AN ANALYSIS OF LARD BY USING DIELECTRIC SENSING (IMPEDANCE)

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BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : An analysis of lard by using dielectric sensing (Impedance)

Sesi Pengajian :

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To my beloved father and mother

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ABSTRACT

An analysis on lard by using dielectric sensing is a method using interdigitated electrode (IDE) to measure the impedance value of lard. In the current market, there are issue of food adulteration which are non-permissible to Muslim. In this project, each of the sample will be distribute into four which is 0, 2, 4 and 6 reheating hour. Besides, the measurement is taken by using LCR meter EDC-1630 which capable supply frequency in between range of 100Hz to 100 kHz. The scope of this project is using Taguchi method to optimize IDE sensor design and using COMSOL Multiphysic to design the IDE. This project conducted an analysis of rapid first stage screening of lard. The graph of result is generated by using Microsoft excel to show the relationship of impedance, frequency supplied and number of reheating hour. The data analysis is achieved by using statistical method linear regression to prove the relationship of impedance and number of reheating hours.

ABSTRAK

Analysis mengenai lemak khinzir telah dianalysis oleh kaedah dielektrik pengesanan dengan elektrod interdigitated (IDE) untuk mengukur nilai impedans lemak khinzir. Pada masa kini, terdapat isu pencemaran makanan yang mengandungi kandungan yang tidak halal untuk Muslim. Dalam projek ini, setiap sampel telah mengagihkan kepada empat keadaan pemanas semula yang berbeza iaitu 0, 2, 4, dan 6 jam. Selain itu, ukuran impedans dalam projek ini diukur oleh alat LCR meter EDC-1630 yang mampu membekalkan frekuensi dalam julat 100 Hz hingga 100 kHz. Skop projek ini telah menggunakan kaedah Taguchi untuk mengoptimumkan reka bentuk IDE dan melukis dengan perisian COMSOL Multiphysic. Projek ini mengutamakan cara peringkat pertama penapisan yang pantas untuk menganalisiskan lemak khinzir. Graf yang dihasilkan akan menunjukkan hubangan antara impedans, jam pemanas semula, dengan frekuensi yang dibekalkan. Akhirnya, analisis data ini akan dicapaikan dengan kaedah statistik linear regresi untuk membuktikan hubangan antara impedans dengan jam pemanas semula adalah selurus.

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LIST OF ABBREVIATIONS

E-NOSE	-	Electronic Nose
FTIR	-	Fourier Transform infrared Spectroscopy
GLC	-	Gas Liquid Chromatography
IDE	-	Interdigitated Electrode
SNR	-	Signal to Noise ratio
PCR	-	Polymerase Chain Reaction
PCB	-	Printed Circuit Board

CHAPTER 1

INTRODUCTION

This chapter gives an overall overview of the project which including problem statement, objective, significance of study and scope of project.

1. 1 Project overview

Lard is a form of fat which in the saturated or unsaturated form that extract from the fatty acid tissue of pigs. Usually it is extracted from back skin, muscle, surrounding digestive organs, surrounding the kidneys of pig[1]. Scientifically, lard is known as triglyceride, it is mainly consisting fats or fatty acid. Culinary use lard to enhance the flavor and crispiness of food. In addition, lard consisting 48% of monosaturated fat that able to reduce the risk of depression and cholesterol compare to other type of fat.

However, it become a main concern in cuisine where chef and baker use lard as shortening or cooking oil. This had increased the risk of consumption of pork content. Foods which contain lard or pig content is non-permissible for Muslim and vegetarian. In the Islamic religious, halal is which mean permissible or allowed. In Islamic law, there are emphasizing prohibited in sources of food which contain pork or lard.

Due to that, the lard detection technique is becoming an important element to implement in the food industry. Adulteration of origin food has been the main focus or issue in the food industry. Adulteration means the origin of food has been substituted with other substances. Current available lard detection technique is time consuming and expensive. The previous lard detection technique had been tested lard content in few

different forms which is lard adulteration in shortening, lard adulteration with different type of meat, lard adulteration with canola oil and lard adulteration with RBD palm oil. The available lard detection method is sufficient to test the lard adulteration yet it is time-consuming and expensive.

