UNIVERSITI PUTRA MALAYSIA

PRACTICE OF REPEATEDLY HEATING COOKING OIL AMONG FOOD PREMISE OPERATORS IN BUKIT MERTAJAM, PULAU PINANG AND DETERMINATION OF PEROXIDE IN COOKING OIL

ADRIANA ABDUL AZIZ

PRACTICE OF REPEATEDLY HEATING COOKING OIL AMONG FOOD PREMISE OPERATORS IN BUKIT MERTAJAM, PULAU PINANG AND DETERMINATION OF PEROXIDE IN COOKING OIL

BY

ADRIANA BINTI ABDUL AZIZ

Thesis submitted in fulfilment of the requirement for degree of Bachelor Science (Environmental and Occupational Health) from Faculty of Medicine and Health Sciences, Universiti Putra Malaysia

ACKNOWLEDGEMENT

I would first like to thank my thesis advisor Dr. Saliza Bt. Mohd Elias of the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia. The door to Dr. Saliza's office was always open whenever I ran into a trouble spot or had a question about my research or writing. She consistently allowed this paper to be my own work, but steered me in the right the direction whenever she thought I needed it.

I would also like to thank my Co- Supervisor who was involved in the validation experimental analysis methodology for this research project, Dr. Mohd Redzwan. I am gratefully indebted to him for his very valuable comments on this thesis. In addition, I owe deepest gratitude to the Universiti Putra Malaysia for allowing me to conduct my research.

Finally, I must express my very profound gratitude to my parents and friends for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you.

ABSTRACT

PRACTICE OF REPEATEDLY HEATING COOKING OIL AMONG FOOD PREMISE OPERATORS IN BUKIT MERTAJAM, PULAU PINANG AND DETERMINATION OF PEROXIDE IN COOKING OIL

ADRIANA BINTI ABDUL AZIZ

Introduction: The repeatedly heating cooking oil in preparation of fried food that has become a main dietary habit among Malaysian which may give deleterious health impacts on humans. The peroxide value (PV) can be applied for identifying the quality in cooking oil through the oxidative change that takes place in fats or oils. High peroxide value indicates bad quality of cooking oil. **Objective**: This study was conducted to study the practice of repeatedly heating cooking oil among food premise operators in Bukit Mertajam, Penang and to determine peroxide in cooking oil. **Methodology:** A total of 124 respondents participated in the survey. This study used a structured questionnaire for data collection through face-to-face interview to obtain information on socio-demographics, awareness and practice of repeatedly heating cooking oil among food premise handlers operated at selected food premises in Bukit Mertajam, Penang. A laboratory analysis to identify peroxide values was performed on the five most favourable brands of cooking oil by respondents. **Result:** Majority of respondents had moderate awareness level (53.2%) and practice level (50.0%) regarding on repeatedly heating cooking oil. There was a significant association between awareness and practice level among respondents (χ^2=3.680, p=0.05). The calculated average peroxide value (PV) has indicated that most of the cooking oil samples had exceeded the standard limit prescribed in the American Oils' Chemist Society (AOCS) standard at the 7^{th} or 9^{th} frying sessions except for cooking oil (Brand C) at the 5^{th} number of frying sessions. **Conclusion:** Relevant actions need to be taken by the governmental food authorities to address this issue and ensure safe consumption of fried foods by consumers.

Keywords: repeatedly heated cooking oil, peroxide, food premise operators, Malaysia

ABSTRAK

AMALAN PENGGUUNAAN MINYAK MASAK YANG DIPANASKAN BERULANG KALI DALAM KALANGAN PENGENDALI PREMIS MAKANAN DI BUKIT MERTAJAM, PULAU PINANG DAN PENENTUAN KEHADIRAN PEROKSIDA DALAM MMINYAK MASAK

ADRIANA BINTI ABDUL AZIZ

Pengenalan: Penggunaan minyak mask yang dipanaskan secara berulang kali dalam penyediaan makanan bergoreng yang menjadi amalan pemakanan yang utama dalam kalangan rakyat Malaysia mampu mendatangkan kesan buruk terhadap tahap kesihatan manusia. Nilai peroksida (PV) boleh digunakan untuk mengenal pasti kualiti bagi minyak masak melalui perubahan oksidatif yang berlaku dalam lemak atau minyak. Nilai peroksida tinggi, menandakan bahawa kualiti minyak masak adalah buruk. **Objektif**: Kajian ini dijalankan untuk mengkaji amalan berulang-kali memanaskan minyak masak dalam kalangan pengendali premis makanan di Bukit Mertajam, Pulau Pinang dan penentuan peroksida dalam minyak masak. **Metodologi**: Seramai 124 responden telah mengambil bahagian dalam kajian ini. Kaedah soal selidik digunakan untuk pengumpulan data melalui temubual secara bersemuka untuk mendapatkan maklumat mengenai sosio-demografik, tahap kesedaran serta amalan pengunaan minyak masak yang dipanaskan secara berulang kali dalam kalangan pengendali premis makanan yang mengendalikan premis makanan di kawasan Bukit Mertajam, Pulau Pinang. Analisis makmal dilakukan bagi mengenalpasti nilai peroksida telah dilakukan ke atas lima jenama minyak masak yang sering digunakan oleh oleh responden. **Keputusan**: Hasil kajian menunjukkan majoriti responden mempunyai tahap kesedaran (53.2%) dan tahap amalan (50.0%) yang sederahana mengenai isu minyak masak yang dipanaskan berulang kali. Terdapat hubungan yang signifikan antara kesedaran dan tahap amalan di kalangan responden ($\chi 2 = 3.680$, $p = 0.05$). Secara umumnya, purata nilai peroksida (PV) telah menunjukkan bahawa kebanyakan sampel minyak masak telah melebihi had standard yang ditetapkan dalam Oils 'Chemist Society (AOCS) pada sesi ketujuh atau kesembilan kali penggorengan kecuali minyak masak (Jenama C) pada kali kelima sesi menggoreng. **Kesimpulan**: Tindakan yang relevan perlu diambil oleh pihak berkuasa untuk menangani isu ini dan memastikan pengambilan yang selamat oleh pengguna bagi makanan yang digoreng.

Kata Kunci: minyak masak yang dipanaskan berulang kali, peroksida, pengendali premis makanan, Malaysia

TABLE OF CONTENTS

	Page
DECLARATION	iii
SIGNATURE OF SUPERVISOR/INTERNAL EXAMINER	iv
ACKNOWLEDGEMENT	v
ABSTRACT	vi
ABSTRAK	vii
TABLE OF CONTENTS	viii
LIST OF TABLES	x
LIST OF FIGURES	xi
LIST OF ABBREVIATIONS	xii
CHAPTER 1: INTERODUCTION	
1.1 Background	1
1.2 Problem Statement	5
1.3 Importance of Study	7
1.4 Research Questions	9
1.5 Study justification	10
1.6 Study variable	12
1.6.1 Independent variable	12
1.6.2 Dependent variable	12
1.7 Objective	12
1.7.1 General objective	12
1.7.2 Specific objectives	12
1.7.3 Hypothesis	13
1.8 Definition	13
1.8.1 Conceptual definition	13
1.8.2 Operational definition	15
1.9 Conceptual framework	16
CHAPTER 2: LITERATURE REVIEW	
2.1 Cooking oil	18
2.2 Palm oil	20
2.3 Changes of cooking oil in deep-frying process	20
2.4 Quality assessment for cooking oil	22
2.4.1 Peroxide value	22
2.5 Iodometric titration	23
2.6 Health risks associated with high peroxide presence in cooking oil	23
2.7 Deep-frying food consumption pattern among Malaysian	25
CHAPTER 3: METHODOLGY	
3.1 Study Location	26
3.2 Study Design	27
3.3 Study Sample	27
3.3.1 Respondent	27

	Page
3.3.2 Cooking Oil Samples	28
3.4 Sampling Method	28
3.5 Sample Size	28
3.6 Data Collection and Instrumentation	30
3.6.1 Questionnaire	30
3.6.2 Peroxide Value Measurement in Cooking Oil	32
3.7 Quality Control	34
3.7.1 Cooking Oil Preservation and Storage	34
3.7.2 Personal Protective Equipment	35
3.8 Data Analysis	35
3.9 Ethical Consideration	37
CHAPTER 4: RESULTS AND DISCUSSION	
4.1Socio-demographic information of respondents among food operators in Bukit Mertajam, Penang	38
4.2 The awareness level of using repeatedly heating cooking oil especially in deep-frying food preparation among respondents in Bukit Mertajam, Penang	40
4.3 The practice of using repeatedly heating cooking oil in deep-frying among food premise handlers at Bukit Mertajam, Penang	45
4.4 The peroxide value in repeatedly heated cooking oil	49
4.5 The correlation between awareness and practice of repeatedly heating cooking oil in food preparation among food premise operators at Bukit Mertajam, Penang	53
4.6 The association between awareness in using repeatedly heating cooking oil especially in deep-frying food preparation among respondents and socio- demographic factors	55
4.7 The association between practice of repeatedly heating cooking oil among respondents and socio-demographic factors	57
4.8 Strengths and limitations of study	59
CHAPTER 5: CONCLUSION AND RECOMMMENDATIONS FOR FUTURE RESEARH	
5.1 Conclusion	60
5.2 Recommendations	61
REREFENCES	63
APPENDICES	68
APPENDIX A	
APPENDIX B1	
APPENDIX B2	
APPENDIX C	
APPENDIX D	
APPENDIX E	

LIST OF TABLES

		Page
Table 3.6.1	Awareness level on peroxide in cooking oil among food premise operators in Bukit Mertajam, Penang	31
Table 3.6.2	Equipment and reagents in laboratory analysis procedure for measurement of Peroxide Values (PV) in oil samples	34
Table 3.8.1	Summary of statistical analysis with the respective specific objectives in this study	36
Table 4.1.1	The socio-demographic factors of respondents	39
Table 4.2.1	The frequency and percentage of awareness level using repeatedly heating cooking oil among respondents	41
Table 4.2.2	The awareness level of using repeatedly heating cooking oil among respondents with health risks to human	43
Table 4.3.1	The frequency and percentage of practice using repeatedly heating cooking oil in deep-frying among	45
Table 4.3.2	The practice of using repeatedly heating cooking oil in deep-frying among respondents at Bukit Mertajam, Penang	48
Table 4.4.1	The average peroxide value in repeatedly heated cooking oil with respective brands of cooking oils	50
Table 4.5.1	The correlation between awareness and practice of repeatedly heating cooking oil among respondents	53
Table 4.6.1	The association between awareness of repeatedly heating cooking oil and educational status among respondents	55
Table 4.6.2	The association between awareness of repeatedly heating cooking oil and age groups among respondents	56
Table 4.7.1	The association between practice of repeatedly heating cooking oil and monthly income among respondents	58
Table 4.7.2	The association between practice of repeatedly heating cooking oil and age groups among respondents	58

LIST OF FIGURES

		Page
Figure 1.9.1	The conceptual framework of this study	17
Figure 2.5.1	Reaction scheme in determination of peroxide by using iodometic titration method	23
Figure 3.1.1	The map location of the study area at Bukit Mertajam, Penang	26

LIST OF ABBREVIATIONS

AOCS	American Oil Chemists' Society
PAHs	Polycyclic Aromatic Hydrocarbons
ROS	Reactive Oxygen Species
PV	Peroxide Value
meq/kg	Miliequivalents of oxygen per kilogram
CVD	Cardiovascular disease
CHPD	Conjugated hydroperoxydiene

CHAPTER 1

INTRODUCTION

1.1 Background

Vegetable oil is a significant and widely used lipid source for our daily life in terms of dietary intake. Its use and applications are increasing from day to day especially for food purposes as well as in the manufacturing of a number of toiletry products like bath soap and cooking oil (Pandurangan, Murugesan and Gajivaradhan, 2014). One of the main advantages using vegetable oil in frying process is the stability properties because of the presence in saturated fatty acids which is richly found in coconut oil, palm oil and olive oil. Those types of vegetable oils are frequently used by consumers due to their resistance at high temperature during frying and did not oxidize or rancid easily. The relative degree of fatty acids saturation is the main factor in determining the resistance of oil towards oxidation and rancidity either at high or low temperature. The relative degree for fatty acids composition in oil could be further divided into saturated fats, which only have single bonds in the fatty acid molecule, the monounsaturated fats have one double bond and polyunsaturated fats that have two or more.

Oxidation process is not one single reaction, but a complex series of reactions. When oil oxidises, it produces a series of breakdown products in stages, starting with primary oxidation products (peroxides, dienes, free fatty acids), followed by the secondary products (carbonyls, aldehydes, trienes) and lastly the tertiary products. The level of oxidation process takes place at different rates depending on factors

such as types of oil, temperature, light, availability of oxygen, presence of moisture and metals such as iron. Both the saturated fats and monounsaturated fats are resistant to heating, but oils that were high in polyunsaturated fats (PUFA) should be avoided due to its unstable properties towards high temperature in cooking process (Attarde et al., 2010). However, in terms of nutritional point of view, it should be taken into consideration on the fact in which oils with high amounts of saturated fatty acids and fats containing trans fatty acids are less desirable in maintaining good health status. The double bonds in PUFA, that richly found in sunflower oil are chemically reactive and sensitive to heat. The reaction between the oil and oxygen present in ambient air can result in the formation of free radicles. The free radicals are dangerous for human consumption. In fact, considerable evidence have been accumulated recently that oxidized lipids might posed detrimental biological effects to health (Dobarganes and Marquez-Ruiz, 2003).

In addition, there are several reactions take place during deep fat frying process, such as the hydrolysis, oxidation, thermal decomposition and polymerization. Many of the oxidation products of PUFAs have been reported to have cytotoxic (toxic to cells) and mutagenic (capable of changing the DNA) effects. A study carried out in 2002 published in *Anticancer Research* journal has concluded that tumour promotion as well as the tumour initiation are influenced by rancid oils. In addition, the productions of cytotoxic and mutagenic substances are commonly known to increase the risk of cancer (Gil et al., 2004).

On top of that, a change in the physico-chemical feature of oil occurs when the cooking oil has been used. This change would indirectly give impact on the product quality and safety. The food value of the edible lipids depends on chemical properties such as iodine value, peroxide value, acid value, saponicfication value and based on some physical properties such as in solidification temperature, colour and appearance (Parker et al., 2003). Realizing the reality of this matter, scientists have been so long working to find appropriate examinations to identify accurate indicators of oil quality (Aidos et al., 2001). For example, a few tests have been recommended and practiced in industrial sites such as peroxide, free fatty acid, viscosities, anisidine, and colour development of cooking oil.

Furthermore, for determination of oil quality, the component which is crucial in determining and controlling oil quality is free fatty acid level. Meanwhile, the parameter to identify the oil degradation level by peroxide numbers evaluation, is the most widely used method. Peroxide could be quantitatively calculated by the total number of iodine released through the peroxide reaction with potassium iodide (KI). The primary oxidized product of oil is known as hydro-peroxide. It should be highlighted that fresh cooking oil that has been deodorized should have a zero peroxide value. In most cases, the cooking oil is assumed to have a good quality level if having peroxide value is at 1 or 0 meq/kg during the storage period.

