LIQUID DETERGENT FROM PALM OIL AND PALM KERNEL OIL

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ABSTRACT

Manufacturing of detergent from distilled fatty acids of palm kernel oil (PKO) and palm oil (PO) is a well-established technology in Malaysia. In this research, the production of detergent from palm kernel oil is by direct saponification fats and oils and is evaluated for water hardness, pH value, viscosity and foam ability of liquid detergent .The objective of this research is to study the production of liquid detergent from palm kernel oil (PKO) and palm oil (PO). This is because of palm oil (PO) and palm kernel oil (PKO) as raw material have important fatty acids involved in detergent making which are C16-C18 and C12-C14 which contribute to the detergency properties, lathering and washing properties of the soaps. Parameters that involve in this research are ratios concentration of raw materials, quantity of water and speed. For the concentration, the ratio is from 0 until 100 %, for the quantity of water the best range is from 200 mL to 1000mL until get the required texture of liquid detergent, for the speed the best range is from 600- 1500 rpm, and within constant the time of process which is 30 minute. The optimum concentration in manufacturing of soap is making from a blend of 70% PO and 30% PKO with the speed minimum 1500 rpm at room temperature. The result is done and the best ratio is 70% PO and 30 % PO with minimum 400 mL water and minimum 1500 rpm speed. This ratio gave a good texture of detergent and can save cost of manufacturing because of using mixture of 70% PO and 30% PKO.

ABSTRAK

Pembuatan cecair pencuci daripada asid lemak minyak biji sawit dan minyak sawit adalah teknologi yang kukuh di Malaysia. Dalam penyelidikan ini, pembuatan cecair pencuci dari minyak biji ssawit adalah mengunakan lemak dari minyak tersebut dengan melalui proses saponification dan cecair pencuci ini di nilai dari segi kekerasan air, nilai pH, kelikatan cecair dan kebolehan buih. Tujuan penyelidikan ini adalah untuk menilai pembuatan cecair pencuci dari minyak sawit dan minyak biji sawit. Ini kerana minyak sawit dan miyak biji kelapa sawit adalah sebagai bahan utama yang mengandungi asid lemak penting dalam cecair pencuci seperti C16-C18 and C12-C14 yang membawa kepada ciri-ciri pencuci, kekuatan buih dan ciri-ciri pembersih cecair pencuci. Paramiter-paramiter yang digunakan dalam penyelidikan ini adalah pembahagiam kandungan minyak sawit dengan minyak biji kelapa sawit, tahap kandungan air dan kelajuan untuk menyebatikan cecair dengan minyak. Pembahagi minyak di adakan dari 0 sehingga 100%, tahap kandungan air adalah dari 200ml – 1000 ml dan ke atas hingga mendapat bentuk cecair pencuci yang bagus dan juga kelajuan mesin dalam lingkungan 600rpm – 1500rpm dengan masa yang di tetap kan selama 30 minit. Di dalam penyelidikan ini, kepekatan yang bagus untuk cecair pencuci adalah 70% minyak biji kelapa sawit dan 30% minyak kelapa sawit, minima 400ml kandungan air dan minima 1500 rpm kelajuan mesin. Pembahagi ini membuatkan bentuk yang bagus dalam cecair pencuci dan dalam masa yang sama dapat menjumatkan wang perlaburan kerana tidak mengunakan satu jenis minyak yang mahal sahaja malah menggunakan minyak yang murah sebagai membantu bahan utama dalam membuat cecair pencuci.

