MANAGEMENT OF COOKING OIL IN UNIVERSITY MALAYA CAFETERIA OPERATOR

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(Received 23rd May 2019; accepted 5th December 2019)

Abstract. Palm oil is cheaper and widely used compared to cooking oil from soy and corn oil. Cooking oil become an issues in management problems due to repeating cooking oil. Minority expert criticize the repeating usage of cooking oil will harm and dangerous to human health. The quality of oil deteriorates with increased length of frying time due to the accelerated formation of oxidized and polymerized lipid in the frying medium. Frequently used heated cooking oil can cause changes in physical appearances of the oil such as increased viscosity, darkening in color, increased foaming and decrease in smoke point. Since repeatedly usage of cooking oil could bring harm and dangerous to environment and human health, the waste cooking oil are suggested to used for other purposes in producing new products. Continuously research study should be carry out in investigate, design, define, and determine the best solution for the issues and problems in cooking oil management.
Keywords: *cooking oil management, issues and problems, research study, new products*

Introduction

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. Basic scientific definition for cooking oil can be pronounced as glycerol esters of fatty acids. Common types of cooking oil use in most countries include Malaysian are palm oil, peanut oil, corn oil and sunflower oil. This oil is used as a heat-transfer medium in frying to generate nicely cooked foods. Cooking oil is typically liquid, although some oils that contain saturated fat such as coconut oil, palm oil and palm kernel oil which exist in solid at room temperature. Based on the export statistic of cooking oil, Malaysia is among top three exporter of palm oil in the world. About 40% of palm oil mostly made into cooking oil, margarine, specialty fats and oleo chemicals. Major of cooking oil made from palm oil. Meanwhile, used cooking oil term refers to cooking oil that is no longer used in food production. The main producers of used cooking oil are the restaurants, food stalls, night market and cafeteria. The disposal of cooking oil becomes an issue and problems because of fried food such as fried chicken, French fries and burgers can produce as much as 15 litres of used cooking oil per day (excluding the business restaurants in university). There are more than hundreds of restaurants in Malaysia and larger volume of used cooking oil is generated per day.

Production and consumption of cooking oil increase will causes the amount of waste cooking oil generated to increases. Cooking oil allocation in Malaysia was reported 7000 tonnes a month in 2010 (Akademi Science Government, 2012). Based on the statistic of cooking oil allocation versus cooking oil consumption in 2010 (*Figure 1*) indicate that the highest consumption of cooking oil are found on January and the month of Ramadhan with more than 73, 000 0000 tones. The main reason for the statistic to fall on Ramadhan is because many restaurant, hotel, night market or "Bazar Ramadhan" are opening on evening that provide several food which involve with the

cooking oil in preparation for food. These become major factor to increase the graph of consumption cooking oil drastically. Meanwhile, Cooking Oil Subsidy report from Akademi Sains Malaysia (2012) showed the top 8 of Malaysian favorite food (*Table 1*), which required cooking oil as main resources for preparation food. The table resulted are not includes deep frying meat-based products such as fast food (include Kentucky Fried Chicken, McDonald, Burger King), "keropok lekor", fish cakes, sausages and so on. Majority of Malaysian especially the teenagers and children are like deep fried foods due to their taste, smell and texture. On the other hands, fast food can also be considered as easiest and cheapest ways of cooking to consume. Even though a little amount of potential toxic products such as polar compounds or polymers are produced during frying, fried foods are considered safe. However, it becomes toxic for human consumption if the frying oil is used repeatedly (Artman, 1969).