On the other hand, some vegetable oils are found not meeting standards of consumers' satisfaction in terms of their physico-chemical properties or for the texture and stability of the food products (Reyes- Hernandez et al. 2007). For

instance, frying process caused a decomposition of fatty acids and at certain level, this process can make the cooking oil unusable which encourage rancidity of oil. in food, the use of rancid oil will expose consumers to such as accelerate aging, raised cholesterol levels, obesity and weight gain. Based on a study from the University of Basque Country, the breakdown rate and total formation of toxic compounds depends on the type of oil and temperature. Initially, the oil decomposes into hydroperoxides, then into aldehydes. The cytotoxic agents in foods and culinary oils during standard frying or cooking process have been implicated in the development and progression of atherosclerosis and are associated with other pathological diseases such as ischemic heart disease and peripheral vascular disease (Pandurarangan et al., 2014).

Additionally, it has been shown to exert gastropathic pro-inflammatory and genotoxicological properties (Phiri et al., 2006). While rancid oil might taste bad, it does not normally make the consumers sick, in a short period of time. The oxidised oil contains free radicals which might increase risk of developing diseases such as heart disease or even in worst cases, development of cancer. In short, the damaging chemicals and substances in oxidised fat and/oil such as peroxides and aldehydes could damage cells and DNA in human (Wai, 2007).

1.2 Problem statement

Diet plays a major role in a person's everyday life. Based on a survey carried out to study on dietary practices of adolescents (total 100 respondents) with age ranged from 11-21 years old, a total of 90.6% of Malaysian adolescents consume deep fried food (Lew and Barlow, 2005). Vegetable oils could be referred as triglycerides from fatty acids extracted from plant-based sources and are liquid in room temperature. It provides energy, essential fatty acids and improves fat-soluble vitamins absorption in human physiological activities (PROTA Foundation, 2008).

The practice of using repeatedly heated cooking oil has been a norm among food premise operators during food preparation to the consumers. In the perspective view among food premise handlers, they prefer to use the same cooking oil for several times for cooking process especially during frying because it can save and reduce the production cost that would benefit their business operation. There are so many different varieties and prices of vegetable oil brands that can be easily purchased in our markets nowadays. Reusing and recycling of the same cooking oil in food preparation, especially during deep-frying, is a common practice to save budgets. Plus, nowadays, the economic crisis which is currently experiences by our country has become a contributing factor to this matter. Even worst, there are also food operators who prefer to purchase and use oil packaged in plastic. These oils are believed to be "recycled" cooking oil and sold at lower price in the market. This issue has not been scientifically proven due to lack of existing studies conducted.

Furthermore, other factor which resulting in this practice include lack of knowledge and information among the food handlers on the negative health impacts of repeatedly heating cooking oils. In order to overcome this issue from getting worse, the responsible regulatory authorities are supposed to provide adequate education on safe practice in food preparation. The food operators can be briefed on the maximum total number of frying process and their associated health effects.

In addition, repeated heating of the oil accelerates oxidative degradation of lipids, forms hazardous reactive oxygen species and depletes the natural antioxidant contents of the cooking oil. in fact, a long-term ingestion of foods prepared using reheated oil could severely compromise the antioxidant activity and lead to the development of diseases such as hypertension, diabetes and vascular inflammation. The detrimental effects of reheated oil consumption extend beyond mere oxidative assault to cellular antioxidant shield (Leong et al. 2015).

Therefore, it is of great importance to determine the quality of cooking oils as oils are basically part of cooking ingredient especially in deep-frying foods. The oil's quality cannot be decided solely by view of naked eye such as by observing the colour changes. The best method in determining cooking oil's quality is by performing analytical measurement in the laboratories. The indicator that can be used to quantify quality in edible oil is by determining was the peroxide value (PV) for identification of the oxidative change in fats or oils. A low value of PV indicates oils

are still not undergoing rancidity process. For instance, the crude pressed oil usually had PV 5 to 20 while 0 to 1 in refined oil.

1.3 Importance of study

The significance of this study is to identify quality for cooking oil with multiple frying processes. In the millennia era, our eating habits in the community has been shifts into eating outside food rather than food cooking at home particularly for deep-frying food since we were now living in a fast-paced society (Lew & Barlow,2005). The consumption of ready-made deep-fried food is high especially in developing countries (Leong et al. 2015). Highly oxidized fatty acids were consumed through the consumption of these fried foods. Cooking oils are selected as the sample in this study because the edible vegetable oil is the major ingredient in cooking especially for these fried food products. In Malaysia, the production of palm oil has been one of the highest oil producing plant with total oil production recorded about 37 million tons of oil/ha/year since by the year of 2006. It has become the most significant edible oil use globally and representing 25% of the total oils and fats production (Oil World Ista GmbH Mielke, 2007). Palm oil is indicated to be the richest natural source of carotenoids particularly in retinol (provitamin A) content and its equivalent. Any industrial crude palm oil must be able to fulfil the requirements of quality applicable to all oils and fats dedicated to human consumption.

Apart from that, cooking oil is refers to the triglyceride that possesses certain fatty acids in a fresh condition. However, if a high volume of oil and a repetitively being used, it can reduces the quality of frying results and the food products as well. This situation is due to a fatty oxidizing process that could lead to the reduction in quality of oil. An over-oxidizing process in body is assumed to be a causal factor of certain diseases such as cardiovascular, cancer, early aging, or cataract. Thus, Peroxide Value (PV) determination has been one of the most frequently application in quality parameters during oil production, storage and marketing. PV indicates the degree of oxidation in the substance and measures the amount of total peroxides as a product of primary oil oxidation (Saad et al. 2006).

Besides, this study also concerned on the regular practice and awareness level among food premise handlers regarding on using repeatedly heating cooking oil in which without realizing, it poses harmful effects to health. This matter should be taken into consideration and addressed accordingly by the local food authorities. Mainly, the purpose of practicing of repeatedly heating cooking oil is to minimize the cost of food preparation expenses. Heating process will result in the formation of free reactive oxygen species (ROS) which is responsible for the oxidative stress and damage to various organs in the body (Ku et al. 2014). Prolonged consumption of the repeatedly heated oil had shown to increase blood pressure and total cholesterol, caused vascular inflammation as well as vascular changes which predispose to atherosclerosis (Ng et al. 2014). The harmful effect of heated oils is attributes to products generated from lipid oxidation during heating process. Therefore, by

conducting this research, it might provides and generates awareness to reach general public of the potential hazard of oxidation products due to the consumption of repeatedly heating oil which would be helpful to curb in cardiovascular related diseases.

1.4 Research Questions

This study was aimed to answer the following questions as stated below:

i) What is the awareness level of using repeatedly heating cooking oil in frying among food premise handlers at Bukit Mertajam, Pulau Pinang?

ii) What is the practice of cooking oil usage in deep-frying among food premise handlers at Bukit Mertajam, Pulau Pinang?

iii) What are the most favour types and brand's name of cooking oils by food premise handlers at Bukit Mertajam, Pulau Pinang?

iv) What is the quality level of fresh and repeatedly heated cooking oil?

v) What is the association between awareness and practice of repeatedly heating cooking oil by food premise handlers especially in deep-frying food preparation at Bukit Mertajam, Pulau Pinang?

1.5 Study justification

Our diet contains a complex mixture of fats and oils consisting of different fatty acids which may affect human health. This is mainly due to the rising consumption of deep-fried products, which are very popular among local citizens because of their desirable flavour, colour and crispy texture. This study was conducted in Bukit Mertajam which has a population of 212,329 making it the second biggest city in Penang. It has been developing and becoming a sub-urban area with rapid growth in total number of food premises to meet consumer's demands that were mostly depend upon outside food purchased at the food premises. The target population in this study was among food premise handlers in the studied area as they are directly involved in food preparation process particularly in frying food products. One of the aims of this study was to evaluate association between practice of repeated heated cooking in frying process among food premise handlers in Bukit Mertajam, Penang and quality of cooking oil based on quantitative data on peroxide values. Indirectly, this study could also create awareness and alleviate related knowledge about dangerous health impacts caused by high consumption of recycled cooking oil during food preparation as a long-term effects on public health which focusing on food handlers since that they were part of local communities.

Besides that, there have been increasing scientific studies carried out to provide evidence and support the fact in which practice of repeatedly heating cooking oil by mixing with fresh oil together may be deleterious to human health status. Polyunsaturated fatty acids (PUFA) that were mostly found in vegetable oils can be easily oxidised and there was concern about possible negative health effects from

intake of oxidized lipids. The thermal and oxidative reactions taken place during deep frying process at high temperature (Marquez-Ruiz. and Dobarganes, 2007) which indirectly will result in many other chemical reactions occurrence such as hydrolysis, oxidation, thermal decomposition and polymerization.

Deep-fat frying decreased unsaturated fatty acids and increased polar material. Oxidative stability was very important factor in oil quality especially for these used for frying because of the high temperature applied. In this study, the indicator used to quantify the quality of cooking oil usage was by determination of peroxide value (PV).Prolonged heating time may cause accumulation of deterioration products.that finally led to organoleptic failures and a decreased of the nutritive value.

Moreover, the public awareness regarding the hazard of using recycled cooking oil was still not satisfactory in developing and under-developed countries. Based on the study by Azman et al. (2010) whish was also in lined with study of Phiri, Mumba and Mangwera (2006) have concluded that about 40–63% of people admitted using the same portion of cooking oil repeatedly. Therefore, this study needed to be carried out to determine quality of cooking oil based on the recycling frying oil that was still widely practised in the society to provide sound basis for setting of standards in food regulations in our country by including parameter of peroxide values in assuring the safe level for human consumption of edible oils.

1.6 Study variable

1.6.1 Independent variable

Practice of repeatedly heating cooking oil in deep frying food preparation among food premise handlers in Bukit Mertajam, Pulau Pinang.

1.6.2 Dependent variable

Peroxide value in cooking oil.

1.7 Objective

1.7.1 General objective

i) To determine practice of repeatedly heating cooking oil among food premise handlers in Bukit Mertajam, Penang and to analyse the peroxide values in cooking oil.

1.7.2 Specific objective

- To describe the socio-demographic of respondents.
- To investigate the awareness level of using repeatedly heating cooking oil by the respondents especially in deep-frying food preparation.
- To determine the practice either using fresh cooking oil or using repeatedly heating cooking oil in deep-frying among respondents.
- To measure the peroxide value in cooking oil.
- To determine correlation between awareness and practice of repeatedly heating cooking oil in food preparation among respondents.
- To identify the association between awareness in using repeatedly heating cooking oil and socio-demographic factors among respondents.

- To determine the association between practice of repeatedly heating cooking oil and socio-demographic factors among respondents.

1.7.3 Hypothesis

i) There is a significant association between awareness and practice of repeatedly heating cooking oil in food preparation among respondents.

ii) There is significant association between awareness in using repeatedly heating cooking oil especially in deep-frying food preparation and socio-demographic factors among respondents.

iii) There is significant association between practice of repeatedly heating cooking oil and socio-demographic factors among respondents.

1.8 Definition

1.8.1 Conceptual definition

i) Practice of repeatedly heating cooking oil in deep frying food preparation

Deep-frying is a cooking process, with which water containing foodstuff is immersed into edible oils or fats at temperatures between 140 – 180 °C. During this process, most of food premise handlers tend to reuse oil until it is being discarded and replaced with fresh oil. Fats and oils have a high heat capacity, thereby enabling heat transfer at temperatures far above that of the boiling point of water. Due to the evaporation in the boundary zone between food and oil, the water bound in the food is gradually transported from the inside to the boundary layer into the surrounding oil (mass transfer). The moisture released from the food acts as a protective shield, preventing direct contact of oxygen to the fat surface. Cooking oil shall be edible oil

used for purposes of cooking. If the same cooking oil is being used and recycled from the previous cooking process for a few times before discarding may result in oil rancidity to occur.

ii) Peroxide

Lipid peroxides are the primary product of oxidized oils or fats. Oxidation is the loss of electrons from atoms or molecules. When a molecule loses its electrons, it becomes a new and different type of molecule. When lipids or phospholipids are exposed to air they react with Oxygen. Oxygen is very electro-negative, so it likes to grab positively charged atoms or molecules like hydrogen, leaving other atoms or molecules with their electrons exposed. Compounds with two adjacent oxygen atoms and no hydrogen atom or other positively charged atoms to couple to the exposed electrons are called peroxides.

iii) Food premise handler

Any person who directly handles packaged or unpackaged food, food equipment and utensils, or food contact surfaces and is therefore expected to comply with food hygiene requirements in order to serve safe food for human consumption.

v) Socio-demographic factors

The term "sociodemographic" refers to a group defined by its sociological and demographic characteristics. Sociodemographic groups are used for analyses in the social sciences. Demographic characteristics can refer to age, sex, place of residence, religion, educational level and marital status. Sociological characteristics are more objective traits, such as membership in organizations, household status, interests, values and social groups.

1.8.2 Operational definition

i) Practice of repeatedly heating cooking oil in deep frying food preparation

It was determined through questionnaire in which the respondents were asked on how many times they were using the same cooking oil. Repeatedly heating cooking oil was defined when the respondents used the cooking oil for 2 times and/or more such as used for frying purpose.

ii) Peroxide

It can be applied as an indicator to indicate quality of cooking oil is based on values of peroxide which can be measured as a result from oil's oxidation reaction. The peroxide value is defined as the amount of peroxide oxygen per 1 kilogram of fat or oil. The unit of milliequivalent has been commonly abbreviated as mequiv or even as meq/kg.

iii) Food premise handlers

Individuals who were responsible to prepare and sell ready-to-eat food products such as fried foods by using large quantity of cooking oil. The business operation hours were usually from 10am until 1.30pm and from 7.30 until 12.30am.

v) Socio-demographic factors

The socio-demographic factors being studied were including age, educational level and monthly income of respondents in this study.

1.9 Conceptual framework

Figure 1.9.1 illustrates the conceptual framework for this study. This study is mainly focusing on the practice using repeatedly heated cooking oil among food premise handlers and peroxide values in the re-use cooking oil. Based on the framework, practice of repeated heated cooking oil are cause by several factors such as by the level of knowledge, attitude and perception among food premise handlers. The reason food premise handlers prefer to keep using the same cooking oil repetitively in cooking process especially frying food products to minimize expenses cost involved in food preparation. Other aspects which also influence the quality in repeatedly heating oil are the types of cooking oil, temperature and types of packaging for the cooking oil.

The level of peroxide may build-up that cause deleterious health impacts to consumer as a result of repeatedly heating oil in cooking. This study emphasis on the peroxide value to demonstrate the level of quality in cooking oil based on determination of oil rancidity. The duration and/or frequencies of frying with the same cooking oil are directly proportional to the level of peroxide detection in cooking oil.

Recently, the published scientific research keep on increasing on the possible health risks upon consumption of repeatedly heated cooking oil by human. It is believe that ingestion of oxidised oil may affect diseases development such as diabetes, atherosclerosis, high blood pressure, induce vascular inflammation and cancer as cumulative effects on health.