The new lard detector sensor design by using interdigitated electrode circuit. Interdigitated electrode is a circuit which combine two comb-shape like form. Design of interdigitated electrode is simple and effective. From the design, it able to generate capacitive sensing field when supply with a small voltage. The spacing in between of each line on sensing layer are able to measure the changes of dielectric of material.

1. 2 Problem statement

Food is necessary for a human and at the same time the enhancement in food science technologies is getting complicated. So that, the origin ingredient of foods are difficult to understand by consumer. Moreover, Chinese cooking culinary including lard as cooking oil or shortening to enhance the flavor is general. In Islamic law, there are impermissible (non-halal) of food which having lard content. Furthermore, Muslim is the religious second most number of people in the world belief and the number is increasing day by day.

Current available lard detection technique are more than five types which including gas chromatography (GC), Electronic nose, Fourier Transform Infrared (FTIR) spectroscopy, etc. However they are huge, time consuming and expensive.

This project is proposed a first stage screening of lard to overcome the problem encountered with rapid speed, cheaper and more portable size.

1. 3 Objective of study

The objective in this study is to analyze lard by using dielectric sensing method and evaluate the potential and limitation of impedance measurement for lard detection. Besides, this project will perform a data analysis on measurement result of lard.

1. 4 Significance of the study

This project is to analyze a possible method of rapid first stage screening for lard which able detect lard rapidly compare to previous lard detection technique can be implement in a food laboratory for food content verification.

1. 5 Scope

This project is to analyze a first stage screening lard detector by using dielectric sensing technique. This project will start by using Taguchi method to optimize the design of sensor probe. Next, the result will further analyse by using Minitab software DOE (Design of experiment) to obtain the parameter of most sensitive design. Apart of it, the design will be simulate by using COMSOL Multiphysics and lastly fabricate the layout design by using Corel Draw.

After the optimization the design of sensor by using software, the sensor probe or also known as interdigitated electrode will fabricate and connect with LCR meter. The sensor probe will measure the impedance of lard at different reheated hours at room temperature 25 Celsius.

This project is divided into three stages:

- Research on related topics and optimize the sensitivity of sensor
- Fabrication of sensor and verify the functionality
- Measure impedance of lard at different reheated hours

The result obtained will finalize in a graph to show the relationship of impedance and different number of reheated lard.

This project is mainly focus on develop a sensor probe for first stage screening lard detector analyze in rapid and low-cost condition. The whole project is focus on hardware where software is used to analyze the data by using different sensor.

CHAPTER 2

LITERATURE REVIEW

This chapter will highlight the past studies which related with lard detection technique, and interdigitated electrode design.

2. 1 Lard detection techniques

In previous studies, there is some achievement of lard detection for halal authentication. The current issue exists is ingredient label does not include the adulteration of food origin[15], and thus causing the worries of consumers. Therefore, there are methods to identify the adulteration by determining the ratios of different type of chemical composition, and analyze the chemical properties of food in the market. The methods used including Polymerase Chain Reaction (PCR) analysis, Electronic Nose (E-Nose), Gas liquid chromatography (GLC), Fourier Transform infrared Spectroscopy (FTIR), Differential scanning calorimetry and Interdigitated Electrode Sensor.

2.1.1 Polymerase chain reaction (PCR)

This method is a highly sensitive method of extracting the tissue and obtain the information of deoxyribonucleic acid (DNA). Sample species is capable to identify by using this method. Deoxyribonucleic acid (DNA) is a type of genetic form molecule which carries the important unique information of cell[4]. In addition, DNA is stable and non-destructive which brings advantages in the analysis. Therefore, PCR is a high sensitivity method for lard detection.

Tissues extract from samples carries the unique information will be amplified by using a Perkin-Elmer gene amplification PCR system 2400. This method is highly

sustainable for repeated analysis. The advantage of this method over others when the pattern of samples obtained, the references are not needed. Moreover, identification of samples species can achieve by PCR primer combine with few enzymes.