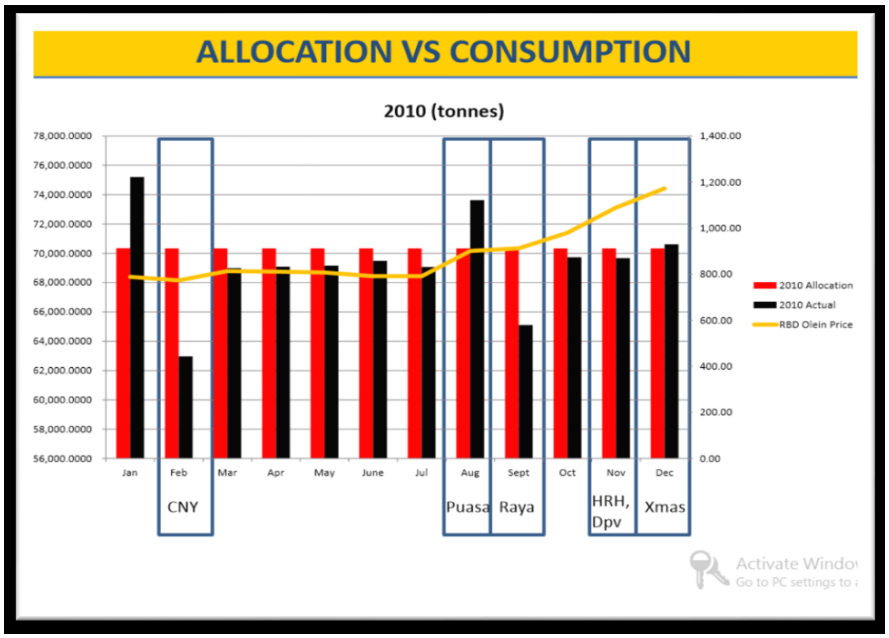

Figure 1. *Cooking oil allocation versus cooking oil consumption in 2010.*
Source: Akademi Sains Malaysia

Table 1. *Top 8 Malaysian favorite food.*

Favourite Food	Oil per Serving (gram)
Nasi lemak	10
Nasi goreng	10
Kuew teow goreng	15
Mee goreng	10
Chicken curry	5
Pisang goreng	5
Curry puff	5
Roti canai	10

Source: Akademi Sains Malaysia (2012)

Waste cooking oil is reported as widely produced all over the world (Kulkarni and Dalai, 2005). Improper waste management of cooking oil leads to discharge of waste cooking oil to environment and this will effect environment and harm the human health. The increasing production of waste cooking oil from household or food industrial source is a new era of growing problems in Malaysia. The waste cooking oil is regularly poured down directly to sink or drain without having any treatment will result in problems for wastewater treatment plants. Fat, oil and grease will cause major problems to drain and sewers. When the waste oil is directly pour down from kitchen sinks or drains, it will cause blockage and bring pollution in streams and rivers when entering the rainwater pipes. Oils and grease may cause the clogging of the pipes because they stick to the inner walls and reduce the diameter of the sewer pipes. Sewage spills will occur when the layer is thicker. The worst condition is it will disrupts normal operations if the oil reaches the wastewater treatment plants and both maintenance costs are extremely high with the rates to be paid for the purification of the water is increase (Payri et al., 2005). Therefore, this review study is conduct to understand the management of cooking oil in cafeteria operator.

Discussion

According to the Basiron (2007) indicate that palm oil are more cheaper and widely used compared to cooking oil from soy and corn oil due to the higher price. According to the study, palm oil has advantages in using for repeatedly frying due to the unique composition in monounsaturated fatty acids (MUFA) but low level of polyunsaturated fatty acid (PUFA). The PUFA are more easily in oxidized to form toxic compounds that increased the risk of hypertension when repeating heating, which result in harm and dangerous to human health (Serbinova et al., 1991). On the other hands, palm oil compound with ability in withstand thermal oxidative changes will maintain the vitamin E quality that consist of tocotrienols which have better antioxidant than tocopherols that exist in soy oil (Serbinova et al., 1991). Therefore, palm oil is more favorable than soy and corn oil due to the chemical benefits and low cost to consume especially in Malaysian.

However, there are some expert criticize the repeating usage of cooking oil will harm and dangerous to human health. Household or food businesses sector are practice in reuse the same frying oil more than 2 times because of budget constraints. Nevertheless, 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 160-190ºC. Chemical reactions such as oxidation, hydrolysis and thermal polymerization occur when cooking oil is heated during the deep frying process. The quality of oil deteriorates with increased length of frying time due to the accelerated formation of oxidized and polymerized lipid in the frying medium. Frequently used heated cooking oil can cause changes in physical appearances of the oil such as increased viscosity, darkening in color, increased foaming and decrease in smoke point. The rate of formation of cooking oil decomposition products depends on the type of food being fried, the type of oil used and the design of the fryer (Azman et al., 2001; Stevenson et al., 1984). Consumption of frequently used cooking oil may increase the risk of developing atherosclerosis. Lipid peroxidation products induce oxidative stress in endothelial dysfunction that could lead to the formation of atherosclerosis. Moreover, thermally oxidized lipids enhance

peroxidation of membrane macromolecules, contributing to their mutagenicity and genotoxicity which could potentially lead to carcinogenesis.

