

Short Communication

DEVELOPMENT OF LARD DETECTION IN CRUDE PALM OIL (CPO) USING FTIR COMBINED WITH CHEMOMETRICS ANALYSIS

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ABSTRACT

Objective: The aim of this research to detect lard in crude palm oil (CPO) using FTIR spectroscopy combined with partials least square (PLS).

Methods: Development of analysis method of lard in CPO using FTIR combined with PLS to quantification of lard in CPO. Data processing in this study is looking for correlation about actual value and FTIR predicted value. The good correlation will give the higher coefficient of determination (R^2 value), and lowest of root mean square error calibration (RMSEC), and root means square error cross validation (RMSECV).

Results: The results showed that the analysis method using FTIR spectroscopy to detect lard in a combination of the fingerprint spectrum at wave number 1481-999 cm^{-1} with wave number 1749-1650 cm^{-1} . This research resulted good correlation about actual value and predicted value at combination of wave number 1481.22-999.05 and 1793.67-1650.95 with R^2 value is 0.998. The detection error is lowest because it has a smaller of RMSEC and RMSECV value with 1.291% (v/v), 0.838% (v/v) respectively.

Conclusion: The characteristic of lard in CPO can be detected using FTIR spectroscopy combined with PLS at wave number 1481.22-999.05 and 1793.67-1650.95 with R^2 value is 0.998 and RMSEC, RMSECV value with 1.291% (v/v), 0.838% (v/v) respectively.

Keywords: FTIR, Halal authentication, Lard detection, CPO

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The detection process of lard in food products has been developed. The aims of this research to detect lard using the fast and simple method because it is difficulty for identifying lard in food products with directly identification using the eye. The method for detect lard in food using FTIR. This instrument has advantage in analytical method. The FTIR analysis is one method that is simple and non-destructive. It is appropriate from [1] that FTIR is a method that is fast, simple, non-destructive and has a great precision. Reference [2] reported that FTIR combined with PLS is an alternative technique for determination of individual curcuminoid. In this case, the application of FTIR spectroscopy is used to detect the various type of vibration of functional groups from lard. Therefore, the basis of infrared spectroscopy is a technique that is based on the vibration of atoms in molecule [3]. The development of the analytical method in this research is looking for of wave number Fourier Transform Infrared (FTIR) which it has characteristics for detect lard in crude palm oil (CPO).

The application of FTIR spectroscopy combined with PLS and discriminant analysis (DA) for quantification and classification of cream mixed with lard [4]. The development process in lard detection depends on a matrix of materials. According to [1] reported that the optimization of FTIR wave number in the detection beef fat in butter at wave number 1500-1000 cm^{-1} . Reference [5] also reported that the optimization of FTIR in the chicken detection in butter at wave number 1200-1000 cm^{-1} . The other research from [6] reported that FTIR wave number region at 4000-650 cm^{-1} can be used to detect red fruit oil at first derivative spectrum, corn oil at second derivative spectrum and soybean oil at the second derivative spectrum.

This research was aimed to optimize of wave number of FTIR for detection of lard in CPO. The identification method to look for characteristics spectrum to detect lard in CPO using FTIR combined with PLS. The FTIR spectrums were processed in 3 conformations such as normal spectrum, first derivative and second derivate of FTIR spectrum.

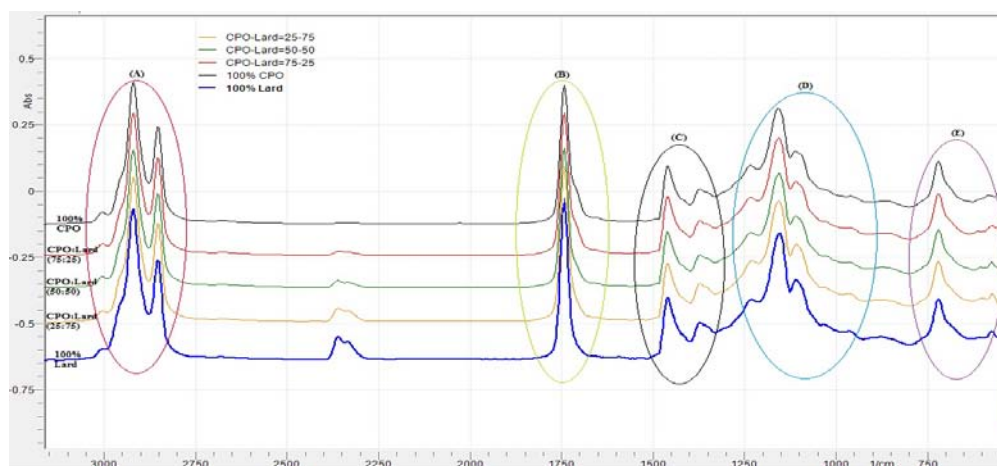


Fig. 1: Normal FTIR spectrum of lard and CPO oil on various concentration ratios

The method development to detect lard in crude palm oil (CPO) using FTIR spectroscopy combined with chemometrics to identify and look for fingerprint area from spectrum FTIR which it has characteristics for lard. References [7] reported that the composition of an amino acid profile in different meat has differences. In this study, the detection of lard in CPO base on vibrational of functional groups of triglycerides or fatty acid. The lard, beef, and CPO have different of triglycerides or fatty acid composition [8, 9]. The differences components of lard and CPO will give differences in the vibrations of FTIR spectrum. Fig. 1 is a normal wave number of FTIR spectrum that will be optimized to determine the characteristics of wave numbers that distinguish between lard and palm oil.

