TO STUDY OPTIMUM PARAMETERS IN THE SOAP PRODUCTION DERIVED FROM PALM KERNEL OIL AND PALM OIL BY SAPONIFICATION

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LIST OF ABBREVIATIONS

AOCS	American Oil Chemists' Society
BAS	Branched Alkyl Sulphates
CO	Coconut Oil
CPO	Crude Palm Oil
EDTA	Ethylenediaminetetraacetic acid
EFB	Empty Fruit Bunches
FAS	Fatty Alcohol Sulphates
FFB	Fresh Fruit Bunch
IEA	International Energy Agency
IV	Iodine Value
KOH	Potassium Hydroxide
LAS	Linear Alkyl Benzene Sulphonates
MPOB	Malaysian Palm Oil Board
NaCl	Sodium Chloride
NaOH	Sodium Hydroxide
PKO	Palm Kernel Oil
PO	Palm Oil
RSO	Refined Soy Oil
SBO	Soy Bean Oil
SBP	Small Business Publications
SV	Saponification Value
TFM	Total Fatty Matter
TN	Titer Number
USDA	United States Department of Agriculture

UNTUK BELAJAR PARAMETER YANG OPTIMUM DALAM PENGELUARAN SABUN DARIPADA MINYAK ISIRONG SAWIT DAN MINYAK SAWIT MENGIKUT SAPONIFIKASI

ABSTRAK

Pembuatan sabun daripada asid lemak minyak isirung kelapa sawit (PKO) dan minyak sawit (PO) adalah teknologi yang kukuh di Malaysia. Dalam kajian ini, produksi sabun daripada minyak isirung kelapa sawit adalah dengan lemak dan minyak melalui saponifikasi dan dinilai dari segi kadar air (%), kekerasan air, pengemulsi sifat, nilai pH, dan penghasilan buih sabun. Objektif kajian ini adalah untuk mempelajari produksi sabun daripada minyak isirung kelapa sawit (PKO). Hal ini kerana minyak kelapa sawit (PO) dan minyak isirung kelapa sawit (PKO) sebagai bahan mentah mengandungi asid lemak yang penting dalam pembuatan sabun iaitu C16-C18 dan C12-C14 yang menyumbang terhadap sifat detergensi, penyabunan dan sifat sabun sebagai pencuci . Parameter yang terlibat dalam kajian ini adalah nisbah konsentrasi bahan mentah, suhu kepanasan, dan kelajuan putaran. Untuk konsentrasi, nisbah adalah dari 0 hingga 100%, untuk suhu kepanasan adalah dari 20 ˚ C-70 ˚ C, kelajuan putaran adalah 600-1500 rpm dan dalam tempoh masa yang berterusan selama 30 minit. Dalam kajian ini, hanya melibatkan satu proses sahaja. Langkah pertama adalah suhu, kelajuan putaran dan masa ditetapkan sebagaimana tercatat di dalam jadual. Langkah kedua, kelapa sawit dan minyak isirung kelapa sawit dicampurkan di atas plat panas. Kemudian natrium hidroksida (NaOH) ditambahkan secara beransur-ansur diikuti dengan natrium klorida (NaCl) berdasarkan pada jumlah yang ditetapkan dalam jadual. Keputusan telah menunjukkan bahawa semua parameter yang optimum menghasilkan kuantiti sabun yang banyak dan kualiti yang bagus berbanding dengan penghasilan sabun daripada lemak dan minyak kelapa. Konsentrasi yang optimum dalam pembuatan sabun ialah terdiri daripada 80% isirong kelapa sawit dan 20% minyak sawit dengan kelajuan putaran 900 rpm pada suhu kepanasan 30 ˚ C.