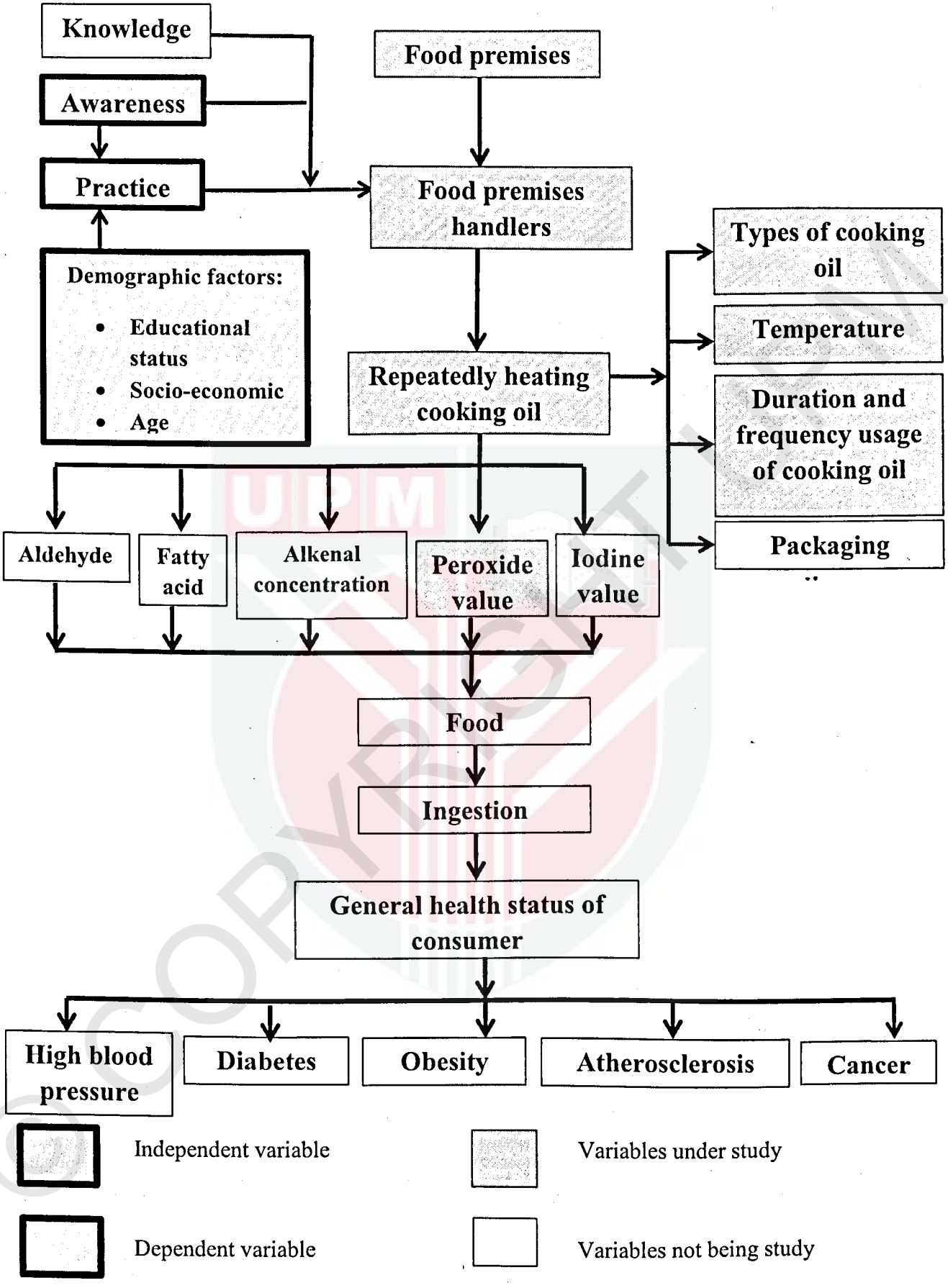


Figure 1.9.1: The conceptual framework of this study

CHAPTER 2

LITERATURE REVIEW

2.1 Cooking Oil

In the past decade, palm oil has risen to become the most produced and consumed vegetable oil in the global. Oils have always been an integral part of human foods, being essential for health. Industrially, they play an important role in the development of different areas of chemical products, pharmaceutical, cosmetics, paints and most importantly, food (Atef, 2010). The growth of commercial plantations in Southeast Asia and recent expansions in the West Africa and Latin America have led to a growing call for sustainable production of palm oil, driven to a large extent by concerns over the associated impacts of deforestation and biodiversity losses (PROTA Foundation, 2008).

Oils are naturally occurring esters of long straight-chain carboxylic acids. They belong to the saponifiable group (contain an ester groups) of lipids. Lipids are biologically produced materials that are relatively insoluble in water but soluble in polar and non-polar organic solvents. Edible oils constitute of triacylglycerol molecules, mainly formed by unsaturated (oleic, linoleic, linolenic acids) and saturated fatty acids (myristic, palmitic, stearic acids), esterified to glycerol units (Andersson et al. 2010). Globally, cooking oil is used for the preparation of food. Cooking oil consists of plant, animal, synthetic fat used in frying, baking and other types of cooking. They can be formed from a single fatty acid that could be esterified up to three times into glycerol backbone, or at least by three different ones (Andersson et al., 2010). There are so many different varieties of vegetable oil

brands in our markets and all of them claim to be cholesterol free. Due to increasing awareness on the health implications of high cholesterol in the diets, most people now prefer to purchase cholesterol free vegetable oils (Attarde et al., 2010). The common types of cooking oil use in most countries include Malaysian are palm oil, peanut oil, corn oil and sunflower oil. Palm oil contains more saturated fats than canola oil, corn oil, linseed oil, soybean oil, safflower oil, and sunflower oil. Thus, palm oil is able to withstand high temperature and heat of deep frying compared to highly unsaturated vegetable oil (Basiron et al., 2007).

Moreover, since 1900, palm oil has been progressively integrated into food by the global commercial food industry due to its stability in deep frying or in baking at very high temperatures and for its high levels of natural antioxidants (Basiron et al., 2007). For instance, palm oil is used as a heat-transfer medium in frying to generate nicely cooked foods. Cooking oils such as coconut oil, palm oil and palm kernel oil are typically liquid at room temperature and may contain saturated fat. Malaysia is one of the top three exporters of palm oil in the world based on the export statistic of cooking oil. There are around 40% of palm oil is being made into cooking oil, margarine, specialty fats and oleo chemicals. In Malaysia, major of the cooking oil are made from palm oil (Berger, 2005). The main users of cooking oil are among the restaurants or food premise handlers, street vendors and night market operators.

2.2 Palm oil

The palm oil in Malaysia has been introduced as an ornamental since 1871. The oil palm was commercially exploited in 1911 as an oil crop when the first oil palm estate was established. The accomplishment of economical sustainability in palm oil industries is mainly due to the varied range of usage in our daily life and together with the affordable market price. According to Basiron (2007), palm oil is cheaper and widely used compared to soy and corn oil. the author claimed that the palm oil has advantages for using in repeatedly frying due to the unique composition of low level of polyunsaturated fatty acid (PUFA) that is more easily in oxidized to form toxic compounds during repeatedly heating process, which results in harm and danger to the human health. On the other hands, palm oil compounds in which having the ability to tolerate thermal oxidative changes would maintain the vitamin E quality. It consists of tocotrienols that was much better antioxidant than tocopherols present in soy oil. Therefore, palm oil is more favourable option than soy and corn oil due to the chemical benefits and low cost to consume especially in Malaysia (Kamsiah & Yusof, 2012).

2.3 Changes of cooking oil in deep-frying process

In deep frying, the food is totally immersed in the hot oil with the fat acting as the medium of heat transfer. Frying involves plunging food into hot oil at a temperature of 160-190°C (International Fragrance Association, 2011), to produce effect of boiling in oil to produce a deep-fried quality. The food remained moist on the inside because of the good heat transfer properties of the hot oil, the cooking

process is very fast. Fried food is one of the most common and popular practices in food preparation (Gil, Cho. and Yoon, 2004). The popularity of deep-fried products is due in part to the basic structure imposed on them by the way in which they are cooked. Cooking in this way is more efficient than the dry heat of an oven and faster than boiling using water since the higher temperatures possible with deep frying increase penetration rate of heat into the cooked product. As a result, the heat converts water within the food to steam and melts the fat within the food. Then, the steam and fat would transfer from the interior of the food through the exterior and into the oil. Conversely, some of the frying oils are absorbed into the food being fried. Even though deep frying method is being claimed as a fast, convenient, and energy-efficient cooking method and increases tastiness due to the characteristics of fat absorption, crust formation, and pleasant flavours and odours, the process would undergo thermal oxidation, polymerization, and hydrolysis if being heated continuously at high temperature with presence of oxygen and water from the fried food (Jaarin et al., 2011).

Moreover, undesired by-products formation from degraded frying oils may even be harmful to health (Innawong, Mallikarjunan and Marcy, 2004). The thermally-induced oxidation of glycerol-bound polyunsaturated fatty acids (PUFAs) in foods and cooking oils during normal frying or cooking sessions result in generation of isomeric conjugated hydroperoxydiene (CHPD) species. It is believed that engagement of PUFA-containing cooking oils in frying poses health hazards in which have drawn public and clinical interest recently. The non-volatile products of lipid oxidation may play a more important role in cardiovascular diseases (CVD)

(Jaarin et al., 2011), since they remain in the oil and are then absorbed by the food and ingested by consumers. The majority of these products are collectively known as polar compounds. These cytotoxic agents have been implicated in the progression of atherosclerosis and its associated pathological sequel such as ischemic heart disease and peripheral vascular disease as a result of consumption in rancid oils.

2.4 Quality assessment for cooking oil

2.4.1 Peroxide value

The peroxide value test is a commonly requested test used to measure the stability of various food products including pet foods, feeds, and human foods. The peroxide value method is referred based on the Cd 8-53 American Oil's Chemist Society (AOCS). It is usually use as an indicator to the shelf life of cooking oil. Basically, this method is carried out by dissolving the oil sample in a solvent and potassium iodide and then titrating with sodium thiosuflate and using starch as an indicator (American Oil Chemists' Society, 1998). Fat oxidation is a normal process that occur when normal fats or oils are exposed to ambient air (oxygen gas), sunlight, or high temperature. These factors cause chemical reactions in the fats, which include breaking fatty acids from glycerin or the addition of oxygen into unsaturated fatty acids, and the formation of peroxide was a natural reaction that occurs. The type, form, and amount of fat (oils) should also be concerned in determination of peroxide in oils.

2.5 Iodometric titration

The basic principle in iodometric titration method is illustrated in Figure 2.5.1 below. The oil sample is mixed in solution with a mixture of acetic acid and a suitable organic solvent and then with a solution of potassium iodide. The liberated iodine is titrated with a standard solution of sodium thiosulfate. Peroxides and similar products which oxidize potassium iodide under the conditions of the test contribute to the peroxide value. The peroxide value is expressed either in milliequivalents of peroxide/kg or millimoles of peroxide/l. (International Fragrance Association, 2011).

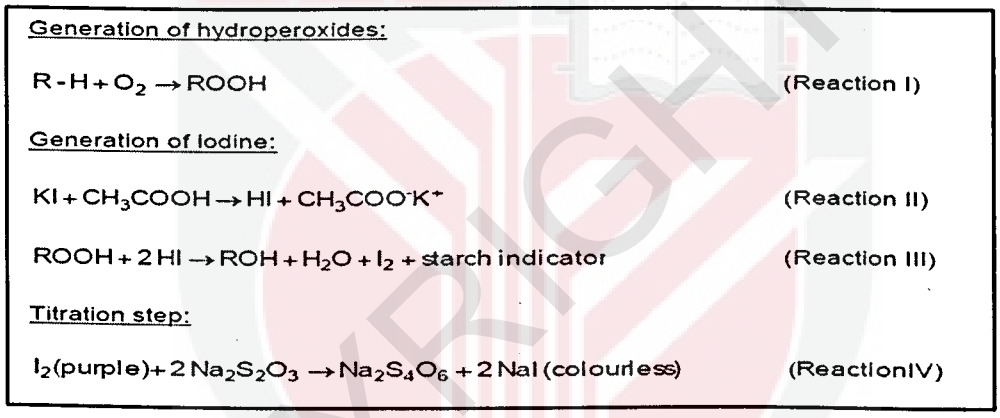


Figure 2.5.1: Reaction scheme in determination of peroxide by using iodometic titration method (International Fragrance Association, 2011)

2.6 Health risks associated with high peroxide presence in cooking oil

There are some experts criticize the repeating usage of cooking oil would harm and dangerous to human health. Both the household or food businesses sector practice reusing the same frying oil for more than two times mainly due to budget constraints. There are several chemical reactions such as oxidation, hydrolysis and

thermal polymerization occur when cooking oil was heated during the deep frying process. The quality of oil deteriorates with the increasing number of frying time that eventually accelerates the formation of oxidized and polymerized lipid in the frying medium. The consumption of frequently used cooking oil may increase the risk of developing atherosclerosis. Lipid peroxidation products induced oxidative stress in endothelial dysfunction that could lead to the formation of atherosclerosis (Leong et al., 2015).

Other than that, the potential atherogenic property of heated oil through oral administration of heated palm oil is observed to elevate the level of lipid peroxides in human plasma, especially in chylomicrons. The human chylomicrons are obtained after heated oil ingestion. It has shown that the chylomicrons treated with heated oil were degraded more rapidly by cultured mouse macrophages. It is then followed by those which undergo treatment with fresh palm oil. In brief, the uptake of heated oil-treated chylomicrons by macrophages resulted in a 10-fold higher accumulation of cholesterol ester mass in the cells than the incubation with fresh oil-treated chylomicrons after 48 hours period (Parker et al., 2003).

In short, ingestion of rancid oil with peroxide will also expose the consumers towards accelerated aging, raised cholesterol levels, obesity and weight gain. The daily consumption increases the risk of degenerating diseases such as cancer; diabetes; Alzheimer's disease; and atherosclerosis, a condition in which artery walls thicken due to accumulation of fatty materials (Berger, 2005). The thermally oxidzed lipids enhance peroxidation of membrane macromolecules,

contributing to their mutagenicity and genotoxicity which could potentially lead to carcinogenesis. These conditions will eventually contributing to cancer development in human.

2.7 Deep-frying food consumption pattern among Malaysian

Malaysia is continuously undergoing a rapid process of urbanization. A poor eating habit is a major public health concern particularly among young adults as that most of them prefer to consume fried foods as part of the dietary intake (Ganasegeran et al., 2012). Based on the result of their study, it has been concluded that up to 73.5% among university students, had fried food twice a week or more while 26.2% took it less than two times. The consumers tend to make their own food choices based on cost and availability of fried food. One of the main concerns pertaining to the regular consumption of fried foods is due to the lack of knowledge on healthy food choices that might affect eating habits and nutritional status of an individual. It was supported based on a previous study in China, which revealed young adults exhibited early risk factors for chronic diseases due to poor eating habits such as frequent consumption of fried foods (Ku et al., 2014). This condition is being worsened as most deep-fried foods laden with fat and when these combine together with the lack of physical activities, it is a "recipe" for gaining unhealthy and excessive weight. Thus, as a consumer, we should monitor and limit intake of fried foods to practice a healthy diet in daily life.

CHAPTER 3

METHODOLOGY

3.1 Area of study

This study took place at food premises located in Bukit Mertajam, Penang (Figure 3.1.1). Overall, there were 213 food premises registered under Seberang Perai Municipal Council with the total population of Bukit Mertajam, Malaysia of 212, 329 based on the GeoNames geographical database in 2014. This was the reason why this area being chosen to conduct the study. Bukit Mertajam, Penang is located at 5.36301 with the latitude in decimal degrees and 100.467 longitude in decimal degrees at an elevation/altitude of meters. The average elevation of Bukit Mertajam, Malaysia is 27 meters.