Previous achievement of this method in lard detection is band of 387bp yield when amplification of PCR on 125rRNA gene[7] as shown in Figure 2.1. Apart of it, there are not detected of Mt-DNA on reheated food, hydrolyzed plant proteins and purify oil.

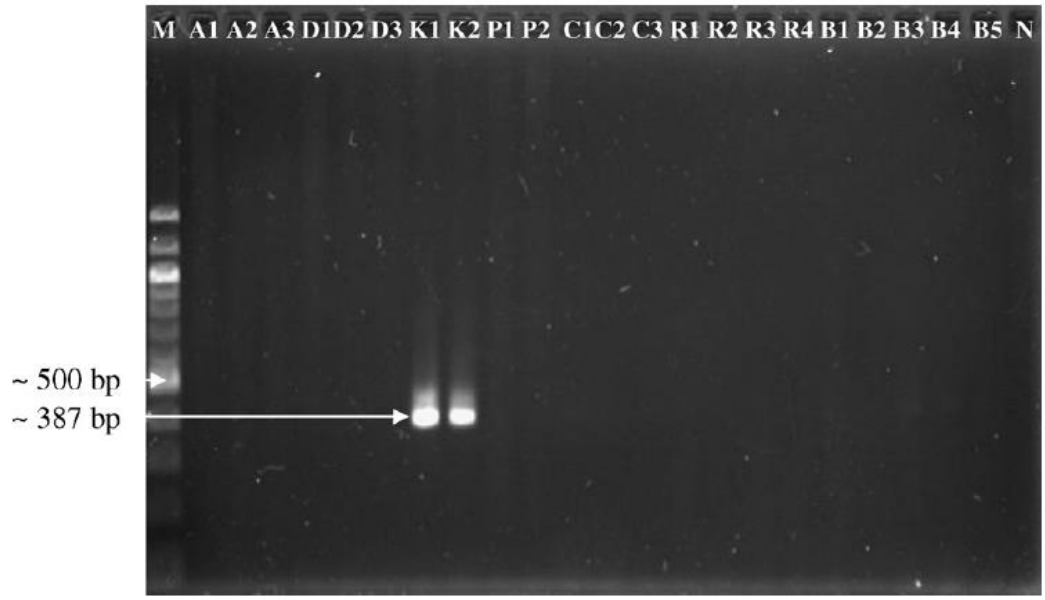

Figure 2.1: Previous study of lard detected at band 387 bp[7]

2.1.2 Electronic Nose (E- Nose)

Electronic Nose or also known as electronic sensing is a device which consisting of multisensory array, processor, software base, and databases[11]. This method use sensor array and pattern recognition system to reproduce the capabilities of human senses. This method is not only applicable to lard detection but on a wide variety market, which including automobile, chemistry, biomedical, food and packaging. This method is designed according to the abilities of human senses. It consists three major parts which is delivery, detection, and computing as shown in Figure 2.2.

Figure 2.2: Working principle of E-Nose

From Figure 2.2, it shows the working principle of this method in block diagram. The sensor array is used to detect the samples and it will computed in a pattern recognition system.

This method is rapid, simple and easy to handle. Previous studies had discussed about this method by comparing lard adulteration with palm olein. The samples had been added iodine volume to indicate the saturation of lard fatty acid[5]. This sensor is sensitive to volatile compounds. In this study, they found the differences of aroma pattern by using VaporPrint as shown in Figure 2.3. Apart of it, there are higher saturated fatty acid compare lard to palm oil.

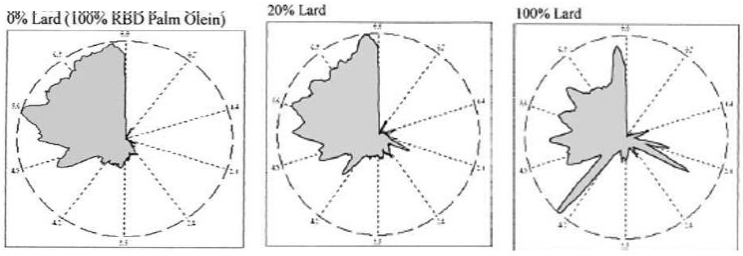

Figure 2.3: Previous study of VaporPrint of aroma pattern [5]

In Figure 2.3, it shows the aroma pattern for 0%, 20%, and 100% of lard adulteration with RBD palm oil which indicate the changes of concentration of lard in adulteration.

