spectral datas. The developed method could detect as low as 1.25ml adulteration.*
Keywords-*edible oil, Mid infrared , Principle Component Analysis*

I. INTRODUCTION

Edible oils mostly consists of triglycerides(98%) and some amount of sterols, phospolipids, carotene and fat soluble vitamins like A,D,E,K. The three fatty acid that is attached to glycerol molecule in the triglycerides can be saturated, mono unsaturated, poly unsaturated. This difference helps in uniquely identifying each fatty acid. The fatty acids also differ by their chain length, type of isomerism. By spotting them we can identify each fatty acid. Mostly these edible oils are extracted from oil seeds and some plants.

Oils like coconut oil, castor oil, sesame oil, ground nut oil are mostly used by south east Asian people as it possesses many nutritional and medical uses.
The nutritional and medical uses are as follows:
● They are mostly composed of unsaturated fatty acid that is considered to be healthy and found to maintain heart health.
● They have a good amount of antioxidant that helps in free radical scavenging leading to the prevention of cell damage.
● They also serve as a carrier of vitamins like A,D,E,K.
● They also possess some antioxidant activity(Lauric acid in coconut oil)
● They also improve the cognitive abilities of Alzheimer and dementia patients.(coconut oil, groundnut oil)
● These oils have anti inflammatory properties helping in the treatment of joint inflammation, tooth aches, scrapes.(sesame oil)
● They also help in long term blood sugar level regulation.(sesame oil)
● They also produce laxative effect helping in the movement of food materials to intestine leading to the prevention of temporary constipation.(castor oil)
● They have anti fungal properties and fight against fungus like *Candida Albicans*.(castor oil)

II. MATERIALS AND METHODS

Fresh edible oils includes Coconut oil (CO), Castor oil (CA), Palm oil (PA), and Sesame oil (SE), Groundnut oil (GR) were obtained from local market and kept in ambient condition till the end of the experiment. coconut oil , caster oil ,groundnut oil, sesame oil are adulterated with palm oil in different ratios.
ATR-MIR Spectra acquisition:
The spectra of all the pure oils and adulterant oils taken were obtained using The Attenuated Total Reflectance – Mid Infrared Spectrometer (ATR-MIR). ATR uses a property of total internal reflection resulting in an evanescent wave. A beam of infrared light is passed through the ATR crystal in such a way that it reflects at least once off the internal surface in contact with the sample. This reflection forms the evanescent wave which extends into the sample. This consists of a grating in which the samples were dropped for absorbance. The source and the detector are3 placed at opposite corners of the grating. so as the sample must cover all the nooks and corner of the grating, thus the entire wave can be detected by the detector. The wavelength of the MIR is 5

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to (25-40) microns. The IR light source passes through the sample and the absorbance wavelength is obtained, similarly 200 measurements were done for single sample.(Described about the internal components)

First distilled water is used to calibrate the device. After the reading of water sample gets over, the oil sample is taken, once the oil sample gets finish, triplicates of the oil sample were taken. It is then repeated for four times. After each triplicate the ATR plate is cleaned using a soft tissue soaked in acetone to clean the residues of oil. Then it is cleaned with distilled water and water reference is taken at a regular interval of a triplicate. The above procedure were followed for each oil sample.

The "Customised acquition software" is used to detect the absorbance at the respective wavelength. 44 readings were taken for each oil and the readings were processed with Principal component algorithm (PCA). This PCA algorithm makes a cluster with the use of give transmittance values of each oil.

III. RESULTS AND DISCUSSION

IR spectra can be used as a potential tool which allows one to make a first differentiation among the different ratios of the oils. By comparing the standard spectrum of the groundnut oil, palm oil, castor oil, sesame oil and coconut oil with the spectrum of ratio of mixture of those oils, we can conclude that what are the adulterants present in them can be observed. It is clear that, in all the 5 spectrum there is some changes in the harmonic peaks of normal frequency samples containing adulterants can also be measure in this region. It can be observed that the oil samples contains some components in very low proportions that are also present in similar concentrations. This could be due to degradation of the small amount of the hydro peroxides contained in the oil. Castor oil can be differentiated with palm oil by investigating the position of fatty acids, saturation level of the chains and the specific minor components present in the oils.
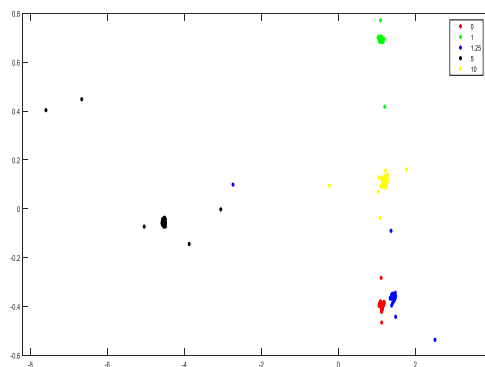