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LIST OF ABBREVIATIONS

Greek

%	*percentage*
^{o}C	*degree celcius*

Subscripts

g	*gram*
ml	*mililetre*

LIST OF ABBREVIATIONS

Na	*sodium*
H_3C	*methane*
K^+CO^{2-}	*calcium carbonate ion*
Na^+CO^{2-}	*sodium carbonate ion*
PKO	*palm kernel oil*
PO	*palm oil*
CPO	*crude palm oil*
SV	*saponification value*
IN	*iodine number*
S.B.P	*small business publications*
NaOH	*sodium hydroxide*
HCl	*sodium chloride*
EFB	*empty fruit bunch*
MPOB	*Malaysian palm oil board*
SBO	*soy bean oil*
RSO	*refined soy bean*
FFA	*free fatty acid*
POME	*palm oil mill effluent*
BOD	*biological demand*
COD	*chemical oxygen demand*
EDTA	*ethylenediaminetetraacetic acid*
ATC	*automatic temperature compensation*

1.0 INTRODUCTION

1.1 Background of Proposed study

Cleaning products such as soap and detergent has similarity that can clean soil, germs and other contaminants. Other than that, it helps to protect us to be healthy and make our surrounding to be more pleasant. Detergents can classify as liquid and powder type which the function is same but different physical properties. Generally, detergents are made by synthetic origin and it may contain sulphate or sulfonate group. Sulfonate group is a group with a strong acid that has below zero level of pH and remain negative charged across the normal pH range of aqueous solution (SDA, 1994). Detergents also can be classified into natural soaps and synthetic detergents (syndets). Both have many similarities regarding their molecular structure and the way their clean the objects. Detergents are soap-like compounds which are sodium salts of long chain alkyl benzene sulphonic acids or sodium salts of long chain alkyl hydrogen sulphate. Soaps are sodium salts of long chain carboxylic acids (science clarified, 2015). It is shows in the chemical formulae in Figure 1.1.1

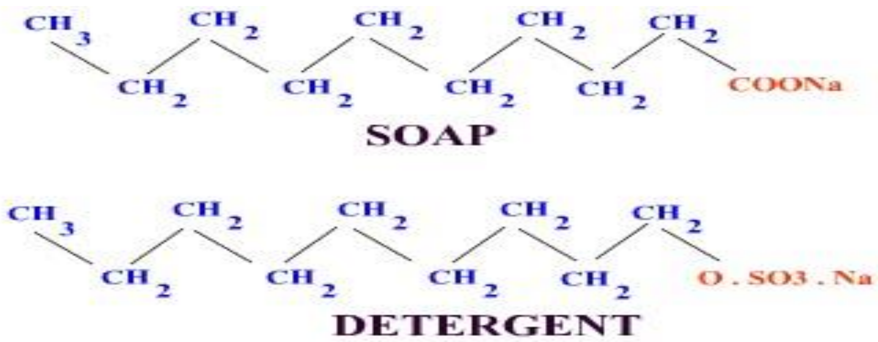

Figure 1.1.1 Chemical structure of soap and detergent (citycollegiate.com)

Soaps and detergent has many advantages and disadvantages especially in chemical property. The table below describe the difference between soap and detergent. Soaps is limited compared to detergents because of it effectivity in hard water. On the other hand, both are available in liquid and powder form. On the basis of charges; detergents can be classify as cationic, anionic and neutral types of detergents. Both soaps and detergent can be call as surfactants as they are surface active agents which work to remove dirt from surface cloth. Table 1.1.1 show the differences between soap and detergent.

Table 1.1.1 Differences between soap and detergent (citycollegiate.com)

SOAP	DETERGENT
Soaps are medium salts of long chain carboxylic acids	Detergents are sodium salts of long chain alkyl benzene sulphonic acids or alkyl sulphate.
It is obtained by natural resources i.e. fats and oils.	Detergent are synthetic materials
Calcium and magnesium salts of soaps are insoluble in water.	Calcium and magnesium salts of detergents are soluble in water
In hard water it produces scum which affect its cleaning action.	Hard water does not affect its cleaning action.

Specifically, all detergents are characterized as containing hydrophilic "head" region and hydrophobic "tail" region as shown in Figure 1.1.2. It is known as a water-attracting and oil-attracting respectively. This two group form large supramolecular of aggregates where is the hydrophilic groups point outward the water while the hydrophobic groups point inward and dissolve similarly hydrophobic substances (Vicki Caligur, 2008).