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ABSTRACT

Manufacture of soaps 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 soap from palm kernel oil is by direct saponification fats and oils and it is evaluated for moisture content (%), water hardness, emulsifying properties, pH value, and foamability of soap .The objective of this research is to study the production of soap from palm kernel oil (PKO). This is because of palm oil (PO) and palm kernel oil (PKO) as raw material have important fatty acids involved in soap 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 ratio concentration of raw materials, temperature and speed. For the concentration, the ratio is from 0 until 100 %, for the temperature the best range is from 20˚C- 70˚C, for the speed the best range is from 600- 1500 rpm, and within constant the time of process which is 30 min. This experiment consists only one process which is reactions process. First step is the temperature, speed and time of raw material are set as stated in the table. Second step is palm oil and palm kernel oil are mixed together on the hot plate. Then the sodium hydroxide (NaOH) is added gradually together with the sodium chloride (NaCl) and EDTA based on the amount stated in table. The study has shown that the relationship of all parameter with optimum condition is achieved in order to produce high yield production of soap and in good quality compared with the production of soap from tallow and coconut oil. The optimum concentration in manufacturing of soap is making from a blend of 80% palm kernel and 20% palm oil with the speed 900 rpm at temperature 30˚ C .

CHAPTER 1

INTRODUCTION

1.1 Background of Proposed study

What is soap?. Soaps are divided into two main types: toilet and industrial. There are a few definition of soap. One of definition, soap is an alkali metal salt of a long-chain fatty acid and is manufactured using vegetable and animal fats. Besides, soap is a chemical compound or mixture of chemical compounds forming from the interaction of fatty acids and alkaline solution. The alkaline solution, often called lye usually used in soap making are sodium hydroxide (NaOH) also known as caustic soda and potassium hydroxide (KOH). Usually, sodium hydroxide is used to make solid soap while potassium hydroxide is used to make liquid soap. NaOH and KOH are water soluble soaps which are different from those made from divalent metals such as calcium and magnesium, which are water insoluble.

A soap molecule of a long hydrocarbon chain which are composed of carbons and hydrogen with a carboxylic acid group on one end which is ionic bonded to a metal ion, usually a sodium or potassium.

The structure of a soap molecule is represented below:

$$CH_3\text{-}CH_2\text{-}CH_2\text{-}\ CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}\ CH_2\text{-}CH_2\text{-}\ CH_2\text{-}CH_2\text{-}\ CH_2\text{-}CH_2\text{-}\ CH_2\text{-}CH_2\text{-}\ \overset{\overset{O}{||}}{C}\text{-}O^-\ Na^+$$

Soap manufacture occurs by saponification which is shown by the following reaction :

Sodium hydroxide + Triglyceride = Soap + Glycerol

Detergents are produced synthetically with the active ingredient being a surface active agent or surfactant. Surfactant molecules are composed of groups of opposing solubility tendencies, for examples hydrophobic (oil-soluble) hydrocarbon chain and a hydrophilic (water soluble) ionic or non-ionic group. It can be anionic, cationic, or non-ionic. Examples of anionic used for the production of soap are linear alkyl benzene sulphonates (LAS), fatty alcohol sulphates (FAS), and branched alkyl sulphates (BAS). LAS was derived from propylene, which was in turn derived from crude oil. Historically, LAS and BAS were the main surfactants for many detergent formulations. But only LAS leaving for many formulations because BAS has been banned from use due to its low biodegradation quality. In Malaysia, there is an abundance of fatty methyl esters primarily from the oleochemical companies as well as from the manufacturers of vitamin E and carotenes from palm oil.

Soaps are mainly used as surfactants for washing-up liquids, bathing, and cleaning, but they are also used in textile spinning and are important components of lubricants. History of soap, it has been made for more than 2500 years and the first recorded manufacture of soap was in 600BC by the Phonecians. His soap made from tallow and ash and very known among the British Celts and throughout the Roman Empire. Actually they used soap for soap medicinally but in the nineteenth century it began spread in the Western world as cleaning soap.

