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Research Article

Prediction of Lard in Palm Olein Oil Using Simple Linear Regression (SLR), Multiple Linear Regression (MLR), and Partial Least Squares Regression (PLSR) Based on Fourier-Transform Infrared (FTIR)

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Fourier-transform infrared (FTIR) offers the advantages of rapid analysis with minimal sample preparation. FTIR in combination with multivariate approach, particularly partial least squares regression (PLSR), has been widely used for adulterant analysis. Limited study has been done to compare PLSR with other regression strategies. In this paper, we apply simple linear regression (SLR), multiple linear regression (MLR), and PLSR for prediction of lard in palm olein oil. Pure palm olein oil was adulterated with lard at different concentrations and subjected to analysis with FTIR. The marker bands distinguishing lard and palm olein oil were determined using Fisher's weights. The marker regions were then subjected to regression analysis with the models verified based on 100 training/test sets. The prediction performance was measured based on the percentage root mean square error (%RMSE). The absorption bands at 3006 cm^{-1}, 2852 cm^{-1}, 1117 cm^{-1}, 1236 cm^{-1}, and 1159 cm^{-1} were identified as the marker bands. The bands at 3006 and 1117 cm^{-1} were found with satisfactory predictive ability, with PLSR demonstrating better prediction yielding %RMSE of 16.03 and 13.26%, respectively.

1. Introduction

Adulteration of oils is an issue persisting in the market [1]. In 2013, a company in Taiwan was found to market cheaper oils as premium class oils. This was followed by an incident of lard-based cooking oil being adulterated with gutter oil where more than 1,300 food products were affected [2, 3]. Consumer Voice [4] further reported that 47.09% of 1,015 edible oil samples tested from 14 states in India were not in compliance with the Food Safety and Standards Regulations.

Lard is considered one of the cheaper oils in the food industry. It can be blended effectively with other oils, with the intention to reduce the production cost. The presence of lard in cooking oil is important due to two perspectives: economic considerations and religious restrictions. Religions such as Islam and Judaism forbid the consumption of swine and any of its derivatives [1, 5] and hence should not be present in halal-labelled products. From the economic perspective, the credibility of Malaysia as a major producer and exporter of palm oil would be at risk should their products be found adulterated. A company in Malaysia was allegedly charged with intention to export palm oil adulterated with fatty acid to Sri Lanka [6].

Various methods have been developed to identify the adulteration of cooking oil; these include Gas Chromatography Mass Spectroscopy (GC-MS), High-Performance Liquid Chromatography Mass Spectrometry (HPLC-MS), Fourier-Transform Infrared (FTIR), Nuclear Magnetic Resonance (NMR), etc. The advantages and disadvantages of these analytical methods for adulterant analysis are summarized in Table 1.

Most of these techniques are costly and time-consuming. FTIR offers the advantages of rapid analysis with minimal sample preparation and is inexpensive. This technique,