2.1.3 Gas liquid chromatography (GLC)

Gas liquid chromatography is chromatography used to analyze the samples that can evaporate without decomposition state. This method able to separate material into two phases, where one phase is in mobile and another in stationary. Liquid is represent the stationary phase where gas is represent the mobile phase. GLC is applicable to complex analysis, which can respond rapidly, high accuracy and high sensitivity. The working principle of GLC is as shown in Figure 2.4.

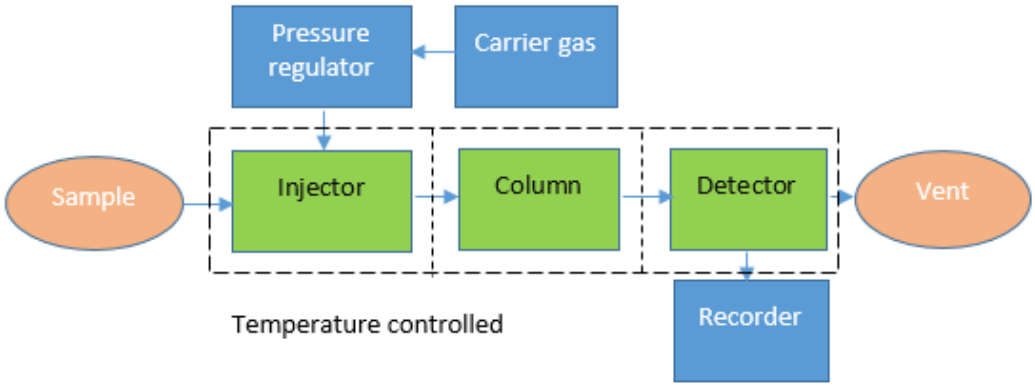

Figure 2.4: Gas Liquid Chromatography working principle

From Figure 2.4, it shows the flow of GLC work. The sample which is the fat in liquid state will solute into the heated injector tube to vaporized the liquid and mixed with helium gas (carrier gas) then only send to the column. Next, in column path, it will distribute in between of two phases: liquid and gaseous. Some part of pressure in solute vapor exist gaseous phase will depend on the solubility of the liquid phase.[13]

This method only needed a small amount of sample to be analyzed. This method focuses on the sample's percentage distribution of fatty acids in lard or other type of fats. Therefore, the previous studies had been taken, the percentage distribution of fatty acids in lard or other type of fats tested by using a flame ionization detector.

From previous studies, it shows the fatty acid (or also known as triacylglycerol) of lard is mainly composed by three main forms which is palmitooleoolein (POO),

palmitooleostearin (POS), and palmitoolepalmitin (POP)[6]. By using this method, it can clearly differentiate the lard by using triacylglycerol (TAG) composition in level of palmitoolepalmitin (POP), palmitooleoolein (POO) and palmitooleostearin (POS). The level of lard composition in this three type of fatty acid had been identified which is POP = 5.10±0.04%, POO = 21.55±0.08 and POS = 14.08±0.04.

2.1.4 Fourier Transform infrared Spectroscopy (FTIR)

Infrared spectrum of sample can be obtain by using method of Fourier transform infrared spectroscopy (FTIR) either in solid, liquid, or gas state. This method is used to identify the chemical, physicochemical and morphological properties of samples. The basic working principle of this method is measures the amount of light absorbed by a sample used in terms of wavelength. The motion of molecules in samples affected the wavelength and frequencies measured. The wavelength spectrum shows the sensitivity and capabilities of FTIR to differentiate the concentration of the sample. [8]

This method is rapid, accurate, and environmental friendly which able to differentiate the sample according to their wavelength. Apart of it, this technique is very useful for food analysis that able to differentiate the chemical composition as well as the functional group of food.