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. But saponification of fats and oils and neutralization of fatty acids are commonly used in soap industry. In saponification, a triglyceride will react with the alkali and will produce glycerine and metal soap. The tradisional raw material using for the production of soap are tallow and coconut oil. The other natural fats which is economically employed to make soap are palm oil, olive oil, cottonseed oil, corn oil, and soya bean oil. But nowadays in world production, soap manufacturers are turning increasing to Palm Oil (PO) and Palm Kernel Oil (PKO) (lauric acid) as replacements for tallow and coconut oil because PO are in greater availability. PKO contained mainly dodecanoic (lauric) acid about 47%.

In addition, the important fatty acids which are involved in soapmaking are C_{16}-C_{18} and C_{12}-C_{14} . These fatty acids are important for production of soap because C_{16}-C_{18} contribute to the detergency properties while C_{12}-C_{14} fatty acids contribute to lathering and washing properties of the soaps. On the other hand, the chemical characteristics of soap depend on several factors which are the strength and purity of alkali, the kind of oil used, completeness of saponification and age of the soap. Such chemical characteristics include moisture content, total fatty acids (TFM), pH, free alkali, and percent chloride.

1.1.1 Physical and Chemicals properties of Palm Kernel Oil

The density in air of Malaysian Palm Kernel Oil lies in the range of 0.9077-0.8809 g/mL for refined oil and in the range of 0.9077-0.8799 g/mL for the crude oil in the temperature range of 35˚C until 75˚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.

Palm Kernel Oil contains mainly C_{12} andC_{14} fatty acids. The Wijs iodine value (IV) of Malaysian Palm Kernel Oil varies normally from 16.2-19.2 with a mean of 17.8 but slightly higher values, up to 19.6 have been observed. Moisture and volatile matter (%), acidity (%) (as palmitic, oleic and lauric acids for mucilage palm oil, tallow and palm kernel oil, respectively), saponification value (S.V), iodine number as Wij's (I.N), unsaponifiable matter (%), neutral oil (%) and titer number ˚ C (T.N) were determined according to the methods described in the A.O.C.S. (1993), as well as I.N.S factor was calculated (as a difference between saponification value and iodine number) according to Ahmed (1981) and Small Business Publications (S.B.P) (1987), while the color was measured by F.A.C method found in the A.O.C.S. (1993).

1.1.2 Uses of Palm Kernel Oil

1. 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, potatoes, stew, fried fish and others.

2. Fuel and Biodiesel

Palm is also used to make biodiesel, as either a simply-processed palm kernel oil mixed with petro diesel, or processed through transesterification to create a palm kernel oil methyl ester blend, which meets the international EN 14214 specification, with glycerin as a byproduct. The actual process used to make biodiesel around the world varies between countries, and the requirements of different export markets. Next-generation biofuel production processes are also being tested in relatively small trial quantities.

Besides, biodiesel for internal combustion engines. It has been promoted as a renewable energy source to reduce net emissions of carbon dioxide into the atmosphere. Therefore, biodiesel is seen as a way to decrease the impact of the greenhouse effect and as a way of diversifying energy supplies to assist national energy security plans.

The IEA predicts that biofuels usage in Asian countries will remain modest. But as a major producer of palm kernel oil, the Malaysian government is encouraging the production of biofuel feedstock and the building of biodiesel plants that use palm kernel oil. Domestically, Malaysia is preparing to change from diesel to bio-fuels by 2008, including drafting legislation that will make the switch mandatory. From 2007, all diesel sold in Malaysia must contain 5% oil palm oil. Malaysia is emerging as one of the leading biofuel producers, with 91 plants approved and a handful now in operation, all based on oil palm oil. On 16 December 2007, Malaysia opened its first biodiesel plant in the state of Pahang, which has an annual capacity of 100,000 tonnes, and also produces byproducts in the form of 4,000 tonnes of palm fatty acid distillate and 12,000 tonnes of pharmaceutical grade glycerine.

Whereas local Africans use palm kernel oil to fuel native lamps for lighting in rural communities that are not connected to electricity.

3. 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. Lauric acid is very important in soap making. A good soap must contain at least 15 per cent laurate for quick lathering, while soap made for use in sea water is based on virtually 100 per cent laurate.