Figure 1 shows the variations in combination of pure coconut oil and palm oil adulterant with 15:5,10:10,18.75:1.25,18.75:1.25 respectively in PCA score plot.
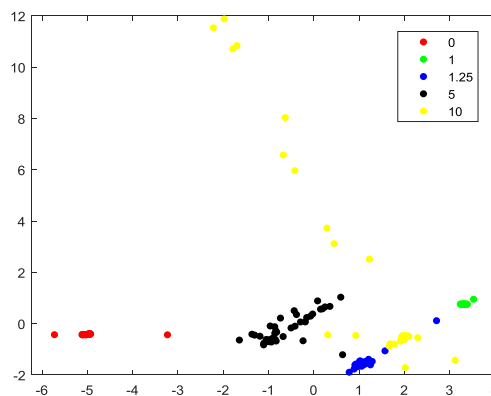

Figure 2 shows the variations in combination of pure caster oil and palm oil adulterant with 15:5,10:10,18.75:1.25,18.75:1.25 respectively in PCA score plot
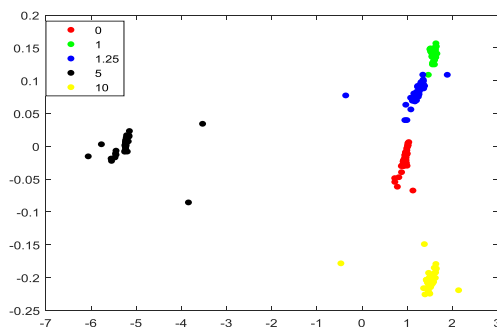
Figure 3 shows the variations in combination of pure groundnut oil and palm oil adulterant with 15:5,10:10,18.75:1.25,18.75:1.25 respectively in PCA score plot.
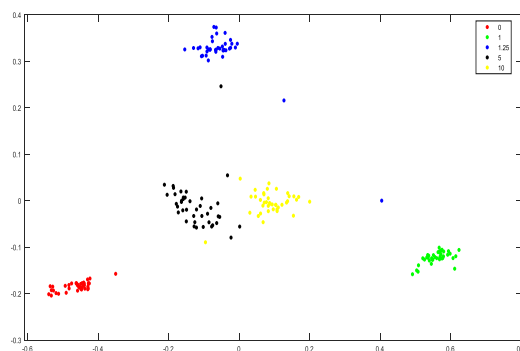

Figure 4 shows the variations in combination of pure sesame oil and palm oil adulterant with 15:5,10:10,18.75:1.25,18.75:1.25 respectively in PCA score plot.

IV. CONCLUSION

MIR spectroscopy can measures the spectral changes in the oils. Detection of edible oil adulteration using MIR spectroscopy techniques has been done. We have concluded that MIR spectroscopy can differentiate edible oil types and adulteration at low levels. The methodology MIR spectroscopy with PCA algorithm detects the pure castor oil, coconut oil, groundnut oil sesame oil adulterant with different ratios of palm oil. The time taken to detect pure oil and adulterant oil is very less, and cost effective.

REFERENCE

[1]. Assessment of Virgin Olive Oil Adulteration by a Rapid Luminescent Method by Raúl González-Domínguez published in Foods 2019, 8, 287; doi:10.3390/foods8080287.
[2]. "Edible oil adulterations: Current issues, detection techniques, and health hazards" by Shubham Yadav in International Journal of Chemical Studies 2018.
[3]. Detection, Purity Analysis, and Quality Assurance of Adulterated Peanut (*Arachis Hypogaea*) Oils by **Shayla C in Foods.** 2018 Aug;
[4]. Identifying camellia oil adulteration with selected vegetable oils by characteristic near-infrared spectral regions by Xuan Chu in Journal of Innovative Optical Health Sciences 2017.
[5]. Analysis of Food Adulterants in Selected Food Items Purchased From Local Grocery Stores Navya P International Journal of Advances in Scientific Research 2017.
[6]. Adulteration of sesame oil with corn oil detected by use of two-dimensional infrared correlation spectroscopy and multivariate calibration by **R. J. Yang** in An International Journal for Rapid Communication 2016.
[7]. NIR detection of honey adulteration reveals differences in water spectral pattern by György Bázár in food chemistry journal 2016.
[8]. Fuel Adulteration Detection System by V. Jersha Felix1 in Indian Journal of Science and Technology, Vol 8(S2), 90-95, January 2015.