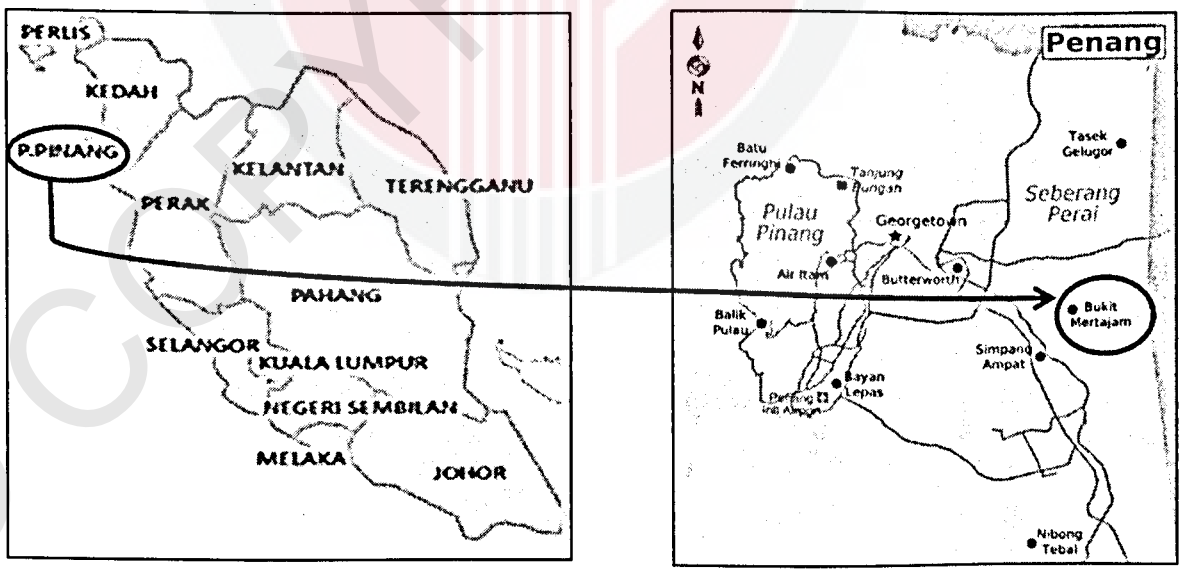


Figure 3.1.1: The map location of the study area at Bukit Mertajam, Penang (Municipal Council of Seberang Perai, 2014)

3.2 Study design

This cross-sectional study was carried out over a period of four months starting from January 2017 at selected food premises in Bukit Mertajam, Penang which involving food premise operators who operated food premises as study population in this study. It was an observational study to measure the presence of peroxide in repeatedly heating cooking oil since that most of the food operators are more likely to reuse and recycle cooking oil in the food preparation for consumers to save cost.

3.3 Study sample

3.3.1 Respondents

The respondents included in this study were among food premise handlers. The inclusion criteria for the respondents were citizens of Malaysia residing in Bukit Mertajam, aged 18 years old and above. They have to use cooking oil which was vegetable oils only in any cooking process or sell ready-fried food for registered food premises with the Municipal Council of Seberang Perai. Relevant data were collected from the respondents focusing on the awareness of peroxide and practice of repeatedly heating oil among food premise handlers based on structured questionnaire in face-to-face interview. Furthermore, information for the most frequent used cooking oil's brands was asked to the respondents for survey purpose.

3.3.2 Samples of cooking oil

There were five different brands of cooking oil purchased from the available groceries based on the survey data among food premise handlers in Bukit Mertajam, Penang. The fresh cooking oil purchased undergone repeated heating procedure in the laboratory at temperature between 169 °C until 180 °C and was frozen at temperature of -18 °C to -20 °C until analysis of samples was performed. All the samples were analysed in triplicates to control for the validity of the method.

3.4 Sampling method

The sampling method in this study was based on a simple random sampling. Each member of the population had an equal chance of being included in the sample. This is known as a probability sampling technique in selection of respondents (food premise operators operating in Bukit Mertajam, Penang). The list of registered food premises with the Seberang Perai Municipal Council was referred as the sampling frame for random selection of respondents in this study.

3.5 Sample size

The sample size calculation was referred to Lemeshow (1990) in cross-sectional study for one group of population. The formula and calculation were as shown below (Equation 3.5.1 and 3.5.2):

$$n = \frac{z^2_{1-\alpha/2}\, P(1-P)}{d^2}$$ **Equation 3.5.1**

Where $z^2_{1-\alpha/2}$ = z-score (1.96 for 95% confident interval)

P = Anticipated population proportion

(86.6% according to the Sivananthan et al., 2013)

d = Absolute precision required on either side of the proportion

(Margin of error is ± 5% or 0.05).

The calculation of estimated sample size:

$n = (1.96)^2 * 0.866 * (1-0.866) / (0.05)^2$

$= 3.8416 * 0.866 * 0.134 / (0.0025)$

$= 0.3408 / 0.0025$

$= 178.32$

$\approx$ 179 respondents

Finite population correction factor.

$$n_a = \frac{n_r}{1 + \frac{(n_r - 1)}{N}}$$ **Equation 3.5.2**

Where n_a = The adjusted sample size

n_r = The original required sample size

N = Population size

$$n_a = \frac{178.32}{1 + \frac{(178.32 - 1)}{213}}$$

$= 97.31$

≈ 98 respondents

Thus, to obtain margin of error of plus or minus 5%, total of 98 respondents were required in this study. However, after taking into consideration, an additional of 20% from the total respondents required to counter non-responsive case and reject questionnaire samples.

$= 98 + [(98 \div 0.8) \times 0.2]$

$= 98 + 24.5$

$=122.5$

≈ 123 respondents

In short, the minimum sample size needed were 123 respondents to participate in this study.

3.6 Data collection and instrumentation

3.6.1 Questionnaire

The structured questionnaire was prepared in English and Malay languages (Appendix B1 and B2). The survey was carried out in January 2017. The respondents were approached and asked for consent permission to voluntarily participate in this study and the interview was done face-to-face. The questionnaire comprised of three parts:

Part A: Information about demographic of respondents that include gender, age, race, marital status, educational level, monthly income and general health status.

Part B: Information on awareness about peroxide content in cooking oil such as factors influencing quality of cooking oil, detection of peroxide in rancid oil or in repeated heated cooking oil and impacts of peroxide towards cooking oil condition. A score of 1 will be given for correctly answered questions in Part B. On the other hand, nil score will be given for incorrect or "Not sure" answer in the questionnaire. The scoring range was described in Table 3.6.1.

Part C: Information about respondent's practice in repeated heating of cooking oil which include types of cooking oil use by respondents, types of food preparation that use the same repeatedly heating cooking oil and frequency of they use recycle oil before discard it.

Pre-test was conducted among food outlet operator in Seri Serdang prior to the official questionnaire survey. Based on the pre-test feedback and comments made by the UPM Ethics Committee (JKEUPM), some of the questions used in the pre-test were modified for the actual study. All data collected was made anonymous, stored and controlled by the authors. There were 13 respondents included during the pre-test.

Table 3.6.1: Awareness level on peroxide in cooking oil among food premise handlers in Bukit Mertajam, Penang

Category	Level of awareness	Range of scoring
Awareness	Low	0-3
	Middle	4-6
	High	7-9

3.6.2 Measurement of Peroxide value in cooking oil

There were three (3) main phases in the measurement of peroxide value. Firstly, the five different most favour cooking oil's brands were purchased from groceries. The fresh oil was heated up to temperature between ranges of 160-180 °C. The potato slices of ±100 gram were fried in a deep fryer with 500 mL of cooking oil for 3 to 5 minutes. Upon completion of the frying process, the heated oil was collected. The process was repeated three times for heating and frying procedures by using the previous session to represent repeatedly heated oil practice with a cooling interval of at least two hours. The food quantity was proportionately adjusted with the amount of vegetable oil left. No fresh oil was added between the frying processes to make up for the loss due to uptake by the frying materials. After being heated, small quantity of the oils was extracted for the peroxide value content measurements (10ml was taken from each different brands of cooking oils as a sample). The sample from each frying session was analysed in triplicates to control validity of the method applied. All collected samples were kept in a separate 100 ml dark-coloured sample bottles. Those samples later were being chilled and frozen at -18 to -20°C until analysis of PV.

Next, a laboratory analysis was conducted based on peroxide analysis (AOCS Method Cd 8-53, 2003). The PV measurement from each sample in respective frying session was done in triplicates. The last stage in determining PV from oil samples was used to compare the calculated peroxide value obtained with the standard. The reference standard based on the American Oil Chemists Society (AOCS) was 10

meqO_2/kg, as an indicator of deterioration for vegetable oils. Below were the steps involved in laboratory analysis of PV determination in oil samples:

1. Five gram of oil is being accurately weight into a 250 ml stopper flask.
2. Twenty five millilitre of acetic acid-chloroform solution and 1 ml of saturated potassium iodide (KI) solution was being added.
3. The flask was swirled and placed in dark environment (such as inside the cupboard) for exactly 1 minute.
4. Seventy five millilitre of water (to stop the further chemical reaction) was added.
5. One millilitre of starch as an indicator is being added and followed by titration 0.01M of sodium thiosulphate solution.
6. The flask was swirled vigorously until blue-black colour disappeared and turned colourless.
7. The total volume of thiosulphate used was measured and recorded in titration process.
8. Peroxide Value (PV) was calculated in the sample. The calculation formula as shown as below (Equation 3.6.2) :

Peroxide Value (meq/kg) =

$$\frac{[\text{Volume of thiosulphate titrate (ml)} \times \text{Concentration of thiosulphate solution (N)} \times 1000]}{\text{Weight of sample (g)}}$$

Equation 3.6.2

The summary of equipment and reagents involve in laboratory procedure for measurement of PV in oil samples (Table 3.6.2).

Table 3.6.2: Equipment and reagents in laboratory analysis procedure for measurement of Peroxide Values (PV) in oil samples

Equipment	Reagents
1. 250 ml conical stoppered flask	1. Glacial Acetic acid-chloroform
2. 50 ml burette	(3:2) by volume
3. Balance	2. Saturated KI solution
4. Automatic pipette 1 ml	(22 g KI and 11 ml water)
5. Pasteur pipette	3. 1% starch solution
6. 25 ml measuring cylinder	4. 0.01 M sodium thiosulphate solution
7. 100 ml measuring cylinder	

3.7 Quality assurance and quality control

3.7.1 Laboratory analysis of oil samples

There were several aspects taken when collecting samples after heating of cooking oil simulation sessions in the laboratory which was by using appropriate equipment and procedures to analyse parameter of interest (peroxide value) and correlate with the sampling objective. The arrangements for samples analysis and adequate availability of reagents and equipment required for experimental analysis were verified with the laboratory ahead since those were used to perform the analysis of samples. Besides, the volume of samples collected must be sufficient to conduct requested analysis and it was also a quality control factor in sampling analysis. Every

containers and equipment used in the experiment was cleaned and labelled accordingly prior analysis.

Furthermore, in order to prevent further reaction between samples and ambient environment after each heating process (deep frying procedure), the samples were kept in 100 ml dark-coloured sample bottles with proper labelling. The samples were chilled and frozen until analysis for determining PV in respective samples prepared.

3.7.2 Personal protective equipment

The person who was responsible and involve in samples handling should wear goggle, nitrile glove and laboratory coat fully to avoid splash or contact accidents with the chemicals use in analysis. It could also prevent contamination to samples testing that might affect the result of measurement reading.

3.8 Data analysis

The data analysis was carried out by using software Statistical Package for the Social Sciences (SPSS) for Windows Version 22. The statistical analysis for each specific objective in this study was shown in Table 3.8.1 below with p-value of <0.05 was considered as statistically significant.

Table 3.8.1: Summary of statistical analysis with the respective specific objectives in this study

Specific objective	Hypothesis	Statistical analysis
i) To describe the socio-demographic of respondents.	No hypothesis.	Descriptive analysis
ii) To investigate the awareness level of using repeatedly heating cooking oil by the respondents especially in deep-frying food preparation.	No hypothesis.	Descriptive analysis
iii) To determine the practice either using fresh cooking oil or using repeatedly heating cooking oil in deep-frying among respondents.	No hypothesis	Descriptive analysis
iv) To measure the peroxide value in repeatedly heated cooking oil.	No hypothesis	Descriptive analysis
v) To determine correlation between awareness and practice of repeatedly heating cooking oil in food preparation among respondents.	There is a significant correlation between awareness and practice of repeatedly heating cooking oil in food preparation among respondents.	Chi-square test
vi) To identify the association between awareness in using of repeatedly heating cooking oil and socio-demographic factors among respondents.	There is significant association between awareness in using repeatedly heating cooking oil especially in deep-frying food preparation and socio-demographic factors among respondents.	Chi-square test
vii) To determine the association between practice of repeatedly heating cooking oil and socio-demographic factors among respondents.	There is significant association between practice of repeatedly heating cooking oil and socio-demographic factors among respondents.	Chi-square test

3.9 Ethical permission and consideration

The permission to conduct this study was obtained from the Ethics Committee for Research involving Human Subjects Universiti Putra Malaysia (JKEUPM) before started the data collection (Refer Appendix A). Explanation about the background of this study was given to the respondents for them to sign the participation consent form as an agreement to involve in this study voluntarily before answering questions based on structured questionnaire (Refer Appendix C). The confidentiality of respondent's personal details remained and was not mentioned or included in any parts of this study and publication.

CHAPTER 4

RESULTS AND DISCUSSION

4.1Socio-demographic information of respondents among food premise handlers in Bukit Mertajam, Penang

A total of 124 respondents from the general food premise handlers in the area of Bukit Mertajam, Penang were approached and enrolled voluntarily in this survey. This study basically surveyed on the awareness and practice of repeatedly heating cooking oil among respondents. Table 4.1.1 describes the socio-demographic information of respondents. The age of respondents ranged from 18 to 65. The largest total number of respondents (n=33) was in the less than or equal to 25 age group, whereas the smallest total number of respondents (n=4) was in the 61 until 65 age group. The age group of below or equal to 25 years old contributed the most in the recruitment of respondents because they worked part time after they had finished the studies and to help their family relatives to manage the business. The respondents were dominated by female (66.5%) if compared to male (33.5%).

Table 4.1.1: The socio-demographic factors of respondents (N=124)

Variables	Frequency (%)	Mean (SD)	Range
Gender			
Male	44 (35.5)		
Female	80 (64.5)		
Age			
<25	33 (26.6)	36.2 (13.0)	18-65
26-30	17 (13.7)		
31-35	18 (14.5)		
36-40	5 (4.0)		
41-45	7 (5.6)		
46-50	29 (23.4)		
51-55	6 (4.8)		
56-60	5 (4.0)		
61-65	4 (3.2)		
Race			
Malay	75 (60.5)		
Chinese	22 (17.7)		
Indian	27 (21.8)		
Educational status			
UPSR	37 (29.8)		
SPM	80 (64.5)		
Degree	7 (5.6)		
Monthly income			
≤ RM 1,000	66 (53.2)		
RM 1,001- RM 2,500	38 (30.6)		
RM 2,501- RM 5,000	16 (12.9)		
≥ RM 5,001	4 (3.2)		

Most of the respondents were Malay (60.5%), followed by Indian (21.8%) and Chinese (17.7%). This situation was not surprising since that the area of Bukit Mertajam has been the settlement of Malay's population and most of them tend to operate the food premise business as source of financial income. Majority of the respondents' educational level was up to secondary school level (65.4%). The respondents claimed that they had taken SPM examination or further their studies until degree level in university. Over half (53.2%) of the respondents have a monthly income of less than RM 1000. Based on the interview conducted, they just prepared a limited variation total of food items especially fried food in order to prevent any

waste. This was the reason majority of respondents only generated a monthly income of RM 1000 or less. This finding was also supported by study of Wai (2007) which emphasized on the limited variation of food products offered by the food operators operating a small-medium scale of business.