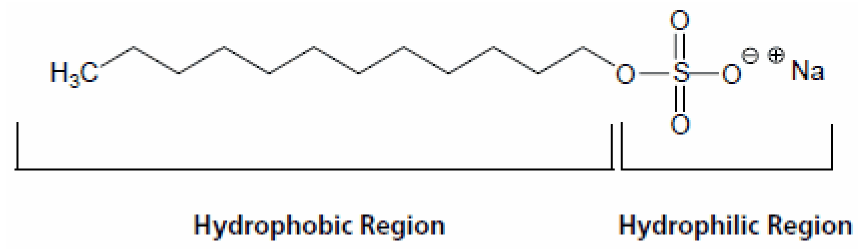

Figure 1.1.2: structure of region hydrophobic and hydrophilic

In detergents, there are cleaning agents that is used which is alkaline plant ashes. Ashes of plants contain potassium carbonate ($K_2 CO_3$) and sodium carbonate ($Na_2 CO_3$). The carbonate ions present in both these compounds react with water to form an alkaline solution.

$K^+ CO^{2-}$ + $H^+ O^{2-}$ = ALKALINE SOLUTION

$Na^{2+} CO^{2-}$ + $H^+ O^{2-}$ = ALKALINE SOLUTION

Detergents are compound that are made from the reaction with a bases of fats chemically known as acid esters. The most important Fatty acid esters are Palmitic [(C15 H3 1 COO)3 C3 H5), Stearin [(C17 H35 COO)3 C3 H5), and Olein [(C17 H3 3 COO)3 C3 H5). Fatty acid is can be found in lard, tallow, olive oil, cotton seed oil, and vegetable fats or oils. Surfactant that contain an ionic species consisting of a long, linear, non-linear, non-polar ‘tail’ with a cationic or anionic ‘head’ and counter ions can be found in all soaps and detergents as an active ingredient (K. R. Janardhanan, 2011). The tail is water insoluble and the head is water soluble. The tail will migrate to align with the solid and thus water can interface and lowering the surface tension at that point to penetrate the fabric better and this will makes surfactant molecule as a wetting agent (Krister Holmberg et al, 2002). It allows the oily dirt particles to form an emulsion with the water so that the tails of many surfactant molecules surround an oily dirt particle, forming a micelle with a drop of oil in the centre and the ionic heads of the surfactant molecules pointing outwards and hence keeping the micelle in the polar solution. When a detergent is dissolved in water, fatty acids in the detergent form spherical structures called micelles, in which the hydrophilic “heads” of the fatty acid molecules are turned toward the water and the hydrophobic “tails” are sheltered in the interior (Encyclopidia Britannica, 2007).

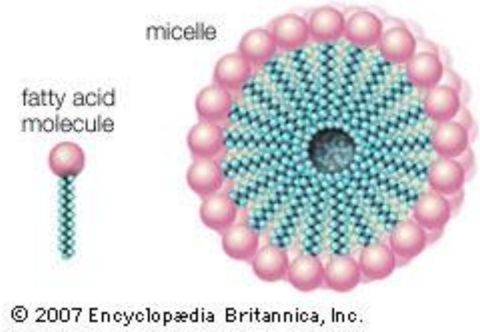

Figure 1.1.3: Structure of micelle

Practically, the detergent is made after the saponification process of soap by the mixture of the borax and washing soda to liquefy the detergent. These process make the properties of soap become liquid detergent by melting it in about 60^{o}C to 70^{o}C (W.H. Simmons, B.Sc. (Lond), F.C.S et al, 1908). The mixture of this element with soap takes a day to make it cold in room temperature and as a concentrated liquid detergent. Besides, there are three main saponification reactions for producing soap which are direct saponification of fats and oils, neutralization of fatty acids and saponification of fatty acid methyl esters (T. Ogoshi and Y. MiyawakiI, 1985). Usually the process that commonly used in industry is saponification of fats and oils and neutralization of fatty acids. In saponification, a triglyceride will react with the alkali and will produce glycerine and metal soap. The raw materials for this process are tallow and coconut oil but it can be change to economically employed raw materials such as palm oil, olive oil, cottonseed oil, corn oil, and soya bean oil (Dusengemungu Leonce, 2012). Nowadays in world of production, detergents manufacturers are turning increasing to Palm Oil (PO) and Palm Kernel Oil (PKO) (lauric acid) as replacements for tallow and coconut oil because of the greater availability while PKO contained mainly dodecanoic (lauric) acid. Lauric acid is inexpensive, non-toxic and safe to handle. Lauric acid is neutralized with sodium hydroxide to be sodium laurate which is soap (Paul May, 2015).