From Figure 2.5, it shows the basic working principle of FTIR technique. The source will generate the radiation that sends the sample across the desired spectrum. Next, the sample will pass through interferometer and reaches the detector. The incident radiation travels through the sample will emit wave front into component frequencies. After that, the signal receives will amplify by analog to digital converter into digital signal form. Lastly, it will signal will reach computer were able to further analysis.

From previous studies, the differentiation is focused on protein and polypeptides which is mainly formed in food. By using FTIR technique, amides I, II, III bands is low intensities shows in porcine gelatin spectrum. Therefore, within the wavelength of 1660 to 1200cm^{-1} and 3290 – 3280cm^{-1}[8], the deformation N-H bonds will happen.

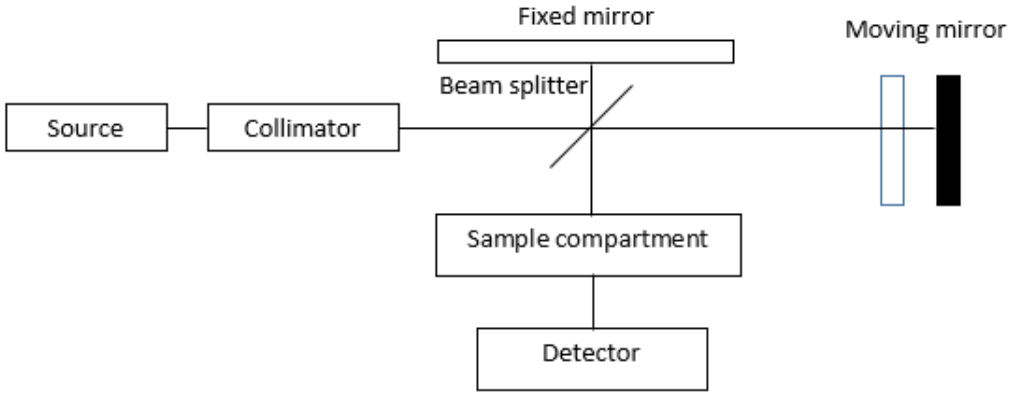

Figure 2.5: Block diagram of FTIR method

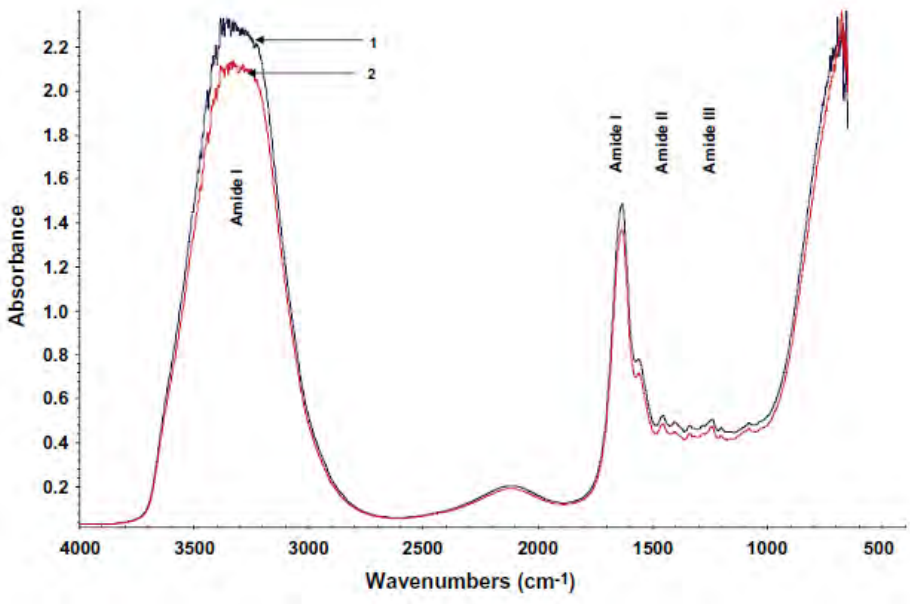

Figure 2.6: Previous studies of FTIR result where 1 is bovine gelatin and 2 is porcine gelatin [8]