A recent study conducted by Leong et al. (2010) showed that consumption of soy oil that has been reused frequently might cause an increase in lipid peroxidation and LDL in ovariectomized female rats (which stimulates a post- menopausal state with estrogen deficiency in humans). The study carry out in laboratory resulted in increased blood pressure and necrosis of cardiac tissues in experimental rats. The increase in blood pressure due to consumption of repeatedly heated cooking oil might be due to quantitative changes in endothelium dependent and independent factors including enzymes directly involved in the regulation of blood pressure. Another study Department of Production Engineering (2005) indicates that the increasing production of waste cooking oil from household and food business operators will provide problems in Brazil (Castellanelli and Mello, 2007). This residue is regularly directly poured down the sink or drain, resulting in problems for wastewater treatment plants and energy loss. This will contributes to the pollution of rivers, lakes, sea and underground water, which is very harmful for environment and human health (Hamasaki et al., 2001). Furthermore, it might integrate into the food chain through animal feeding, thus becoming a potential cause of human health problems (Neto et al., 2000). As discuss previously, waste cooking oil may indirectly cause sewer pipes to spills and bring problems to the maintenance operation due to the cost increase and higher paid in purification of water (Payri et al., 2004). Only a small amount of the used cooking oil is properly collected and recycled, especially in rural areas (Cardone et al., 2002). In this situation, biodiesel manufacturing may be an alternative option for reusing waste cooking oil.

According to a group of researchers stated that several factors included ventilation, temperature and heating duration during the process of frying, oil type, the oil saturation ratio, and the presence of a catalyst/antioxidant will lead to the changes in fatty acid where it converts from the cis isomer to the trans isomer when oil is repeatedly use at high temperature (> 180°C). From this research, the researchers found that chronic consumption of heated palm and soy oils for the duration of 24 weeks lead to significant increase in blood pressure. This proved that usage of repeatedly heated cooking oil can lead to human health problem. Free radicals are generated and vitamins and antioxidants levels are reduced when this oil is heated repeatedly which lead to oxidative stress (Jaarin et al., 2011). Vegetable oils that used for cooking contain excellent source of vitamin E at the concentration of between 15 and 49 mg a-tocopherol equivalents/100g. The unsaturated oxidation process of fatty acids will lead to the lost of vitamin E during heating. The food is absorbing the frying oil. The amount of the oil absorbed by the food based on the quality of the oil used for cooking process and this affect the amount of vitamin E's net intake (Ghidurus et al., 2010).

Dang et al. (2013) expressed that deep frying is commonly utilized for food preparations such as frozen per-fried foods, snack foods, and fast foods. Fried foods are more popular today in much country especially among teenagers and children. Deep frying of foods at high temperature creates the special flavor, golden brown color and crispy texture. It is fact that frying cause's oil to undergo hydrolysis, oxidation and thermal reaction and consequently numerous byproducts such as fatty acids, alcohols, cyclic compounds, dimmers and polymers can be produced. Some products of decomposition in used oil have been identified to have adverse effects on human health, as it may have a higher chance of absorption into the fried foods. Therefore, it is

important to understand and know the factors affecting the deterioration of frying oil and to monitor the quantity of products of decomposition for ensuring the quality of fried foods. The mechanism of thermal degradation of frying oil is complicated. Variables involved in the process include frying condition, replenishment of fresh oil, original ol quality, food materials, and fryer type. Cooking oil with more saturated fatty acids such as palm oil is usually more stable for frying. On the other hand, soybean oil with more unsaturated fatty acids is less stable, and decomposes easily at high frying temperature.

In Taiwan, soybean oil is one of the most commonly used cooking oils at household and is also used by many small vendors for frying. Palm oil is mostly used commercially to prepare fried potato foods. Among frying oils, those with high oleic acid content such as sunflower oil and palm oil in having better heat profile and heat stability. Moisture in foods induces and accelerates oxidation with the hydrolytic compounds. Food with high water content like potato and foods with breading or battering materials cause faster hydrolysis of frying oil. The content of total polar compound and acid value are the most predominant indicators for oil quality and are widely used in many international regulations. For public health concerns, the content of total polar compounds in frying oil is regulated at no more than 25% and 2.0 mg KOH/g, respectively in Taiwan. Determination of total polar compounds in frying oil provides a more robust measurement on the extent of deterioration in most situations due to its higher accuracy and reproducibility (Fritch, 1981). The contents of free fatty acid (FFA) and total polar compounds were commonly used for initial oil quality assurance and after-use frying oil quality assessment respectively. However, the standard analytical procedure for oil quality evaluation needs to be done in a laboratory with proper equipment by skilled technicians. It is not suitable for a small restaurant, cafeteria or small food business sector (Bansal, 2010).