1.2 Physical and Chemical properties of Palm Kernel Oil

In Malaysia, the densities of Palm Kernel Oil is in the range of 0.9077 – 0.8809 g/mL for the crude oil in the temperature range of 35^{o}C until 75^{o}C, the viscosity of Palm Kernel Oil decreases from 40.41 cP to 10.43 cP for the refined oil and from 39.03 cP to 8.7 cP for the crude oil over the same temperature range (cibaria-intl.com).

Palm Kernel Oil contains mainly C12 and C14 fatty acids (Thiagarajan, 2015). The viscosity (mPas), water hardness, acidity and foam ability (as palmitic, oleic and lauric acids for mucilage palm oil, tallow and plam kernel oil, respectively) were determined according to the methods described in the A.O.C.S (1993).

1.3 Uses of Palm Kernel Oil

1. Health benefit

   Palm Kernel Oil is rich in antioxidants and have the active substance may have ability to reverse blockage of the carotid artery platelet aggregation and reducing the risk of life from diseases.

   The black palm kernel oil is use to cure convulsion and to avoid body odour and make baby’s skin shinning. On the other hands, because of rich in unsaturated fatty acid, palm kernel oil is use to soften the throat during first cough and can also cure tumour promotion arteriosclerosis, stroke and other disease problems.

   In addition, tocotrienols present in palm oil may also inhibit certain types of cancer. Palm kernel oil increase good cholesterol as compared to other saturated oils such as coconut oil. Thus the health benefits of palm kernel oil also include promoting healthy cardiovascular health (GreenHealth Care, 2013).

Figure 1.3.1: Before and after Palm Kernel Oil (PKO) to be the black oil

2. Weapons and Warfare

   Palm kernel oil was instrumental in making weapons during the Second World War. The Palmitic Acid component was one of the two most important Ingredients of the Anti-Personnel Weapon popularly known as Napalm by the combination of Naphthenic acid and Palmaitic Acid (Agbogun James Otejiri, 2014).

3. Food and Bakery

   Palm Kernel Oil is known to confer special attractive physical features and Aroma to baked Bread. It is also used for making other baked Products like Cakes and Biscuits. Palm Kernel oil is semi-solid at room temperature, hence it is suitable for making Margarine, Chocolate and some other related food products. Palm Kernel oil is further used at home for frying and cooking different types of food like Plantain Chips, Potatoe, Stew, Fried Fish, Akara, Moin Moin, etc (Frank D. Gunstone, 2012).

Figure 1.3.2: PKO as Cooking Oil

4. Fuel and Biodiesel

   Local Africans use palm kernel oil to fuel Native Lamps for lighting in rural communities that are not connected to Electricity. Palm Kernel oil can also be directly combined with Petro-diesel or used in making Biodiesel for diesel Engines (Satish Lele, 2006).

Figure 1.3.3: PKO Biodiesel

5. Cosmetics

   Palm Kernel oil is a major Ingredient for large-scale production of various types of Soap, Detergents, Hair Creams, Body Creams, and all sort of Body cream and Pomades.

Figure 1.3.4: Cosmetics from PKO

6. Industrial Materials

   So many industrially produced common house-hold materials are made with palm Kernel oil. Some of the products include Candle, Glue, Printing Inks, Grease, Rub, Washing Powder, Pharmaceutical Products, and Rubber.

1.4 Problem Statement

Coconut oil (CO) is widely used as a raw materials in the production of liquid detergent. However, there are problems in getting continuous supply of CO. In addition, the price of CO is much higher than other vegetable-based oil compared to PO and PKO that can easily get from Malaysia and Indonesia while CO is imported from Philippines. Again, continuous supply of CO from the exported country cannot be taken for granted. So, risk of becoming too dependent on that exporter is quite high.

