Detection of lard contents using fiber optic sensors

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Abstract. Preliminary studies of testing samples using optical fiber sensors were carried out to obtain the appropriate data results and compared with UV-Vis spectrometers as well as to obtain optical characteristics of lard compared with other fat samples. The test method used instruments such as ocean optics HR4000CG-UV-NIR and DH -2000-BAL UV-Vis light source (halogen) NIR with wavelength range (200-1200) nm. The results of testing pure pork samples (chicken and beef mixture) with optical fiber sensors obtained peaks at $\lambda = 715$ nm and $\lambda = 937$ nm. The characteristics possessed by pure pork samples are high intensity (reflecting) values and low absorbance (absorption). Tests carried out with optical fiber indicate the detection of pure lard content or with a mixture of other ingredients. The graph of absorbance relation to concentration shows an upward linear trend with a value of $R^2 = 0.092193$, 0.9474 and 0.95901.

1. Introduction
Meat is a food that is often consumed by humans. Technology has development and the crime of food forgery is easy to do. Indonesia is a country with a majority Muslim population. One of the prohibitions in the Islamic religion is to consume pork. Research conducted using the Sodium Dodecyl Sulfate-Polyacrylamide Gel Electrophoresis (SDS-PAGE) electrophoresis method found that the Rheumatoid Factor (RF) value is not good for the human body if consumed in raw pork [1]. Food safety is a major problem in food products in Indonesia caused by lack of government attention and supervision in the processing, production, and distribution of food products [2].

Food product testing has been carried out with many different tools and methods, one of which is to test ingredient content by relying on the chemical properties of the sample using Fourier Transform Infrared (FTIR) [3], Gas Chromatography (GC), Gas Chromatography-Mass Spectrometry (GC-MS), spectrophotometry UV-Vis [4,5], PCR-electrophoresis and gold nanoparticles. Meanwhile, the most commonly used methods are chromatography, electronic scent, Differential Scanning Calorimetry (DSC) and Polymerase Chain Reaction (PCR) [6]. This research is based on the same principles as previous studies, by utilizing optical fiber. The advantage of using optical fiber is that it is inexpensive and widely available, easy to use, and has a high success rate [7,8]. Previous studies at Optic and Photonic Laboratory Sebelas Maret University that successfully conducted research related to the utilization of fiber optic to perform the detection process, among them are the detection of cholesterol content in the blood [9], the detection of glucose content in the blood [10], fiber optic heart rate
detection\cite{11}, Sugar concentration detection\cite{12}, persistent organic pollutants detection\cite{13}, Glucose Solution Concentration detection\cite{14} and pressure detection\cite{15}. This article is examined by the use of fiber optics to detect the presence of borax in meat. Based on these problems, this study will be carried out as a preliminary study of testing foods and products containing lard using optical fiber sensor.

2. Experimental
The sample is divided into three types, the first sample is a mixture of chicken meat, the second sample is a mixture of beef, and the third sample is a mixture of both. Each sample varies in weight to 0 gram, 10 gram, 20 gram, 30 gram, 40 gram and 50 gram (first and second sample) and 0 gram, 5 gram, 10 gram, 15 gram, 20 gram, 25 gram (sample third). The sample was extracted using a 5 m n-hexane solution, which was mashed with a 25 mL water mixture. After extracting, the sample is filtered with filter paper which is given Na$_2$SO$_4$ powder to bind the remaining water. Initial testing was carried out with a UV-Vis (200-800) nm spectrometer using aquades as a solvent. The second test with optical fiber HR4000CG spectrometer UV-NIR halogen light source (200-1200) nm with CCD array sensor (1 x 3648 pixels) has an optical resolution of 0.3 to 10 nm full width at a half maximum (FWHM), fiber optic cable type ferrule connector (FC) single-mode. Fiber optic cable connects each component in the circuit (Figure 1), the light is fired the sample and then forwarded to the spectrometer to be converted into an information signal that can be read by an oceanview application on a laptop/computer.

3. Result and Discussion
A light is fired on the sample will experience absorption, reflectance, and transmittance depending on the frequency of the sample molecule. Then, the light passes through the diffraction grating and the lens is received by the CCD array and the data is processed. Settings on the oceanview are set with an integration time of 1000 ms and a scan average of 20, the acquisition of data results is shown in Figure 2.
Meat samples were obtained from Pasar Gede, Surakarta, Central Java, Indonesia. The acquisition of data obtained from each sample differs from one another. The two peaks in Figure 2 show the specific characteristics of each sample. The first and second peaks for the pure pork sample obtained 715 nm and 937 nm, and there is a significant shift for the mixed sample. Meanwhile, Figure 2c with a large concentration of pork has the first peak of 702 nm and the second of 930 nm. The intensity in the pure pork sample is higher than the sample of pork in the mixture. Attenuation in the results of Figure 2 is shown from wavelengths of 200 nm to ≥ 628 nm causing some intensity received in the form of negative numbers.

Figure 2. Spectrum graph (optical fiber) of the sample (a) chicken and pork (b) beef and pork and (c) chickens, beef and pork
Figure 3. Results of the linearity from testing samples (a) chicken and pork (b) beef and pork and (c) chicken, beef and pork.

The gradient of the linear equation Figure 3 is used to calculate the value of existence ($\varepsilon$) with the beer lambert law equation and each value of $\varepsilon$ for the first, second and third samples is $\varepsilon_1 = 0.24774 \text{ M}^{-1}\text{cm}^{-1}$, $\varepsilon_2 = 0.27538 \text{ M}^{-1}\text{cm}^{-1}$ and $\varepsilon_3 = 0.86837 \text{ M}^{-1}\text{cm}^{-1}$, for the values of $R^2$ are 0.92193, 0.9474 and 0.95901. Characteristics of sample testing are determined using the first rule in the form of a maximum wavelength ($\lambda_{\text{max}}$) and the second rule in the form of an existing value ($\varepsilon$). The range of $\varepsilon$ from the UV-Vis spectrometer and optical fiber test results is between $10^{-3}$ - $10^3 \text{ M}^{-1}\text{cm}^{-1}$ so that it shows the occurrence of electron transitions in the form of $n \rightarrow \pi^*$. Also, mixed pork samples have a greater absorbance value than pure pork samples. The energy owned by pure pork samples is smaller compared to pure pork samples based on the value of $\lambda_{\text{max}}$ obtained from the conversion of intensities in the results of optical fiber to absorbance.

4. Conclusion
The conclusion of this analysis, the content of lard in the sample can be detected using optical fiber sensors. Light passed into optical fiber is sampled and received by a set of optics and then processed.
by the sensor according to the principle of light propagation. Pure pork samples have a higher intensity than mixed samples and are inversely proportional to absorbance. Optical fiber testing on pure pork and mixed samples showed two peaks in the wavelength range of $\geq 700$ nm and $\geq 900$ nm with linearity in all three samples of 0.92193, 0.9474 and 0.95901.

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