4.2 The awareness level of using repeatedly heating cooking oil especially in deep frying food preparation among respondents in Bukit Mertajam, Penang

This study assessed the level of awareness regarding to the use of repeatedly heating cooking oil amongst the sub-urban population in Bukit Mertajam, Penang. This population was interesting to study because it was a city which experiencing development and modernization. It is assumed that a sub-urban population is more aware and knowledgeable about health issues compared to a rural population (Azman et al., 2012). Therefore, the level of awareness among selected respondents at Bukit Mertajam, Penang regarding the health issue could be seen as having an appropriate consciousness on the harmful effects especially on human health associated with continuous consumption of repeatedly heated cooking oil as part of daily diet of an individual. The description of frequency and percentage of respondents answered agree, disagree and not sure for each question are shown in Table 4.2.1.

Table 4.2.1: The frequency and percentage of awareness level using repeatedly heating cooking oil among respondents (N=124)

No.	Question	Frequency (%)
1	Do you know peroxide presence can be detected in cooking oil especially if using repeatedly heating cooking oil?	
	Yes	47 (37.9)
	No	50 (40.3)
	Not sure	27 (21.8)
2	If **"Yes"** (question no. 1), please state source of information obtained regarding on peroxide presence in cooking oil especially if using repeatedly heating cooking oil. (N=47)	
	Newspaper	6 (4.8)
	Magazine	5 (4.0)
	Television	3(2.4)
	Radio	10 (8.1)
	Internet	4 (3.2)
	Family/ Friends	19 (15.3)
3	Usage of repeatedly heating cooking oil for frying food is a good practice as it saves cost and there is no side effect.	
	Agree	39 (31.5)
	Disagree	55 (44.4)
	Not sure	30 (24.2)
4	The quality of oil used for frying will remain the same regardless of how many times the oil is reheated.	
	Agree	71 (57.3)
	Disagree	31 (25.0)
	Not sure	22 (17.7)
5	We can still use the same oil for many times and discard it only when it turns dark.	
	Agree	61 (49.2)
	Disagree	40 (32.3)
	Not sure	23 (18.5)
6	The frying duration influence types of by-products formation of repeatedly heating cooking oil.	
	Agree	68 (54.8)
	Disagree	22 (17.7)
	Not sure	34 (27.4)
7	The type of cooking oil does not influence the quality of the cooking oil.	
	Agree	61 (49.2)
	Disagree	43 (34.7)
	Not sure	20 (16.1)
8	Will repeatedly heated cooking oil used for frying cause bad effects to human health?	
	Yes	54 (43.5)
	No	41 (33.1)
	Not sure	29 (23.4)

9	If **"Yes"**, to the above question (question no. 8) , what type of disease do they associate with the prolonged consumption of repeatedly heating cooking oil? (N=54)	
	Tuberculosis	3 (2.4)
	Food poisoning	13 (10.5)
	Hypertension	17 (13.7)
	Diabetes	1 (0.8)
	Cancer	20 (16.1)
10	What is the impact of high peroxide value in cooking oil?	
	Good quality of cooking oil.	11 (8.9)
	Bad quality of cooking oil.	49 (39.5)
	Handlers can still use and recycle the same cooking oil.	40 (32.3)
	Discard and replace used cooking oil with new, fresh cooking oil.	24 (19.4)

Based on the Table 4.2.1, the total scores of awareness for respondents was summed up by allocating a score of one (1) for correctly answered question, otherwise nil (0) mark would be given. The respondent's scores for awareness were subsequently categorised into three levels (Azman et al., 2012) as illustrated in Table 4.2.2. Most of the respondents (40.3%) did not aware on the presence of peroxide, which can be detected in cooking oil mainly in repeatedly heated cooking oil. This might be due to their level of education. For instance, it was found that respondents having a higher level of education were found to have significantly higher level of awareness regarding usage of repeatedly heated cooking oil if compared to respondents with lower level of education (Azman et al., 2015).

Moreover, surprisingly up to 44.4% of respondents disagreed on the use of repeatedly heating cooking oil for frying food as a good practice and with no side effects in order to save cost. Based on the interview session, they claimed to be aware about the deleterious health effects such as cancer upon long-term consumption of oil being repeatedly heated. Ironically, they were still using the same

cooking oil for several times before discarding it due to economic crisis experience in our country.

In addition, the respondents agreed that they could still use the same oil for many times and discarded only when it turned dark in colour (57.3%). This was in lined by a previous study which stated that according to the Malaysian Food Act and Regulation in September 2005, there was no provision for frying oil quality and meant the usage of repeatedly used cooking oil was not prohibited and the food makers could discarded the oils whenever seem to be necessary (Wai, 2007). Since there is no relevant guidelines to be followed, thus the food operators are not monitored by the local authorities regarding on how long duration and total number of frying sessions allowed so it would eventually affected the quality of cooking oil used. The respondents also had perception it was fine to re-use the similar cooking oil for several times as long as if they were using a high quality brands of cooking oil.

Table 4.2.2: The awareness level of using repeatedly heating cooking oil among respondents (N=124)

Variable	Level	N	Frequency (%)	Range
Awareness in repeatedly heated cooking oil.	Low	124	42 (33.9)	0-3 score
	Moderate		66 (53.2)	4-6 score
	High		16 (12.9)	7-9 score

The awareness scores of respondents were then sorted out into 3 categories as illustrated in the Table 4.2.2 in order to obtain respondents' level of awareness regarding this issue. Nearly half of the respondents (53.2%) scored 4 to 6 out of total scores of 9 which indicated that majority of them were having moderate awareness level.

Based on the survey, moderate level of awareness among food premise operators could be due to the lack of information and related knowledge that emphasize on the harmful health effects and danger of prolonged consumption of rancid oil from the repeatedly heating process during food preparation. The sources of information are limited and even worst when there are still some of the respondents interviewed had admitted that they have never heard about this matter before. Indeed, it is important to highlight the health impacts imposed by detection of high peroxide in cooking oil used by food premise handlers as they were part of the communities and responsible preparing food products for consumers. Long-term ingestion of food items prepared using reheated oil could severely affecting antioxidant defence network of an individual which causing to pathologies such as hypertension, diabetes and vascular inflammation. The detrimental effects of reheated oil consumption lead to a more serious oxidative assault to the cellular antioxidant shield (Leong et al., 2015).

4.3 The practice of using repeatedly heating cooking oil in deep-frying among food premise handlers at Bukit Mertajam, Penang

An overwhelming majority of the respondents claimed to use palm oil for frying food (63.7%) for 2 to 4 times before discarding it (Table 4.3.1). This practice was not too bad since most of them were using used palm oil (88.7%) for frying. The practice of using palm oil in any food preparation is advisable because it could withstand thermal oxidation quite well (Pandurangan et al., 2014). Those who used fresh oil for each frying session as they thought it was a healthy practice apart from it was able to improve the appearance of fried food.

Besides, in order to maintain the quality of oil during frying, majority of respondents claimed to use stainless steel frying utensils (34.7%). This was a good practice, since low concentration of copper found in brass and other copper alloy utensils acted as a catalyst for thermal oxidation (Berger, 2005). The majority of respondents also maintained a small flame while frying, which was also a good practice because very high temperatures could decompose cooking oil very rapidly. The top five most favourable cooking oil's brands were Matahari, Buruh, Cap Bintang Lima, Cap Bulu Tangkis and Minyak Masak Sehati.

Table 4.3.1: The frequency and percentage of practice using repeatedly heating cooking oil in deep-frying among respondents (N=124)

No.	Question	Frequency (%)
1	Type of cooking oil's usage:	
	Palm oil	110 (88.7)
	Coconut Oil	1(0.8)
	Corn oil	5 (4.0)
	Olive oil	8 (6.5)
2	Do you use repeatedly heated cooking oil for cooking?	
	Yes	87 (70.2)
	No	37 (29.8)

3	If choose **"YES"** (in Question 2) how many times is the same cooking oil being reused before discard it? (N=87)	
	1 time	37 (43.0)
	2 times	25 (29.1)
	3 times	14 (16.3)
	4 times	4 (4.7)
	5 to 8 times	6 (7.0)
4	If choose **"NO"** (in Question 2) please state reason for not using repeatedly heating cooking oil? (N=37)	
	Harmful to health	8 (5.6)
	Cause food spoilage	12 (9.7)
	Increase cholesterol level in cooking oil	18 (14.5)
5	What is the food prepare using repeatedly heating cooking oil for cooking? (N=87)	
	Chicken	20 (19.4)
	French fries	8 (7.3)
	Keropok lekor	13 (9.7)
	Banana fritter	9 (9.7)
	Sweet potatoes	22 (23.4)
	Nugget or sausages	15 (15.3)
6	Do you eat food that is not being sold out of your business?	
	Yes	73 (58.9)
	No	50 (40.3)
7	Please state most favour brand's name of cooking oil used.	
	Ali Jaya	6 (4.8)
	Matahari	16 (12.9)
	Saji	1 (0.8)
	Seri Murni	5 (4.0)
	Buruh	21 (16.9)
	Cap Pisau	12 (9.7)
	Cap Bintang Lima	24 (19.4)
	Cap Bulu Tangkis	15 (12.1)
	Minya Masak Sehati	24 (19.4)
8	What is the method attempted to maintain quality of cooking oil?	
	Use fresh cooking oil for cooking purpose every time	18 (14.5)
	Maintain small flame while cooking process	30 (24.2)
	Transfer oil in stainless steel or glass container after usage	43 (34.7)
	Perform oil filtration to strain food particles or foreign matter in cooking oil.	33 (26.6)
9	Please state source of information obtained regarding on usage of repeatedly heating cooking oil.	
	Newspaper	24 (19.4)
	Magazine	9 (7.3)
	Television	12 (9.7)
	Radio	12 (9.7)
	Internet	29 (23.4)
	Family/ Friends	19 (15.3)
	No prior information about this issue	19 (15.3)

The unique composition of palm oil allows it to withstand heat better than soybean oil. Palm oil was rich in saturated and monounsaturated fatty acids (MUFA) but has low levels of polyunsaturated fatty acids (PUFA) compared to soybean oil, as shown in in a study conducted by Kamsiah & Yusof (2012). Vegetable oils which rich in PUFA are more prone towards oxidation compared to those which high in MUFA such as palm oil and olive oil. Those oils are able to withstand oxidation better and formed less degradation products on repeated heating.

Besides, palm oil also has an abundant content of vitamin E, which demonstrating an important role in its ability to withstand thermal oxidative changes. Inclusion of α-tocopherol to frying oil was found to render PUFA more resistant to oxidation. Vitamin E, which effectively protects fatty acids in the oil from oxidation, deteriorates after each frying episode. A repeatedly heated of frying oils destroyed the vitamin E content and exposed the fatty acids to oxidation with the ambient air. The vitamin E content of palm oil mainly consists of tocotrienols, while the vitamin E in soybean oil mainly consists of tocopherols. Tocotrienols have better antioxidant capacity than tocopherols and this has enhanced resistance of palm oil towards oxidative changes due to repeatedly heating of cooking oil (Pandurangan et al., 2014).

Table 4.3.2: The practice of using repeatedly heating cooking oil among respondents at Bukit Mertajam, Penang (N=124)

Variable	Level	N	Frequency (%)	Range
Practice in repeatedly heated cooking oil based on total number of frying session.	Bad	87	37 (43.0)	5 times or more
	Moderate		43 (50.0)	2-4 times
	Good		6 (7.0)	0-1 time

The practice on repeatedly heated cooking oil by respondents is shown in Table 4.3.2. There were many studies which have used potato slices to measure the oxidative stability of cooking oils, such as corn, palm and olive oil, either using deep frying (Tabee et al., 2008). However, based on the survey, fried sweet potatoes (23.4%) was one of the popular snacks in Malaysia, which was commonly consumed deep-fried and can be easily found in most of the food premises. Half (50.0%) out of 87 respondents admitted only using the cooking oil two to four times only before they would discarded it. This was because they were concerned about the physical attractiveness of food products instead of health impacts, so they decided not to re-used and recycled the cooking oil for up to four times of frying sessions or even more.

In brief, according to Dang et al. (2013), he expressed that deep frying was commonly utilized for food preparations such as frozen per-fried foods, snack foods, and fast foods. Fried foods were more popular today in much country especially among teenagers and children. Deep frying of foods at high temperature creates the special flavour, golden brown colour and crispy texture. It was a fact that frying

might resulted oil to undergo hydrolysis, oxidation and thermal reaction and consequently several by-products were formed such as fatty acids, alcohols, cyclic compounds and polymers. Some products of decomposition in repeatedly heating cooking oil which could be easily absorbed into the fried foods had been identified to adversely affecting on human's health.

4.4 The peroxide value in repeatedly heated cooking oil

In this study, there were 5 cooking oil's brands chosen based on the most preferred choices of usage among respondents (Table 4.4.1). Based on the calculated average peroxide value (PV), most of the cooking oil samples had exceeded the standard limit prescribed in American Oils' Chemist Society (AOCS) standard at the 7^{th} or 9^{th} frying sessions except for cooking oil (Brand C) which drastically increased pattern and has already recorded PV of 12.0 meq/kg even at 5^{th} number of frying sessions. This scenario might happen as the oxidation progresses occur at different rates depending on factors such as temperature, light, availability of oxygen as well as the presence of moisture and metals from utensils being used during frying.

Table 4.4.1: The average peroxide value in repeatedly heated cooking oil with respective brands of cooking oils (N=5)

Total number of frying sessions by using the same cooking oil (times)	Average Peroxide Value (PV) with respective cooking oil's brands (meq/kg)				
	A	B	C	D	E
Fresh cooking oil	3.6	1.2	2.0	1.2	1.8
1	5.2	3.8	2.6	2.0	3.2
3	7.0	5.8	7.2	3.0	5.4
5	9.8	9.4	12.0*	6.2	7.6
7	10.6*	10.0*	12.8*	8.0	8.2
9	12.0*	16.2*	15.8*	12.2*	11.0*

* The cooking oil sample exceeds standard limit for Peroxide according to AOCS standard (PV ≥ 10 meq/kg)

Brand A: Minyak Masak Buruh
Brand B: Minyak Cap Bintang Lima
Brand C: Minyak Masak Cap Bulu Tangkis
Brand D: Minyak Masak Sehati
Brand E: Minyak Cap Matahari

Peroxide Value (meq/kg) = [Volume of thiosulphate titrate (ml) x Concentration of thiosulphate solution (N) x 1000] / Weight of sample (g)

Furthermore, oils higher unsaturated fatty acids oxidized more quickly than less unsaturated oils (Parker et al., 2003). The results showed that the trend of the PV was consistently increased for all samples. In the beginning, the values of peroxides from the original cooking oils increasing in corresponded with increasing number of frying sessions. This was due to the formation of hydroperoxides of unsaturated fatty acids that were obtained as a result of lipid oxidation. This was proven based on the vegetable oils examined in the present study which consisted of olive oil, soy oil, corn oil and palm oil, has shown variations in PV. Out of 20 samples only three samples had a PV below than 3 meq/kg after five times of frying sessions. All

samples recorded PV below 3 meq/kg were tested by using the palm oils (Kamsiah &Yusof, 2012).

Deep frying is a frying process where the food is completely immersed in the frying oil in the presence of air and moisture at temperatures of between 160-190°C. During this process, several chemical reactions take place like reactions of oxidation, hydrolysis and thermal polymerization. In this study, it was more focused on oxidation since it could cause undesirable flavours and taste, disintegrating the nutritional quality and leading to production of toxic compounds. Oxidation of oils was influenced by different factors such as the degree of unsaturation, heat, light, oil processing, antioxidants and transition metals. Another important issue is the reusing of fried oils. This practice was not only restricted to roadside food stalls. Even the reputable food outlets in large cities also used this technique to lower their costs. The repeatedly heating of cooking oil result in oil that was more prone to lipid peroxidation (Jaarin et al., 2011).