Besides, there are some quality problem with the detergent from coconut oil and tallow in aspects of physical properties, such as the consistency of detergent, formation of foams in water and hard water resistance. Basically, the detergent made from coconut oil and tallow cannot be stored for a long time because it is easy to oxidise when expose to the air and give odour smell. Thus, thorough analysis on detergent quality is needed in this research works.

Finally, part of raw material in soap production which is tallow can be obtained from animal fats such as beef, mutton and pork have problem with HALAL certification.

1.5 Research Objectives

- To study the silky texture of detergent with the ratio of Palm Oil (PO) and Palm Kernel Oil (PKO) in producing liquid detergent
- To study the required quantity of water
- To study the required speed in the process
- To study the characteristic of the detergent compare with the characteristic of Dynamo™.

1.6 Scope of Proposed Study

At first, the production of liquid detergent using ratio of Palm Oil (PO) and Palm Kernel Oil (PKO), speed of stirred and quantity of the water were done. For the mixing ratio between palm kernel oil and palm oil, the range of concentration is from 0 until 100% and to see the silky texture of liquid. Besides, the best range for the speed of stirrer to mix water and oils is from 600 until 1500 rpm and the ratio of the water is need to be control in range of 100 mL to 1000 mL to produce more liquid detergent without less quality while the pH meter should be control to prevent damage of cloths by adding sodium hydroxide (NaOH) and phosphoric acid until the pH meter is exceed the normal pH level for detergent.

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Table 1.6.1 Composition (% v/v), temperature, speed and time of liquid detergent blends made from distilled PO and PKO

Parameters control for liquid detergent				
Ratio conc. of PO and PKO, (%)	100 PO / 0 PKO	80 PO / 20 PKO	30 PO / 70 PKO	0 PO / 100 PKO
Speed, (rpm)	600-1500	600-1500	600-1500	600-1500
Distilled water, (mL)	100-1000	100-1000	100-1000	100-1000

1.7 Significant of Proposed Study

1. Production of detergent from Palm Kernel Oil (PKO) shall produces low cost compared production of detergent from tallow and coconut oil. Moreover, Palm Oil (PO) and Palm Kernel Oil (PKO) are easily available in Malaysia at a low price.
2. The abundance of palm oil in Malaysia led to the growth of the oleo-chemical industry and consequently to Malaysia being the world's largest producer of soap noodles. Palm oil production which showed the largest growth compared with other fat and oil resources, has reached 13% of world vegetable oil consumption for food in 1980, up from 7% in 1970. Palm Oil production in Malaysia, having reached 3.5 million tons (60% of world production) in 1892, is expected to rise to 4 million tons in 1985, and to 6 million tons in 1990 (A. Yoshiteru, 1985).
3. The detergent manufacturing processes will produce glycerol as a by-product. However, it is also much more valuable than soap itself, so only a minimum of glycerine is left in soap and via separation process, the soap can separate from the glycerol (called washing operation). It will be extracted, purified and sold. From that, the manufacturers will get some money.
4. Furthermore, the quality of detergent from palm kernel oil and palm oil in aspects of physical properties such as the harness of soap, and formation of foams in water are really good.

2.0 LITERATURE REVIEW

2.1 Palm Oil

Traditionally, palm oil is important as a resource for the food and oleo-chemicals industries (Zah R, etc ,2004). In Malaysia, palm oil (PO) is utilized in the production of biodiesel such as palm oil methyl ester or palm oil diesel for buses and cars and major expansion of Malaysia diesel production with 5% palm oil fuel is expected from 2006. In fact, while Malaysia is recognised as the global centre for oleo-chemicals, producing about 20% of world basic oleo-chemical, further downstream activities at the high-end value products remain limited and insignificant in the country (M.A. Kalam, etc, 2002). In 2008, palm oil is one of the 17 major oils traded in the global edible oils and fats market. It can be found in one out of every ten food products worldwide. The key importers of palm oil in 2008 are China, India, EU-27 and Pakistan.