Fig. 1 showed that the FTIR spectrum was selected of some wave number areas. The selection process is based on the vibration of functional groups in lard and palm oil. The vibration of functional

groups of fat appears at wave number above 3000 cm^{-1} which is the alkenes ($\text{Csp}^2\text{-H}$) vibration. While the alkanes ($\text{Csp}^3\text{-H}$) vibration appears at wave number 2800-3000 cm^{-1} . The carbonyl group vibration appears at wave number 1745 cm^{-1} and the $\text{-CH}_2\text{-}$ (methylene) and -CH_3 (methyl) vibration appears at wave number 1450 cm^{-1} and 1375 cm^{-1} respectively. The lard and CPO have a similarity of vibration type of functional groups.

The FTIR spectrum of lard and CPO has different. It has seen of some wave number areas is A) wave number 2990-3045 cm^{-1} is characteristic vibrations of functional groups alkane and alkene group, B) from 1749 to 1650 cm^{-1} that the vibration of carbonyl functional group, C) and D) 1481-999 cm^{-1} which both are FTIR fingerprint area, and E) wave number of 779-650 cm^{-1} is a vibrational of functional group for the double bond in the cis or trans form.

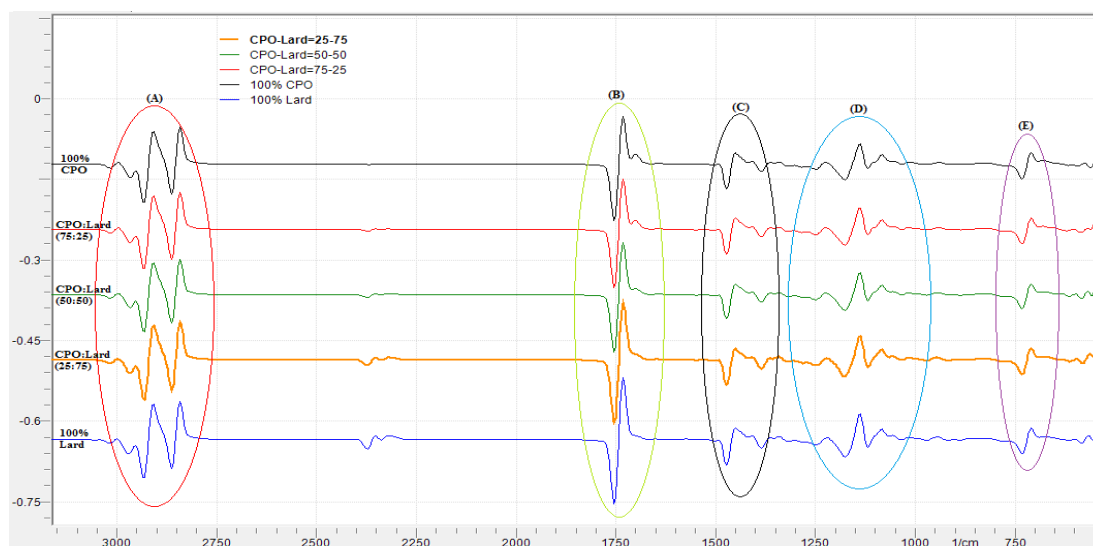


Fig. 2: First derivate of FTIR spectrum of lard and CPO oil on various concentration ratios

The analysis method using FTIR for lard detection with a combination of the fingerprint spectrum at wave number 1481-999 cm^{-1} with wave numbers such as 779-650 cm^{-1} , 1749-1650 cm^{-1} and 2990-3045 cm^{-1} . The optimization process of the wave number of FTIR spectrum was also performed on the first and second derivative FTIR (fig. 2 and fig. 3). The

optimization process of wave number at first and second derivatives is done with the same way as normal FTIR spectrum. Detection optimization is expected to generate wavenumbers that are characteristic of lard. The development method is demonstrated by the sensitivity, accuracy and precision are both in the detection process of lard in CPO.