In food business sectors, Food and Environmental Hygiene Department (FEHD) (2011) pronounced that this hazard can be controlled by implement of Good Manufacturing Practice (GMP) (Carpentier and Cerf, 2011). The purpose of GMP are to optimize the life of cooking oil for maintain food acceptability and wholesomeness, to avoid extensive oxidative decomposition and formation of polymeric compounds. The characteristic of Good Manufacturing Practices (GMP) includes the choosing cooking oil of good quality and consistent stability, using the properly equipment, selecting the lowest possible frying temperature, filtering cooking oil frequently to remove food particle, cleansing equipment frequently and must replacing cooking oil as needed to maintain quality. This GMP practices is important especially for food business operators. It's their responsibilities on the general health of the Malaysian population. Moreover, the FEHD monitors the quality of cooking oil through its food surveillance programme. The samples of cooking oil for analysis will take by health Inspectors to ensure they are suitable for cooking and safe for human consumption. The public Health and Municipal Service Ordinance (Cap 132) stipulates that sale of food not fit for human consumption is an offence. Offenders shall be liable to a maximum fine $50.000 and imprisonment of six months.

Based on a research study, said that the cooking of food was one of the first steps to create new flavor and textures to make food not only nutritious but also enjoyable (Berger, (2005). Frying involves close contact between the oil used and the raw food being cooked. Oil is absorbed by the food and contributes significantly to its flavor and nutritional properties, and becomes a major component of the final product consumed

(*Table 2*). The author also recommended some data about different temperatures are required for various foods. At frying temperature, complex chemical changes take place. Initially, these changes create desirable flavor cause the gelatinization of starch, the denaturation of proteins, and some changes in the oil. Finally, the food becomes cooked. However, if the temperature or cooking time is not controlled, too much "chemistry" occurs and the food is spoilt. So the author focused on three main methods of frying such as shallow pan frying, deep frying in batch fryers, and deep frying in continuous fryers.

Table 2. *Usual frying temperatures for various of foods.*

Food Item	Recommended Temperature (°C)
Potatoes – French fries: blanching	165
Potatoes – French fries: finishing	185
Potatoes crisps	170-175
Doughnuts	185
Chicken – large pieces	165
Chicken – small pieces	175
Meat cutlers	165-170
Instant noodles	130
Extruded pellets for expansion	185-205

Source: Berger, 2005

Shallow Pan Frying

Shallow pan frying suitable for some foods such as fried egg, it is easy to see when it sufficiently cooked. At the end of cooking, most of the oil would be absorbed into the food, the residue is discarded and poured into bottle to sell and the pan is washed.

Continuous Fryers

The production of fried snack food and convenience food on a manufacturing large scale requires continuous fryers. The size of fryers is chosen depending on the production volume and the cooking time required. Special design features are incorporated for specific product: for example, a turnover system for doughnuts and a submerged belt to hold down products and ensure complete cooking. Based on an observation of the author in the university's canteens regarding the proper management of good practice frying oil. After training of staff and implementation of an HACCP system, a second survey found no results higher than 23% total polar materials. The training was based on the good personal hygiene, adequately done of frying, oil must be filtered, the rate of frying and turnover rate of oil must be done correctly, and the important thing was fresh oil should never added to used cooking oil. This attitude should not be practices and unacceptable.

Another interesting survey report from the members of private enterprise, local government and non-profit economic development collaborated to conduct a mini research in quantifying the waste vegetable oils (WVO) resources in the Algoma District (Demirbas, 2008). The range of oil consumed volume in one week, or one month of operation timeframe, more issues of interest exist in supporting local

initiatives that would use the waste oil. The table below showed the results from several of business type in Algoma District.