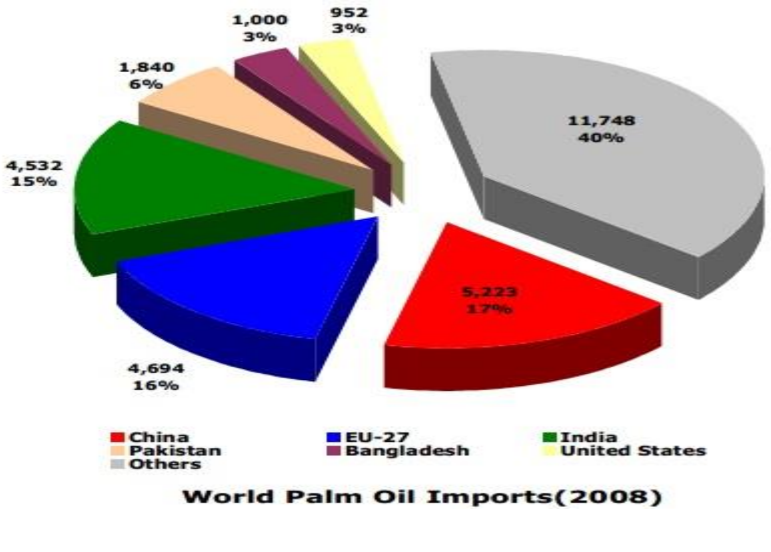

Figure 2.1.1 Global Palm Oil Industry (*LMC – Oilseeds Outlook for Profitability to 2020 (Jan 2009), USDA Database – April 2009*)

Palm Oil has benefits to the versatile and healthy. In food, palm oil is used as cooking oil, shortening, margerines, vanaspati, cocoa butter substitutes and key ingredient in instant noodle production. Examples for the non-food used are oleochemicals, biodiesel and energy generation. For the healthy, palm oil acts as a balanced composition of fatty acids, has high carotene content, cholesterol free, no risk of trans fatty acids and it is contains vitamin E.

Furthermore, for the sustainable, compared to other oilseeds, the oil palm tree is the highest oil yield and it requires the lowest fertiliser inputs and the productive cycle is within 25 years. On the other hand, palm oil is eco-friendly practices for the reason of the wastage from plantations are reused for example EFB for mulched as fertilisers back in estates, palm kernel shells for biomass at mills for steam generation and lastly palm oil mill effluent for biogas for electricity generation (MPOB, 2009).

Palm oil is traded vegetable oil in the world. It is cultivated in tropical areas of Asia, Africa and South America. In Asia, 90% of palm oil is produced by three members of the ASEAN namely Indonesia, Malaysia and Thailand as shown in Figure 2.1.1. This is because high productivity of oil palm is concentrated in the tropical zone within 10^o North or South of equator where Malaysia, Indonesia, part of Thailand and Mindanao, Philippines are located. Thailand has the least area for production of palm oil that is less than half of Philippines. Global demand for vegetable oils has grown fast in recent decades and upstream palm oil production has expanded rapidly to meet that demand (Palm Oil Industrial Cluster, 2015).