The peroxide value is often used as an indicator for the oxidative stability of fats and oils. It is found to be highly correlated with the total concentration of major odorants that were including pentanoic acid, hexanoic acid and 1-nonanal as well as and the total concentration of five unsaturated aldehydes such as the t-2-heptenal, t-2-octenal, t-2-decenal, t-2-undecenal and t,t-2,4-decadienal in oils. These odorants and aldehydes showed strong cytotoxicity in the heated oils (Basiron, 2007). However, the characterisation of individual fatty acids such as oleic, linoleic and

linolenic acids was not done in this study. Oils that are being repeatedly heating at high temperature for a long period would undergo thermal oxidation process with configuration changed in fatty acid from cis to trans isomer. A prvious study had proven that food containing high trans fatty acid could increase the risk of cardiovascular disease by inducing a pro-inflammatory response in the endothelial cells (Gil et al., 2004).

Moreover, it was relatively easier to measure the peroxide value compared to the direct measurement of odorants in cooking oils. Therefore, the peroxide value is significance in the assessment of quality and stability of foods with high oil content. There were several factors that can affect the quality of oil during the deep frying process, such as the types of food being fried, composition of the oils used, frying temperature, length of frying time, use of a continuous or intermittent frying method and replenishment of fresh oil. However, in this study, only the effect of different brands of cooking oil which available in market and mostly used for the deep frying process on the quality of repeatedly heated oil was investigated.

In short, the mechanism of thermal degradation of frying oil is very complicated. Thus, it is noteworthy to understand and know the factors affected the deterioration of frying oil and to monitor continuously the quantity of products of decomposition to ensure the quality of fried foods prepared. There are several variables that involved in the process include frying condition, replenishment of fresh oil, original oil quality, food materials, and fryer type. Cooking oil having more

saturated fatty acids such as palm oil is usually more stable and resistant high temperature during frying process.

4.5 The correlation between awareness and practice of repeatedly heating cooking oil in food preparation among food premise handlers at Bukit Mertajam, Penang

Based on the interview conducted in this study, it has been identified that the respondents had an adequate level of awareness about using repeatedly heated cooking oil in food preparation process (Table 4.5.1). Their source of information for this particular health issue was limited and some of the respondents have never heard about this issue at all. Despite that, most of them made an effort to maintain the quality of oil used for frying due to various reasons. Nevertheless, there was still gap which could be filled up in order to alleviate awareness concerning on the aspect of health issues associated with consumption of oxidised oils. Sadly, there were still some food handlers who know nothing about this issue.

Table 4.5.1: The association between awareness and practice of repeatedly heating cooking oil among respondents (N=124)

	Frequency practice of using repeatedly heated cooking oil				
Awareness of using repeatedly heated cooking oil	0-1 time (%)	2-4 times (%)	5 times or more (%)	x^2 (df)	p- value
Low	13 (10.5)	27 (21.7)	2 (1.6)	3.68	0.05*
Moderate	15 (12.1)	42 (33.9)	9 (7.3)	(4)	
High	3 (2.4)	10 (8.1)	3 (2.4)		

*Significant at p-value <0.05

In addition, there are some measures that could be implemented such as by providing education either through awareness campaign or the governmental public health officers should visit the registered food premises at a continual scale to educate on the proper techniques to perform deep-frying. For instance, they have to be advised to drain the fried foods as much as possible and followed by placing those foods onto the absorbent paper towel so the excess oil before serving to the customers. This action would indirectly change and transform the pattern of frying methods which had been practiced by respondents.

In brief, the knowledge on danger using repeatedly heating oils is able to be widely spread to the communities by fully optimized usage of mass media. Nowadays, there is no limit and boundaries to share any information globally regarded places and time. Though practice using the same cooking oil up to four times in frying still did not exceed the permissible limit prescribed by reference standard, a continuous and frequent consumption of rancid oils would pose harmful risks to the consumer's health status particularly related to the development of non-communicable diseases which are closely related to the dietary pattern in daily life of an individual at all levels of age.

4.6 The association between awareness in using repeatedly heating cooking oil especially in deep-frying food preparation among respondents and socio-demographic factors

The next study objective was to identify association between awareness in using repeatedly heating cooking oil among food premise handlers and educational status. One important factor found in this study was the level of education attained by respondents. This study revealed that there was no significant association between the educational level and the level of awareness about the usage of repeatedly heated cooking oil.

Table 4.6.1: The association between awareness of repeatedly heating cooking oil and educational status among respondents (N=124)

	Awareness of using repeatedly heated cooking oil				
Educational status	High (%)	Moderate (%)	Low (%)	χ^2 (df)	p- value
Primary level	3 (2.4%)	21 (16.9%)	13 (10.5%)	13.2 (4)	0.10
Secondary level	9 (7.3%)	43 (34.7%)	28 (22.6%)		
Tertiary level	4 (3.2%)	2 (1.6%)	1 (0.8%)		

Thus, it can be concluded from this study that those having lower educational level were more aware of this issue. The reason might be that even though, those who were not with higher educational level still could referred to and were able to gain more information regarding this issue from the resources that are made available to them. For example, from this study, we found that the major source of information regarding this matter was from the Internet (23.4%). Nowadays, Internet has

provided access to global repository of information to the users anytime and anywhere.

Table 4.6.2: The association between awareness of repeatedly heating cooking oil and age groups among respondents (N=124)

	Awareness of using repeatedly heated cooking oil				
Age groups	High Freq (%)	Moderate Freq (%)	Low Freq (%)	χ^2(df)	p- value
Below 19 years old	1(0.8%)	6 (4.8%)	8 (6.5%)	3.19 (4)	0.53
20 to 44 years old	9 (7.3%)	33 (26.6%)	20 (16.1%)		
45 years old and above	6 (4.8%)	27 (21.8%)	14 (11.3%)		

Moreover, it can be deduced that there was no significant association between awareness of repeatedly heating cooking oil and different age groups among respondents. Most of respondents aged ranging from 20 to 44 years old (young adult phase) had moderate level of awareness regarding presence of peroxide in reused cooking oils. This scenario was mainly due to the lack of health-related campaign emphasizing on the aspect of food adulterants such as issues on peroxide in food products organize by relevant government agencies. Based on the interview, it had been found out the respondents especially older adult aged above 45 years old assumed that usage of repeatedly heating cooking oil was a good practice and would not contribute to any bad health effects to humans. Majority of people residing in semi-urban populations belong to poor socio-economic and educational background (Niranjan et al., 2016).

4.7 The association between practice of repeatedly heating cooking oil among respondents and socio-demographic factors

The last objective for this study was to determine association between practice of repeatedly heating cooking oil and monthly income among respondents. There was no significant association between practice of repeatedly heating cooking oil and monthly income of involved respondents in the study (Table 4.7.1). Most of the respondents had a moderate level in practicing repeatedly heating cooking oil either respondents with monthly income less or more than RM 5,000. They tend to re-use the similar cooking for a few times and only discarded it when turned black in order to save cost.

This situation might be due to the economic crisis that is currently happening globally in which its impacts have affecting pattern of practice in using the same cooking oil several times to reduce cost for food preparation by the food handlers. However, even the practice of using oil repeatedly for frying is necessary due to economic reasons, then palm oil would be the better choice if compared to other types of cooking oil against oxidation stability (Kamsiah & Yusof, 2012). The perception of using of palm oils was supported by government-backed public campaign which has successfully promoted health benefits due to good ability of palm oils to withstand high temperature during frying to the community.

Table 4.7.1: The association between practice of repeatedly heating cooking oil and monthly income among respondents (N=124)

	Frequency practice of using repeatedly heated cooking oil				
Monthly income	0-1 time (%)	2-4 times (%)	5 times or more (%)	χ^2(df)	p- value
≤ RM 5,000	18 (14.5%)	44 (35.5%)	9 (7.3%)	0.37 (2)	0.83
≥ RM 5,001	13 (10.5%)	35 (28.2%)	5 (4.0%)		

Based on the Table 4.7.2, no significant association between the practice of repeatedly heating cooking oil and the age groups among respondents was observed. This was due to the habits of reheated same cooking oil has become a norm and they have gotten used with the method in food preparation without even realising harmful health impacts posed by their practice especially those in young adult age group (33.9%) among respondents. It was even worst as some of respondents preferred to use low grade oil sold in market at a much cheaper price and packaged in plastic. In short, respondents were more concerned on making profits from their business instead of health risks due to consumption of rancid oil.

Table 4.7.2: The association between practice of repeatedly heating cooking oil and age groups among respondents (N=124)

	Frequency practice of using repeatedly heated cooking oil				
Age groups	0-1 time (%)	2-4 times (%)	5 times or more (%)	χ^2 (df)	p- value
Below 19 years old	3 (2.4%)	9 (7.3%)	3 (2.4%)	3.32 (2)	0.51
20 to 44 years old	16 (12.9%)	42 (33.9%)	4 (3.2%)		
45 years old and above	12 (9.7%)	28 (22.6%)	7(5.6%)		

4.8 The strengths and limitations of study

One of the strengths of this study was the ability to provide a baseline data related to the peroxide value in reused and recycled cooking oils since that there was limited studies focusing onto this issue. Apart from that, the level of awareness especially among communities could be enhanced by educating them on the correct ways in order to maintain good quality of cooking oils. On the other hand, there were some limitation in this research where this was a cross sectional study where the accuracy of data recorded were effective at the time survey was done. After some time, if the same survey wants to be performed, some variations may be expected. For example, the same food operator might not be doing business due to bankruptcy or sick or death or switch to do other business. In another word, a cross sectional study is a snapshot of situations present at that instant. Inclusion of more participants will produce better result since more answer can be gathered to make a concrete conclusion on the topic of repeatedly heated cooking oil. During face-to-face interview session, information that provided by the food premise handlers may true and may not because they might think that problems may arise for their business if answered negatively and they may modified their answers for that moment.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study was carried out to assess the awareness and practice of repeatedly heating cooking oil among food premise handlers in area of Bukit Mertajam, Penang. It was found that majority of respondents had moderate in both for the awareness level (53.2%) and practice level (63.7%) regarding usage of repeatedly heated cooking oil based on interview conducted.

Furthermore, there was a significant correlation between awareness level and frequency practice of using repeatedly heated cooking oil (χ^2 = 3.68, p=0.05). However, there were no significant association between awareness in using repeatedly heating cooking oil among food premise handlers and educational status (χ^2 =13.2, p=0.1) as well as for association between practice of repeatedly heating cooking oil and monthly income among respondents (χ^2 = 0.37, p= 0.83) respectively.

Besides, in this study, there were 5 cooking oil's brands chosen based on the most preferred choices of usage among respondents. Based on the calculated average peroxide value (PV), most of the cooking oil samples had exceeded the standard limit prescribed in American Oils' Chemist Society (AOCS) standard of 10.0 meq/kg at the seventh and ninth frying sessions except for cooking oil (Brand C) which has already recorded PV of 12.0 meq/kg even as early as during the fifth frying sessions. The lowest peroxide value recorded in fresh cooking oil was 1.2 meq/kg for cooking

oil (Brand B and Brand D) while 3.6 meq/kg was the highest recorded by cooking oil (Brand A).

Overall, it can be concluded that there was room for improvement to alleviate the knowledge and awareness among the respondents regarding the presence of peroxide in food products particularly in deep-fried food. It was also important to allow them to know the permissible limit allocated for peroxide in which fit for human consumption. For instance, some approach could be applied to enable adequate knowledge and information regarding this little-known issue towards the food premise handlers such as by providing more publicity from the mass media. Other than that, a one-to-one individual sharing should be provided along with the awareness campaign focusing on food safety aspects.

5.2 Recommendations for future research

As for the improvements for upcoming studies, there are a few other assessments that could be carried out in order to determine quality of cooking oil in spite of peroxide detection. For instance, by analyse the parameter of anisidine value, saponification value, iodine value and total polar compound (TPC). All these assessments involved laboratory analysis. However, there are also other methods in assessing quality of cooking oil used such as by observing the viscosity, colour, foam height and odour. The physical changes could be easily identified even for non-expert which may be helpful in making a decision to discard the frying oil used by the food handlers.

In a nutshell, more proactive steps and actions can be taken to alleviate awareness on deleterious health impacts resulting from consumption of rancid oil to human. Related governmental institutions and organizations are encourage to publicly promoting and sharing relevant knowledge to the food handlers such as by using one-to-one approach to educate them. Apart from these agencies and communities must play a role in spreading the information to relatives, friends and family members. These spread of words can go viral if everyone aware the consequences of consuming repeatedly heated cooking oil. These steps may aid to create a safer pattern of practice in using cooking oil repeatedly which fit for human's consumption. Prevention is better than cure.

REFERENCES

Aidos, I., Padt, A. F. D., Remko, B. M., & Luten, J. B. (2001). Upgrading of Maatjes herring by-products: production of crude fish oil. *Journal Agriculture and Food Chemistry*, *49*(8), 3697-3704.

American Oil Chemists' Society (AOCS). (1998). Official methods and recommended practices of the American Oil Chemists' Society. *AOCS, Champaign, 5th Ed.*, 212-217.

Andersson, B., Caroline, W. P. D., Francinete, R. C., Fabio, S., Cesar, A., Antonio, G. F. (2010). A simple methodology for the determination of fatty acid composition in edible oils through 1H NMR spectroscopy. *Magn. Reson.Chem.*, *48*, 642-650.

Atef, M. A. (2010). Physiological effects of some plant oils supplementation on streptozotocin-induced diabetic rats. *Res. J. Med. Sci.*, 5, 55-71.

Attarde, D. J., Pawar, B. and Chaudhari, S., Pal. (2010). Estimation of sterols content in edible oil and ghee samples. *Int. J. Pharm. Sci. Rev. Res.*, *5*, 135 -137.

Azman, A., Khalid, B. A. K., & Ima-Nirwana, S. (2001). The effects of vitamin E on bodyweight and fat mass in intact and ovariectomized female rats. *Medical Journal of Islamic Academic of Sciences*, *14*, 125-138.

Azman, A., Mohd Shahrul, S., Chan, S. X., Noorhazliza, A. P., Khairunnisak, M., Nur Azlina, M. F., Qodriyah, H. M. S., Kamisah, Y. and Jaarin, K. (2012). Level of knowledge, attitude and practice of night market food outlet operators in Kuala Lumpur regarding the usage of repeatedly heated cooking oil. *Medical Journal of Malaysia, 67*(1), 91-101.

Azman, A., Suondoh, M. S., Xuan, C. S., Abdul Patah, N., Mokhtar, K., Mohd Fahami, N. A. et al., (2010). Level of awareness amongst the general public

regarding usage of repeatedly heated cooking oil in Kuala Lumpur, Malaysia. *Int Med J. 17*(4), 310–311.

Azman, A., Suondoh, M. S., Xuan, C. S., Patah, N. A., Mokhtar, K., Mohd Fahami, N. A., and Jaarin, K. (2015). Awareness regarding the usage of repeatedly heated cooking oil in Kuala Lumpur, Malaysia. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, *6*(1), 184-195.

Basiron, Y., Jalani, B. S. and Chan, K. W. (2000). Advances in Oil Palm Research. *Malaysian Palm Oil Board, Ministry of Primary Industries, Malaysia, 1*(782), 783-1526.