Table 3. *Waste vegetable oil survey results categorized by type of establishment.*

Business Type	Total Population	Number of Respondents	Average Waste Oil Generated by Respondents (L/month)
Restaurant & Pizzeria	6	2	132
Fast Food	20	12	262
Italian Restaurant	14	5	278
Italian Restaurant	14	5	278
Bar & Grill	18	6	211
Mexican Restaurant	1	1	5
Sandwich Shop	10	8	0
Coffee Shop	4	4	0
Pizzeria	5	2	0
Steak House	3	2	320
Oriental Restaurant	10	0	N/A
Unspecialized Restaurant	60	10	215
Total	151	52	1422

Source: Demirbas, 2008

This table shows the average volumes of waste oil generated by respondents and also projected waste oil generated per month for each type of restaurant in Algoma District. Steak House, Fast Food and Italian food generated the largest portion of WVO among the survey. Another issue involves franchise restaurants. The author stated that this survey provides a profile of total used cooking oil that produced in Algoma. It also identified a general positive public response to the idea of a local biodiesel initiative. In ensuring for better data collection, this research should be continuing with larger staff and food business restaurant operators. The author end the writing with word there is always room for improvement. In my opinion, this review paper provide good basis for future study of this resource (Macleod, 2009).

Recycled or waste oils have evolved as very popular raw materials for the production of biodiesel, as it is are inexpensive and offer the potential environment benefits of using substances which would have to be discarded of. The first references to the utilization of waste oils was made by Rudolf Diesel (1911), who reported on successful engine tests for methyl-ethyl-, and1-butylesters produced from used cooking oils (Murugesan, 2009). At the same time, recycled cooking oils were also studied as raw material for biodiesel production by M. Mittlebach, who later developed a commercial process for converting waste oil from households and restaurants as well as fatty (Mittelbach, 2006). In Austria, recycled frying oil is now an established alternative source of fatty material for the production of biofuels. A large number of articles published on the use of waste oils as raw materials for biodiesel production impressively illustrate the growing importance of the feedstock world-wide. A research

conducted by Hossain and Boyce (2009) related the biodiesel production from waste sunflower cooking oil as an environmental recycling process and renewable energy. The current feedstock of production of biodiesel is vegetable oil, animal fat, and micro algal oil. Vegetable oil is currently being used as a sustainable commercial feedstock. Unfortunately, only sunflower, palm oil, soybean, rapeseed, and peanut oils are preferred as potential alternative fuels for diesel engines among more than 350 identified oil-bearing crops (Demirbas, 2007).

The increase of virgin vegetable oil price has leaded the problems to the biofuel manufacturing industry. An option with great potential such as used cooking oil recycling, which includes a variety of processes like pyrolysis and catalytic cracking, designed to transform used cooking oil into hydrocarbon products for use in the preparation for refined chemicals or fuels. From this review, this author aims to determine some properties of used cooking for the production of biofuel. Preliminary analysis of used cooking oil properties via GCMS using capillary column shows n-Hexadecanoic acid and Oleic acid as the major compounds present in the used frying oil. The analysis for determination of volatile and moisture content with 3 replicates show an average of 0.02% moisture and volatile content, which the experimental procedure was based on MPOB Test Methods (Fukuda et al., 2001).

Cooking oil recycling or purification companies also play a significant role in ensures the quality and also origin of the oils they use. They also only can process cooking oils supplied by certificated collection/transport companies. Cooking oil purification or recycling companies should be obliged to establish a quality control system which necessary for traceability of the end product to obtained. They must have legal license and appropriate certification. In addition, the companies must analyses all the potential risks involved in their operations such as storage of cooking oils, purification treatments, handling, storage and transport of the recycled oil, as well as the operations process include collectors and transporters to ensuring the quality and safety of the purified products they will be delivering. The companies must register of all their activities, with quantity data relating to the total flow of fatty materials. They must have a suitable system for making tanks, drums and other containers to ensure the type of product contained can be identified at any time and errors avoided that could lead to break in tracing the end product. Any variations observed must be recorded with as much information as possible, the batches must set aside and the relevant authorities must always be informed. Besides that, the fatty waste generated in the process of purification or cleaning tanks and containers must be disposed in an appropriate manner, bearing in mind its contamination level. For example, waste from tank cleaning, if it is good quality, may be used in feed provided its safety and quality is strictly controlled. Any waste generated must also be recorded and used for a purpose suited to its level of contamination.

Conclusion

Cooking oil is compulsory to be involved in cooking purposes. Most of food preparation will need oil for cooking the raw food. Since the cooking oil is advices to reduce in repeating usage, the attitude are still significant in reducing the financial issues and affordable factors. However, waste cooking oil can be transferable into benefit usage like biodiesel. On the other hands, the product of biodiesel is more environmental friendly and less harm to human health. Widely research should be

continuously carry out to investigate, design, define, and determine the best solution for the issues and problems in cooking oil management.

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