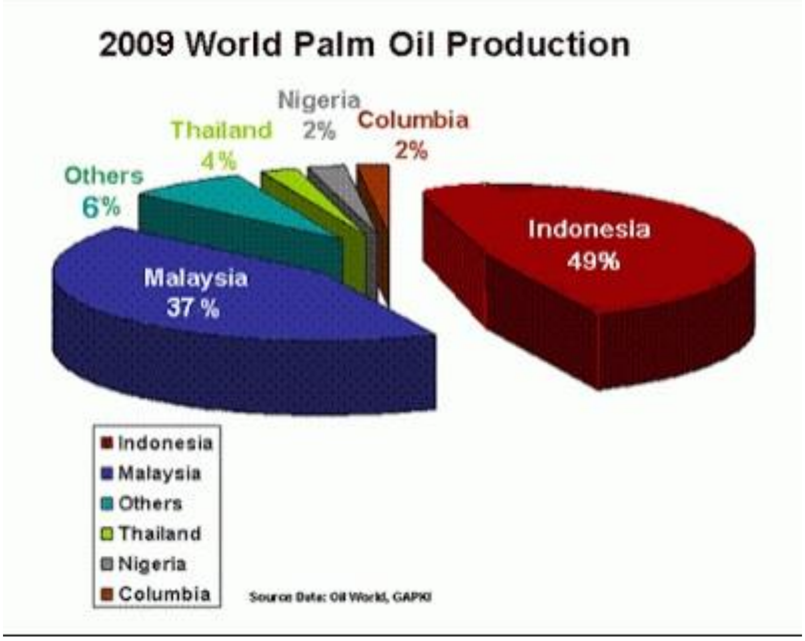

Figure 2.1.1 2009 ASEAN Palm Oil production

Table 2.1.1 Leading Countries in the production of palm oil in terms of area and production in 2009 (*Arie Malagyudo, The Oil Palm Planters*)

COUNTRY	PRODUCTION		PERCENT OIL PRODUCTION
	AREA (Ha) (1000)	CRUDE PALM OIL (CPO) PRODUCTION (MT)	
1. Indonesia	7,500.00	24,500	49%
2. Malaysia	4,500.00	18,600	37%
3. Thailand	625.00	1,500	4%
4. Nigeria	460.00	850	2%
5. Colombia	390.00	810	2%
6. Others	1,126.00	3,077	6%
TOTAL	14,601.00	49,337	100%

Malaysia economy for palm oil sector has contributed significantly to the growth for the past 30 years with a revenue amount of RM65 billion in 2008. The production of palm oil is more efficiently in terms of land use than any other oil crop and it has seen global production double in each of the last decades. Oil palm tree crop grown in tropical regions, thus the key features of its cultivation include a long lead time between planting and productive harvest in at least 2-4 years followed by a long productive period until 25 years (FSG Social Impact Advisors, *2015).* The oil palm (*Elaeis guineensis Jacq)* is an ancient plant and the most productive oil palm that still grows wild in West Africa while also cultivated there and across the tropics. It produced 10-35 tonnes of Fresh Fruit Bunch (FFB) per year with one hectare. Generally FFB can be harvested 3 years after planting. The economic life of oil palm plants is 20-25 years of its lifespan of 200 years. Normally, oil palm grows in the lowlands of the humid tropics, 15^{o}N-15^{o}S where there is evenly distributed rainfall at 1,800-5,000 mm per year.

The oil palm fruit produces two tails which are palm from the fleshy mesocarp and palm kernel oil from the seed or kernel. The fleshy mesocarp of the fruit is used to obtain and the yield is about 45-56% of fresh fruit bunch (FFB). Oil yield from the kernel is about 40-50% (Kittikun et al. 2000). Potential yield from both mesocarp and kernel accounts for about 17 t ha^{-1} $year^{-1}$ of oil (Corley, 1983). In addition, its oil, extracted from its fruits, has been used as food and medicine through the ages, the earliest archaeological evidence suggestion so being an earthenware jar containing residues of palm oil in a 5,000-year-old Egyptian tomb. Oil palms grow in equatorial conditions in Asia, Latin America and Africa. Besides, palm kernel oil is used primarily in food products such as cooking oil, shortening, margarine, milk fat replacer and cocoa butter substitute. Palm kernel oil is mostly used in the oleo-chemical industry for making soap, detergent, toiletries and cosmetics.