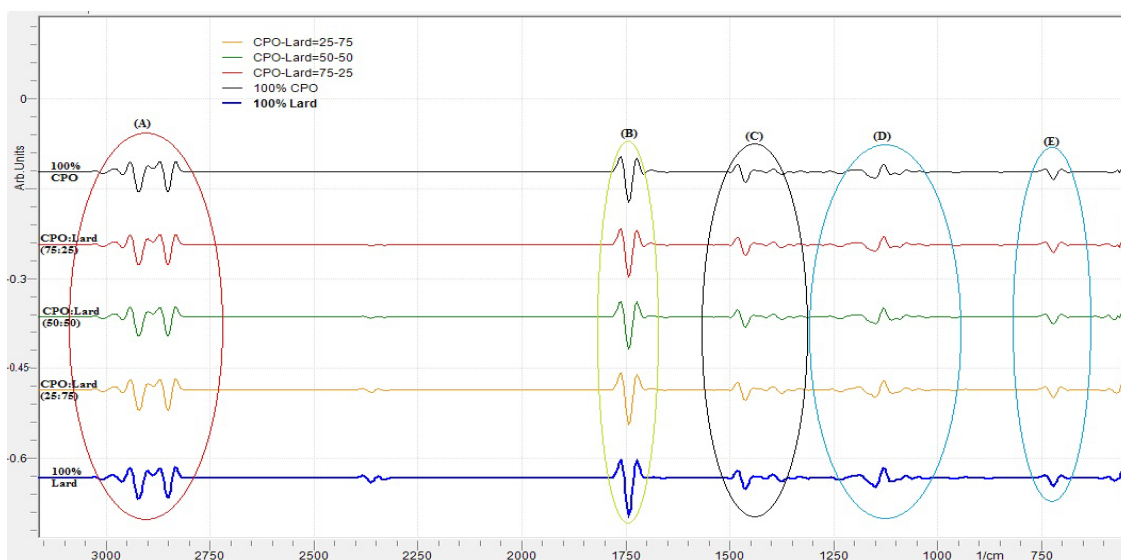


Fig. 3: Second derivate of FTIR spectrum of lard and CPO oil on various concentration ratios

This optimization process was done by quantification using partial least square (PLS). The process of quantifying the PLS method will make an equation between the actual value and the predicted value. The equation was obtained will can be used to determine the accuracy and precision value. The results of optimization wave with a selection of the determinant coefficient (high of R^2), the good accuracy and precision value (lower of RMSEC and RMSECV). According to [4, 10] reported that the selection process is based on the wave number area high value of the coefficient of determination (R^2) and also low-value RMSEC. The high of R^2 value showed that the

good of relationship between the actual and predicted values. This R^2 value indicated the relationship between the actual value and the predictive value of FTIR on the sample [1].

The results of this study showed that the good of calibration model is the combination of 1481.22-999.05 cm^{-1} and 1793.67-1650.95 cm^{-1} in normal of FTIR spectrum (table 1). The result of this research has a different result from [10] research. According to [10] reported that the optimization results of FTIR spectrum for lard detection in crude palm oil (CPO) at wave number 1480-1085 cm^{-1} .

Table 1: Data processing using PLS method in combination of wave number 1480-1085 cm^{-1} and another wave number of FTIR spectrum

Kind of spectra	Wavenumber (cm^{-1})	Calibration curve		Validation curve	
		R^2 value	RMSEC	R^2 value	RMSECV
Normal	999.05-1481.22	0.8774	3.688	0.981	5.342
	999.05-1481.22 and 651.95-763.75	0.9875	2.051	0.996	2.379
	999.05-1481.22 and 1650.95-1793.67	0.9983	1.291	0.999	0.839
	999.05-1481.22 and 2769.57-3020.30	0.9192	3.473	0.986	6.229
1 st Derivate	999.05-1481.22	0.9930	1.829	0.998	1.531
	999.05-1481.22 and 651.95-763.75	0.9960	1.537	0.999	0.835
	999.05-1481.22 and 1650.95-1793.67	0.9979	1.287	0.998	1.292
	999.05-1481.22 and 2769.57-3020.30	0.9884	1.981	0.995	2.523
2 nd Derivate	999.05-1481.22	0.9953	1.567	0.998	1.189
	999.05-1481.22 and 651.95-763.75	0.9977	1.325	0.999	0.829
	999.05-1481.22 and 1650.95-1793.67	0.9984	1.187	0.999	0.943
	999.05-1481.22 and 2769.57-3020.30	0.9932	1.730	0.996	2.201

The best result of optimization method for detect of lard in CPO at combination of wave number 1481.22-999.05 and 1793.67-1650.95 cm^{-1} was producing the R^2 value, RMSEC and RMSECV value, are 0.998, 1.291 % (v/v), 0.838% (v/v) respectively (table 1). The research from [10] produced the R^2 value, RMSEC and RMSECV, are 0.998, 1.69% and 2.87% (v/v) respectively. Quantitative analysis will be performed by minimization of RMSEC value, RMSECV value and resulted in excellent predictions between the actual value and predicted FTIR value [11]. The results of this study showed that the optimization method has a small error which it indicated from lowest of RMSEC and RMSECV value. The result of this research has a good linearity and low error detection. The quantification analysis to detect of lard in CPO can use the combination of this wave number.

CONCLUSION

Development of analysis method to detect lard in CPO can be detected at wave number 1481.22-999.05 and 1793.67-1650.95 cm^{-1} in the normal spectrum of FTIR. The PLS model gives the good result of the correlation about actual value and predicted value with R^2 value is 0.998. The detection error is lowest because it has a small of RMSEC and RMSECV value with 1.291 % (v/v), 0.838% (v/v) respectively.

CONFLICT OF INTERESTS

Declare none

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