Berger, K. G. (2005). The use of palm oil in frying, Selangor. *Malaysian Palm Oil Promotion Council*, *23* (3), 113-117.

Ganasegeran, K., Al-Dubai, S. A. R., Qureshi, A. M., Al-abed, A. A. A., Rizal A. M. and Syed M A.(2012). Social and psychological factors affecting eating habits among university students in a Malaysian medical school: a cross-sectional study. *Nutrition Journal, 11,* 48-55.

Gil, B., Cho, Y. J. and Yoon, S. H. (2004). Rapid Determination of polar compounds in frying fats and oils using image analysis. *Lebensm Wiss u Technol.*, *37*, 657-661.

Innawong, B., Mallikarjunan, P. and Marcy, J .E. (2004). The determination of frying oil quality using a chemosensory system. *Lebensm Wiss u Technol., 37*, 35-41.

International Fragrance Association (2011). IFRA Analytical Method: Determination of the Peroxide Value. Retrieved on September 28th, 2016 from

http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwiHl9nl787PAhXMro8KHeedC6oQFggjMAE&url=http%3A%2F%2Fwww.ifraorg.org%2Fview_document.aspx%3FdocId%3D22291&usg=AFQjCNFo776ieKZR7EorMLlHhAEA6I0UGA&bvm=bv.135258522,d.c2I

Jaarin, K., Mustafa, M. R., Leong, X. F. (2011). The effects of heated vegetable oils on blood pressure in rats. *Clinics*, *66* (12), 2125–2132.

Kamsiah J. and Yusof K. (2012). Repeatedly Heated Vegetable Oils and Lipid Peroxidation, Lipid Peroxidation, Dr. Angel Catala (Ed.). *InTech*. doi: 10.5772/46076.

Lew, K. and Barlow. P. J. (2005). Dietary practices of adolescents in Singapore and Malaysia. *Singapore Med J, 46*(6), 282-289.

Ku, S. K., Muhamad Ruhaifi, M. S., Fatin, S. S., Saffana, K., Taty Anna, K., Das, S., Kamsiah, J. (2014). The harmful effects of consumption of repeatedly heated edible oils: a short review. *Clin Ter., 165*(4), 217-21. doi: 10.7417/CT.2014.1737.

Leong, X. F., Ng, C. Y., Jaarin, K. and Mustafa, M. R. (2015). Effects of repeated heating of cooking oils on antioxidant content and endothelial function. *Austin J Pharmacol Ther., 3(*2): 1068.

Malaysia. (1985). Food Act 1983 and food regulations 1985 (Act 281): Revised 7th October, 1985. Kuala Lumpur: MDC.

Mongabay. (2015). Population of Bukit Mertajam, Malaysia. Retrieved on September 28th, 2016 from

http://population.mongabay.com/population/malaysia/1735079/bukit-mertajam

MPOB. (2011). Official palm oil information source. PalmOilWorld.org. Retrieved on October 1st, 2016 from http://www.palmoilworld.org/about_palmoil.html

Niranjan, G., Kiriprasad, R., Subiman, Sathish, B. M. (2016). Educating people about the healthy edible oils and its storage practices can reduce the incidence of metabolic syndrome: A KAP study. *International Journal of Clinical Biochemistry and Research, 3*(1), 45-49

Parker, T. D., Adam, D. A., Zhou, K., Harris, M., and Yu, L. (2003). Fatty acid composition and antioxidant stability of cold-pressed edible seed oils. *J. FoodSci., 68,* 1240-1243.

Pandurangan, M. K., Murugesan, S. and Gajivaradhan, P. (2014). Physico-chemical properties of groundnut oil and their blends with other vegetable oils. *Journal of Chemical and Pharmaceutical Research, 6*(8), 60-66.

Phiri, G., Mumba, P. and Mangwera, A.(2006). The quality of cooking oil used in informal food processing in Malawi: a preliminary study. *Int J Consum Stud., 30*(6), 527–32.

PROTA Foundation. (2008). Vegetable oils of tropical Africa. Conclusion and recommendations based on PRTA 4: Vegetable oils. Plant resources Africa, 84.

Saad, B., Wai, W. T., Lim, B. P. and Saleh, M. I. (2006). Flow Injection Determination of Peroxide Value in Edible Oils Using Triioydide Detector. *Analytica Chimica Acta., 3*, 565: 261–270.

Sivananthan, M., Elamaran, M., Jasmin, K., & Kushha, R. (2013). Level of knowledge, attitudeand practice of food outlet operators in Raub, Pahang morning marketregarding the usage of repeatedly heated cooking oil- A cross sectional study. *International Journal of Biomolecules and Biomedicine (IJBB), 3*(3), 9-16.

Tabee, E., Azadmard-Dimirchi, S., Jagerstad, M., Dutta, P.C. and Am, J. (2008). Stability of minor lipid components with emphasis on phytosterols during chemical interesterification of a blend of refined olive oil and palm stearin. *Oil Chem. Soc., 85*, 857.

Toro-Vazquez, J. F., Perez-Martinez, D. B., Dibildox-Alvarado, E. A., Charo-Alonso, M. A. and Reyes-Hernandez, J. B. (2004). Rheometry and polymorphism of cocoa butter during crystallization under static and stirring conditions.*J. Am. Oil Chem. Soc., 81*, 195–202.

Wai, T. N. K. (2007). Local Repeatedly-Used Deep Frying Oils Are Generally Safe. *IeJSME,1*(2), 55- 60.

APPENDICES

APPENDIX A

(ETHICAL APPROVAL LETTER)

ETHICS COMMITTEE FOR RESEARCH INVOLVING HUMAN SUBJECTS (JKEUPM)
UNIVERSITI PUTRA MALAYSIA

Research title	:	**Practice Of Repeatedly Heating Cooking Oil Among Food Premise Handlers And Determination Of Peroxide In Cooking Oil In Bukit Mertajam, Pulau Pinang**
Study Site	:	**Bukit Mertajam, Pulau Pinang**
JKEUPM Ref No.	:	**FPSK(EXP16-OSH)U001**
Researcher	:	**Adriana Binti Abdul Aziz**
Supervisor	:	**Dr. Saliza Bt Mohd Elias**

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 18/10/2016
2. Respondent Information Sheet & Consent (English) Version 2 dated 8/12/2016
3. Proposal (English), Version 1 dated 18/10/2016
4. Questionnaire (English), Version 1 dated 18/10/2016
5. Questionnaire (Malay), Version 1 dated 18/10/2016
6. Curriculum Vitae of:
    a. Dr. Saliza bt Mohd Elias

The University Research Ethics Committee, Universiti Putra Malaysia (JKEUPM) operates in accordance to the ICH-GCP Guidelines.

Decision by JKEUPM:

[X] Approved

[X] **Permission MUST BE OBTAINED from the respective hospitals/ institutions before conducting the research**

[ ] Disapproved

Please note that the approval is valid until 9 December 2017

Researchers should comply with the following:

I. Complete a Study Final Report upon study completion (Form D).

II. Ethical approval is required in the case of amendments/ changes to the study documents/ study sites/ study team.

APPENDIX B1

(SUBJECT INFORMATION SHEET ENGLISH VERSION)

JAWATANKUASA ETIKA UNIVERSITI UNTUK
PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

FORM B1: RESPONDENT'S INFORMATION SHEET AND CONSENT

Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

1. STUDY TITLE

Practice of repeatedly heating cooking oil among food premise handlers in Bukit Mertajam, Penang and determination of peroxide in cooking oil.

2. INTRODUCTION

Vegetable oil is a significant and widely used lipid source for our daily life in terms of dietary intake. The vegetable oils are frequently used by consumers due to resistant at high temperature during frying and do not oxidize or rancid easily. The peroxide value (PV) can be applied for identifying the quality in cooking oil through oxidative change that take place in fats or oils. The aims of this study are to study the practice of repeatedly heating cooking oil among food premise handlers in Bukit Mertajam, Penang and determination of peroxide in cooking oil.

3. WHAT WILL YOU HAVE TO DO?

Please provide accurate information as required in the questionnaire which will be provided by the researcher to gather information needed for the study. All given information wiill be used for research purpose only.

4. WHO SHOULD NOT PARTICIPATE IN THE STUDY?

Not applicable.

5. WHAT WILL BE THE BENEFITS OF THE STUDY:

(a) TO YOU AS THE SUBJECT?

It will helps the respondents to be awared of the health impacts due to presence of peroxide in repeatedly heating cooking oil. Thus, they are able to modify the practice of using repeatedly heated cooking oil (if applicable) in food preparation to consumers.The respondents may also get some advise on the bad health impacts associated with consumption of repeatedly heating cooking oil.

(b) **TO THE INVESTIGATOR?**

It will aid the researcher to identify the trend of the respondents' practice using repeatedly heated cooking oil in cooking process.

6. WHAT ARE THE POSSIBLE RISKS?

This study does not have any risks to the respondents since no biological samples taken in the study.

7. WILL THE INFORMATION THAT YOU PROVIDE AND YOUR IDENTITY REMAIN CONFIDENTIAL?

The confidentiality of respondent's personal details remains and will not be mentioned or included in any parts of this study and publication.

8. WHO SHOULD YOU CONTACT IF YOU HAVE ADDITIONAL QUESTIONS DURING THE COURSE OF THE RESEARCH?

If you have any additional questions, you may contact the Supervisor of this research, Dr. Saliza Mohd Elias at 016-2213574 or by e-mail:saliza_me@upm.edu.my. Besides, you may also refer to the researcher of this study, Adriana Abdul Aziz at 019-2524384 or through e-mail at azizadriana14@gmail.com

*Please initial here if you have read and understood the contents of this page*_____

9. CONSENT

PERSETUJUAN

I ..... Identity Card No. .....
address.....
.....hereby voluntarily agree to take part in the research stated above *(clinical /drug trial/video recording/ focus group/interview-based/ questionnaire-based).

I have been informed about the nature of the research in terms of methodology, possible adverse effects and complications (as written in the Respondent's Information Sheet). I understand that I have the right to withdraw from this research at any time without giving any reason whatsoever. I also understand that this study is confidential and all information provided with regard to my identity will remain private and confidential.

I* wish / do not wish to know the results related to my participation in the research

I agree/do not agree that the images/photos/video recordings/voice recordings related to me be used in any form of publication or presentation (if applicable)

* delete where necessary

Signature ..... Signature .....
(Respondent) (Witness)

Date :..... Name :.....

I/C No. :.....

I confirm that I have explained to the respondent the nature and purpose of the above-mentioned research.

Date ..... Signature .....
(Researcher)

APPENDIX B2

(SUBJECT INFORMATION SHEET MALAY VERSION)

JAWATANKUASA ETIKA UNIVERSITI UNTUK PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG, SELANGOR, MALAYSIA

BORANG B1: PENERANGAN DAN PERSETUJUAN RESPONDEN

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.

1.TAJUK KAJIAN

Amalan berulang kali memanaskan minyak masak di kalangan pengendali premis makanan di Bukit Mertajam, Pulau Pinang dan penentuan peroksida dalam minyak masak.

2. PENGENALAN

Minyak sayuran adalah sumber lemak penting dan digunakan secara meluas dalam kehidupan seharian kita dari segi pengambilan makanan. Minyak sayur-sayuran sering digunakan oleh pengguna disebabkan tahan pada suhu yang tinggi semasa menggoreng dan tidak mengoksidakan atau tengik dengan mudah. Nilai peroksida (PV) boleh digunakan untuk mengenal pasti kualiti dalam minyak masak melalui perubahan oksidatif yang berlaku dalam lemak atau minyak. Tujuan kajian ini adalah untuk mengkaji amalan berulang kali memanaskan minyak masak di kalangan pengendali premis makanan di Bukit Mertajam, Pulau Pinang dan penentuan peroksida dalam minyak masak.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Sila berikan maklumat yang tepat seperti yang dikehendaki di dalam soal selidik yang akan disediakan oleh pengkaji untuk mengumpul maklumat yang diperlukan untuk kajian. Semua maklumat yang diberikan wiill digunakan untuk tujuan pengajian sahaja.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Tidak berkaitan.

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANDA SEBAGAI PESERTA?

Ia akan membantu responden memberikan perhatian terhadap impak kesihatan akibat kehadiran peroksida dalam penggunnan minyak masakyang dipanaskan berulang kali. Oleh itu, mereka mampu untuk mengubah suai amalan menggunakan minyak masak berulang kali dipanaskan (jika berkenaan) dalam penyediaan makanan kepada pengguna.

b) KEPADA PENYELIDIK?

Ia akan membantu penyelidik untuk mengenal pasti trend sama ada responden mengamalkan menggunakan minyak masak berulang kali dipanaskan atau tidak dalam proses memasak. Penyelidik juga boleh memberikan beberapa nasihat mengenai kesan buruk kepada kesihatan berkenaan dengan penggunaan minyak masak yang dipanaskan berulang kali kepada responden yang terlibat dalam kajian ini.

6. ADAKAH IA BERISIKO?

Kajian ini tidak mempunyai apa-apa risiko kepada responden kerana tiada sampel biologi yang diambil dalam kajian ini.

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Kerahsiaan maklumat peribadi responden kekal dan tidak akan disebut atau termasuk dalam mana-mana bahagian kajian dan penerbitan.

8. SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMPUNYAI SOALAN TAMBAHAN SEMASA MENGIKUTI PENYELIDIKAN INI?

Jika anda mempunyai sebarang soalan tambahan, anda boleh menghubungi Penyelia penyelidikan ini, Dr Saliza Mohd Elias di 016-2213574 atau melalui emel iaitu saliza_me@upm.edu.my. Selain itu,anda juga boleh menghubungi penyelidik kajian ini iaitu, Adriana Abdul Aziz di 019-2524384 atau melaui emel di azizadriana14@gmail.com.

Sila tandatangan di sini sekiranya anda telah membaca dan memahami kandungan halaman ini

9. PERSETUJUAN

Saya..... No Kad Pengenalan. .....
beralamat.....
.....dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti tertulis pada Helaian Penerangan Responden). Saya memahami bahawa saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan.Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang melibatkan saya.

I setuju/tidak bersetuju untuk imei/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan .....
(*Responden*)

Tarikh :.....

Tandatangan .....
(*Saksi*)

Nama :.....

No. K/P: .....

Saya mengesahkan bahawa saya telah menerangkan kepada responden ini sifat dan tujuan penyelidikan yang tersebut di atas.

Tarikh .....

Tandatangan .....
(*Penyelidik*)

APPENDIX C

(QUESTIONNAIRE FORM)

DEPARTMENT OF ENVIRONMENTAL AND
OCCUPATIONAL HEALTH
FACULTY OF MEDICINE AND HEALTH SCIENCES
UNIVERSITI PUTRA MALAYSIA

QUESTIONAIRES FORM/ *BORANG SOAL SELIDIK*

ID Number:

STUDY TITLE
TAJUK KAJIAN

Practice of repeatedly heating cooking oil among food premise handlers in Bukit Mertajam, Penang and determination of peroxide in cooking oil.
Amalan berulang kali memanaskan minyak masak di kalangan pengendali premis makanan di Bukit Mertajam, Pulau Pinang dan penentuan peroksida dalam minyak masak.