Figure 2.1.2 *Elaeis guineensis Jacq*

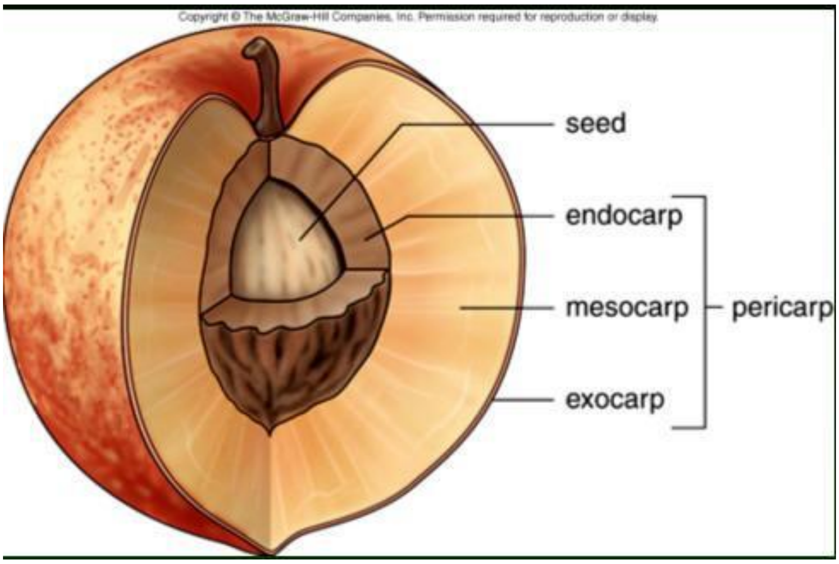

Figure 2.1.3 Structure of Oil Palm

2.2 Advantages of Palm Oil

Fresh Fruit Bunch (FFB) from palm tree has many usages that can be used as a raw material to produce the product that are based on palm oil. Figure 2.2.1 show the production with the percentage that can be produce from FFB. This fresh fruit brunch is get from the palm tree and with the many process such as extraction, it can produce products that can be use and sell to the other company with different prices.

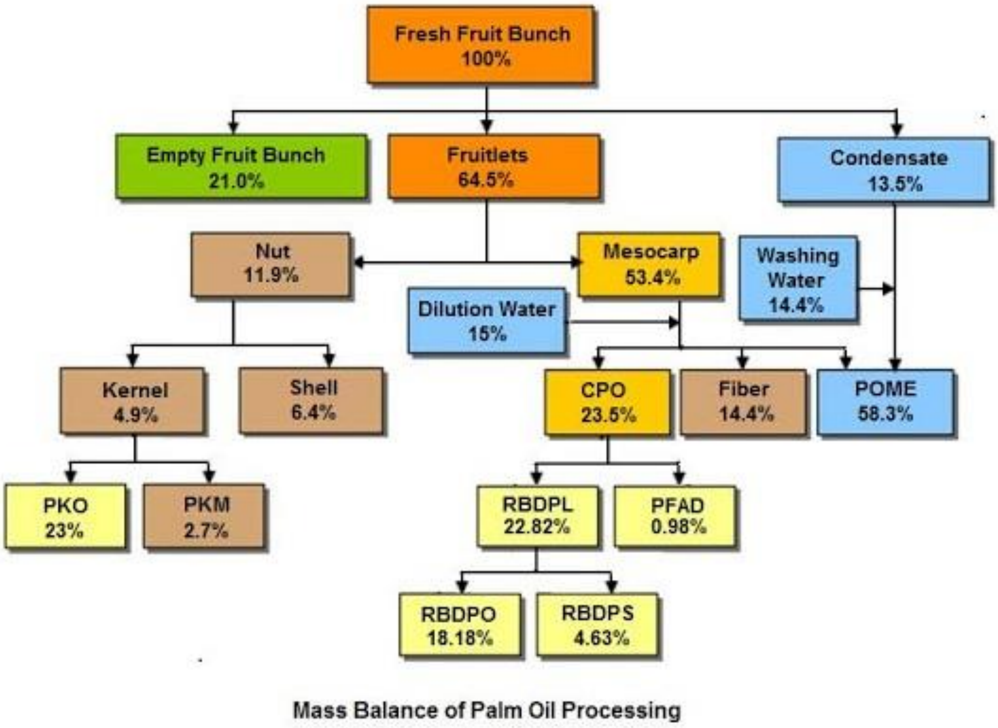

Figure 2.2.1 Mass Balance of Palm Oil Processing *(Arie Malagyudo, The Oil Palm Planters*)