INTRODUCTION
PENGENALAN

Vegetable oil is a significant and widely used lipid source for our daily life in terms of dietary intake. The vegetable oils are frequently used by consumers due to resistant at high temperature during frying and do not oxidize or rancid easily. The peroxide value (PV) can be applied for identifying the quality in cooking oil through oxidative change that take place in fats or oils. The aim of this study is to study the practice of repeatedly heating cooking oil among food premise handlers in Bukit Mertajam, Penang and determination of peroxide in cooking oil.
Minyak sayuran adalah sumber lemak penting dan digunakan secara meluas dalam kehidupan seharian kita dari segi pengambilan makanan. Minyak sayur-sayuran sering digunakan oleh pengguna disebabkan tahan pada suhu yang tinggi semasa menggoreng dan tidak mengoksidakan atau tengik dengan mudah. Nilai peroksida (PV) boleh digunakan untuk mengenal pasti kualiti dalam minyak masak melalui perubahan oksidatif yang berlaku dalam lemak atau minyak. Tujuan kajian ini adalah untuk mengkaji amalan berulang kali memanaskan minyak masak di kalangan pengendali premis makanan di Bukit Mertajam, Pulau Pinang dan penentuan peroksida dalam minyak masak.

PART A: Demographic Information
BAHAGIAN A: Maklumat Demografi

Instruction: Please Fill in the blanks and tick (✓) where appropriate.
Arahan: *Sila isikan tempat kosong dan tandakan (✓) dimana yang berkenaan.*

1. Gender: *Jantina*
   Male *Lelaki* ☐ Female *Perempuan* ☐

2. Age: _____
   Umur

3. Race: *Bangsa*
   Malay *Melayu* ☐ Chinese *Cina* ☐ Indian *India* ☐
   Others (please state)
   Lain-lain (sila nyatakan) _____

5. Education Status: *Status Pengajian*
   PMR/SRP *PMR/SRP* ☐ SPM *SPM* ☐ DEGREE *Ijazah* ☐ MASTER *Master* ☐ PhD *PhD* ☐

6. Monthly income: *Pendapatan bulanan*
   ≤ RM 1,000 ☐
   RM 1,001- RM 2,500 ☐
   RM 2,501- RM 5,000 ☐
   ≥ RM 5,001 ☐

PART B: Respondent's Awareness about Repeatedly Heating Cooking Oil
BAHAGIAN B: Kesedaran Responden mengenai Minyak Masak yang dipanaskan Berulang Kali

Instruction: Please fill in the blanks and tick (✓) where appropriate.
Arahan: *Sila isikan tempat kosong dan tandakan (✓) dimana yang berkenaan.*

1. Do you know peroxide presence can be detected in cooking oil especially if using repeatedly heating cooking oil?
Adakah anda tahu tentang kehadiran peroksida boleh dikesan di dalam minyak masak terutamanya jika menggunakan minyak masak yang berulang kali dipanaskan?

Yes / *Ya* ☐ No / *Tidak* ☐ Not sure / *Tidak pasti* ☐

2. If **"Yes"** (question no. 1), please state source of information obtained regarding on peroxide presence in cooking oil especially if using repeatedly heating cooking oil. (Please answer **ONE** option only)
*Jika menjawab **"Ya "**, sila nyatakan sumber maklumat yang diperolehi mengenai kehadiran peroksida dalam minyak masak terutamanya bagi penggunaaan minyak masak yang berulang kali dipanaskan: (Sila tandakan **SATU** pilihan sahaja)*

Newspaper / *Surat khabar* ☐ Magazine / *Majalah* ☐ Television / *Televisyen* ☐

Radio / Radio ☐ Internet / Internet ☐ Family/ Friends / Keluarga/Rakan ☐

3. Usage of repeatedly heating cooking oil for frying food is a good practice as it saves cost and there is no side effect.
Penggunaan minyak masak berulang kali dipanaskan untuk menggoreng adalah amalan yang baik kerana dapat menjimatkan kos dan tiada kesan sampingan.

Agree / *Setuju* ☐ Disagree / *Tidak setuju* ☐ Not sure / *Tidak pasti* ☐

4. The quality of oil used for frying will remain the same regardless of how many times the oil is reheated.
Kualiti minyak yang digunakan untuk menggoreng akan tetap sama tanpa mengira berapa kali minyak tersebut dipanaskan.

Agree / *Setuju* ☐ Disagree / *Tidak setuju* ☐ Not sure / *Tidak pasti* ☐

5. We can still use the same oil for many times and discard it only when it turns dark.
Kita masih boleh meggunakan minyak masak yang sama banyak kali dan membuangnya hanya apabila ia bertukar menjadi gelap.

Agree ☐ *Setuju* Disagree ☐ *Tidak setuju* Not sure ☐ *Tidak pasti*

6. The frying duration influence types of by-products formation of repeatedly heating cooking oil.
Tempoh menggoreng mempengaruhi produk sampingan yang dihasilkan daripada minyak masak yang berulang kali dipanaskan

Agree ☐ *Setuju* Disagree ☐ *Tidak setuju* Not sure ☐ *Tidak pasti*

7. The type of cooking oil does not influence the quality of the cooking oil.
Jenis minyak masak tidak mempengaruhi kadar kualiti minyak masak berkenaan.

Agree ☐ *Setuju* Disagree ☐ *Tidak setuju* Not sure ☐ *Tidak pasti*

8. Will repeatedly heated cooking oil used for frying cause bad effects to human health?
Adakah penggunaan minyak masak yang berulang kali dipanaskan untuk menggoreng akan mendatangkan kesn buruk terhadap kesihatan manusia?

Yes ☐ *Ya* No ☐ *Tidak* Not sure ☐ *Tidak pasti*

9. If **"Yes"**, to the above question (question no. 8), what type of disease do they associate with the prolonged consumption of repeatedly heating cooking oil? (Please answer **ONE** option only)
*Jika menjawab **"Ya"**, bagi soalam di atas (soalan no. 8), apakah penyakt yang berkaitan dengan pengambilan minyak masak yang berulang kali dipanaskan? (Sila tandakan **SATU** pilihan sahaja)*

Tuberculosis
Tuberkulosis (penyakit kencing tikus) ☐

Food poisoning
Keracunan makanan ☐

Hypertension
Tekanan darah tinggi ☐

Diabetes
Kencing manis ☐

Cancer
Kanser ☐

10. What is the impact of high peroxide value in cooking oil? (Please answer **ONE** option only)
*Apakah kesan nilai peroksida yang tinggi dalam minyak masak? (Sila tandakan **SATU** pilihan sahaja)*

Good quality of cooking oil. ☐
Kualiti minyak masak adalah bagus.

Bad quality of cooking oil. ☐
Kualiti minyak masak adalah tidak bagus.

Handlers can still use and recycle the same cooking oil. ☐
Pengendali masih boleh menggunakan dan mengitar semula minyak masak yang sama.

Discard and replace used cooking oil with new, fresh cooking oil. ☐
Membuang dan menggantikan minyak masak terpakai dengan minyak masak yang baru dan segar.

PART C: Respondent's Practice in Repeatedly Heating Cooking Oil.
BAHAGIAN C: Amalan Penggunaan Minyak Masak yang dipanaskan Berulang Kali oleh Responden.

Instruction: Please fill in the blanks and tick (✓) where appropriate.
Arahan: *Sila isikan tempat kosong dan tandakan (✓) dimana yang berkenaan.*

1. Type of Cooking Oil Usage:
Jenis Penggunaan Minyak Masak

Palm oil *Minyak kelapa sawit*	☐	Peanut oil *Minyak kekacang*	☐
Soy oil *Minyak soya*	☐	Coconut Oil *Minyak kelapa*	☐
Corn oil *Minyak jagung*	☐	Olive oil *Minyak zaitun*	☐

2. Do you use repeatedly heating cooking oil for cooking?
Adakah anda menggunakan minyak masak yang sama berulang kali untuk tujuan masakan?

Yes ☐ *Ya* No ☐ *Tidak*

3. If choose **"YES"** (in Question 2), how many times is the same cooking oil being reused before discarded?
*Jika memilih **"YA"** (dalam Soalan 2), berapakah kali penggunaan minyak masak yang sama sebelum membuang minyak tersebut?*

1 time *1 kali* ☐ 2 times *2 kali* ☐ 3 times *3 kali* ☐ 4 times *4 kali* ☐ 5 to 8 times *5 hingga 8 kali* ☐

4. If choose **"NO"** (in Question 2), please state reason for not using repeatedly heating cooking oil? (Please answer **ONE** option only)
*Jika memilih **"TIDAK"** (dalam Soalan 2), sila nyatakan sebab tidak menggunakan minyak masak yang sama berulang kali untuk tujuan masakan? (Sila tandakan **SATU** pilihan sahaja)*

Harmful to health ☐
Berbahaya kepada kesihatan

Cause food spoilage ☐
Menyebabkan kerosakan makanan

Increase cholesterol level in cooking oil ☐
Meningkatkan kadar kolesterol dalam minyak masak

Others (please state)
Lain-lain (sila nyatakan) _____

5. What is/are the food prepare using repeatedly heating cooking oil for cooking?
(Please answer **ONE** option only)
Apakah makanan yang disediakan dengan menggunakan minyak masak yang sama berulang kali?
*(Sila tandakan **SATU** pilihan sahaja)*

Chicken ☐
Ayam goreng

French fries ☐
Kentang goreng

Keropok lekor ☐
Keropok lekor

Banana fritter ☐
Pisang goreng

Sweet potatoes ☐
Ubi keledek goreng

Nugget or sausages ☐
Nuget atau sosej

6. Do you eat food that is not being sold out of your business?
Adakah anda akan makan makanan yang tidak habis dijual dari hasil perniagaan anda?

Yes ☐ No ☐
Ya *Tidak*

7. Please state most favour brand's name and net weight of cooking oil use for cooking purpose.
Sila nyatakan nama jenama dan kandungan berat bersih bagi minyak masak yang sering digunakan untuk kegunan masakan.

Cooking oil brand's name: *Nama jenama minyak masak*	**Net weight (in unit gram or millilitre):** *Berat bersih (dalam unit gram atau mL)*

8. What is the method attempted to maintain quality of cooking oil?
(Please answer **ONE** option only)
Apakah kaedah yang digunakan untuk mengekalkan kualiti minyak masak berkenaan?
*(Sila tandakan **SATU** pilihan sahaja)*

Use fresh cooking oil for cooking purpose every time ☐
Menggunakan minyak masak baharu setip kali bagi tujuan masakan

Maintain small flame while cooking process ☐
Mengekalkan api kecil semasa memasak

Transfer oil in stainless steel or glass container after usage ☐
Menyimpan minyak masak didalam keluli tahan karat atau bekas kaca selepas penggunaan

Perform oil filtration to strain food particles or foreign matter in cooking oil ☐
Melakukan penapisan minyak bagi memerangkap zarah-zarah makanan dan bahan asing dalam minyak masak

9. Please state source of information obtained regarding on usage of repeatedly heating cooking oil:
(Please answer **ONE** option only)
*Sila nyatakan sumber maklumat yang diperolehi mengenai penggunaaan minyak masak yang sama berulang kali: (Sila tandakan **SATU** pilihan sahaja)*

Newspaper ☐
Surat khabar

Magazine ☐
Majalah

Television ☐
Televisyen

Radio ☐
Radio

Internet ☐
Internet

Family/ Friends ☐
Keluarga/Rakan

No prior information about this issue ☐
Tiada sebarang informasi berkaitan isu ini

10. Does the respondent would like to get more information on this issue?
Adakah responden ingin mendapatkan lebih banyak maklumat mengenai isu ini?

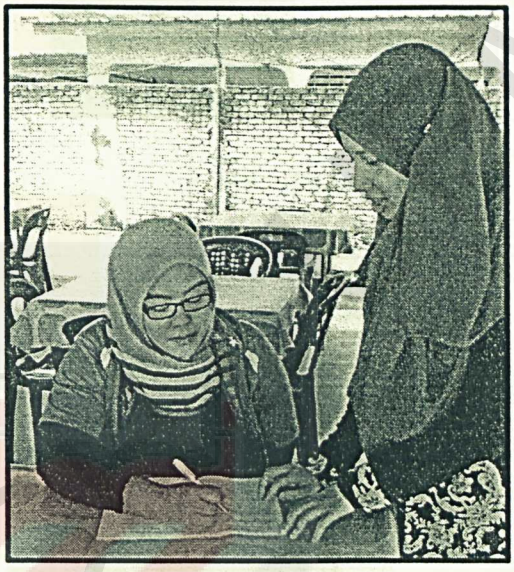
Yes ☐
Ya

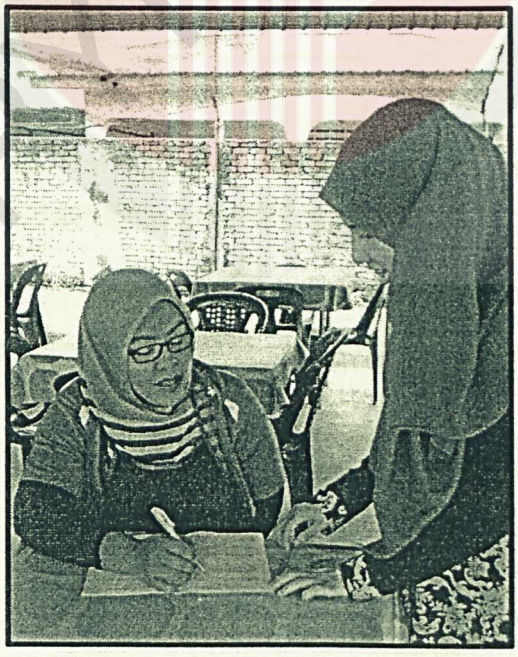
No ☐
Tidak

-THANK YOU-
-SEKIAN TERIMA KASIH-

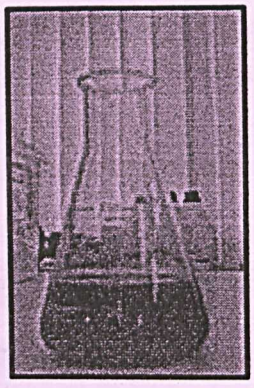
APPENDIX D

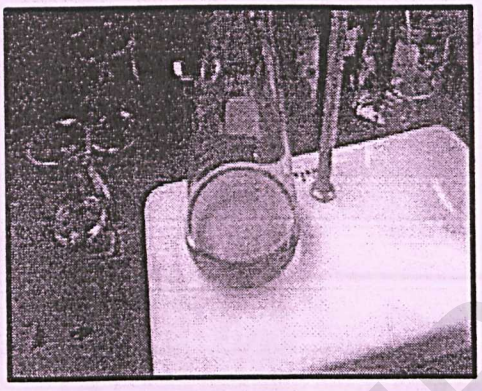
(ON-SITE WORKS PICTURES AND LABORATORY ANALYSIS FOR DETERMINATION OF PEROXIDE IN COOKING OILS)

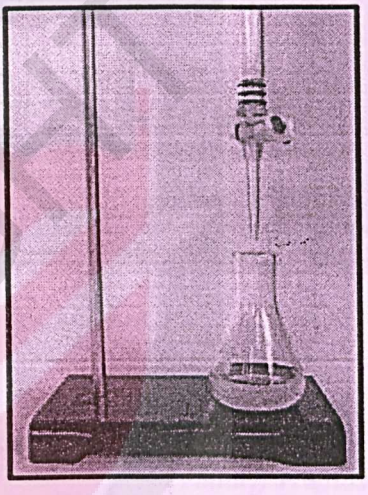




A face-to-face interview was carried out to obtain related information on socio-demographics, awareness and practice of repeatedly heating cooking oil among respondents.







A laboratory analysis (iodometric titration method) was conducted to analyse peroxide in selected brands of cooking oil.

APPENDIX E