4. Industrial Materials

So many industrially produced common house-hold materials are made with palm kernel oil. Some of the products includes candle, glue, printing inks, grease, rub, washing powder, soap pharmaceutical products, and rubber.

5. 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. The name is a combination of Naphthenic Acid and Palmitic Acid.

1.2 Problem Statement

Coconut oil (CO) is widely used as raw materials in the production of soap. However, there are problems in getting continuous supply of CO. In addition, the price of CO is much higher than other vegetable-based oil, particularly Palm Oil (PO) and Palm Kernel Oil (PKO). The vast supply of PO and PKO coming from Malaysia and Indonesia, where as CO is imported from Philippines. Again, continuous supply of CO from the exported country cannot be taken for granted. So, the risk of becoming too dependent on that exporter is quite high.

Besides, there is some quality problem with the soap from coconut oil and tallow in aspects of physical properties, such as the consistency of soap, formation of foams in water and hard water resistance. Basically, the soap 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 odor smell. Thus, thorough analysis on soap 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. Thus, alternative vegetable based materials can be the right substitute.

1.3 Research Objectives

1.3.1 To study the production of soap from blends of palm kernel oil (PKO) and palm oil (PO)

1.3.2 To produce soap in silky-textured in term of high yield and good quality soap

1.3.3 To study the physical and chemical characteristics of the obtained soap from palm kernel oil and palm oil

1.4 Scope of Proposed Study

Scope of research is, control production of soap using suitable parameters which are concentration ratio, mixing temperature, speed of stirred, but at a constant mixing time in order to produce good quality of soap. For the mixing ratios between palm kernel oil and palm oil, the range of concentration is from 0 until 100 %. Whereas for the mixing temperature, the best range is from 20˚C- 70˚C within 30 min. Besides, the best range for the speed of stirrer is from 600 until 1500 rpm.

Table 1.1 Composition (% v/v) of soap blends made from distilled PO and PK fatty acids

	Soap blends				
	1	2	3	4	5
Raw material	100 PKO / 0PO	80 PKO / 20 PO	50 PKO / 50 PO	25 PKO / 75 PO	0 PKO / 100 PO

Table 1.2 Temperature, speed and time of soap blends made for distilled PO and PK fatty Acids

	Soap blends				
	1	2	3	4	5
Raw material	100 PKO	80 PKO	50 PKO	25 PKO	0 PKO
	0PO	20 PO	50 PO	75 PO	100 PO
Temperature (^{0}C)	60	60	60	60	60
Speed (rpm)	1300	1300	1300	1300	1300
Time (min)	30	30	30	30	30

1.5 Significance of Proposed Study

1. Production of soap from palm kernel oil shall produces low cost compared production of soap from tallow and coconut oil. What more the palm oil (PO) and palm kernel oils (PKO) are easily available at low prices in Malaysia, but not so for the coconut oil.

2. The abundance of palm oil in Malaysia led to the growth of the oleochemical 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 February 1985).

3. The soap or detergent manufacturing processes will produce glycerol as a byproduct. However, it is also much more valuable than soap itself, so only a minimum of glycerine is left in the soap and via separation process, the soap can be 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 soap from palm kernel oil and palm olein in aspects of physical properties such as the hardness of soap, and formation of foams in water are really good.

CHAPTER 2

LITERATURE REVIEW

2.1 Oil Palm

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 producing 10–35 tonnes of fresh fruit bunch (FFB) per year with one hectare. Generally FFB can be harvested 3 years after planting and the largest amount of FFB is harvested about 10 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°N- 15°S where there is evenly distributed rainfall (1,800–5,000 mm year-1).

The oil palm fruit produces two oils which are palm oil from the fleshy mesocarp and palm kernel oil from the seed or kernel. The fleshy mesocarp of the fruit is used to obtain oil 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 archaelogical evidence suggesting 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 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 oleochemical industry for making soap, detergent, toiletries and cosmetics.

Figure 2.1 Oil palm named *Elaeis guineensis Jacq*

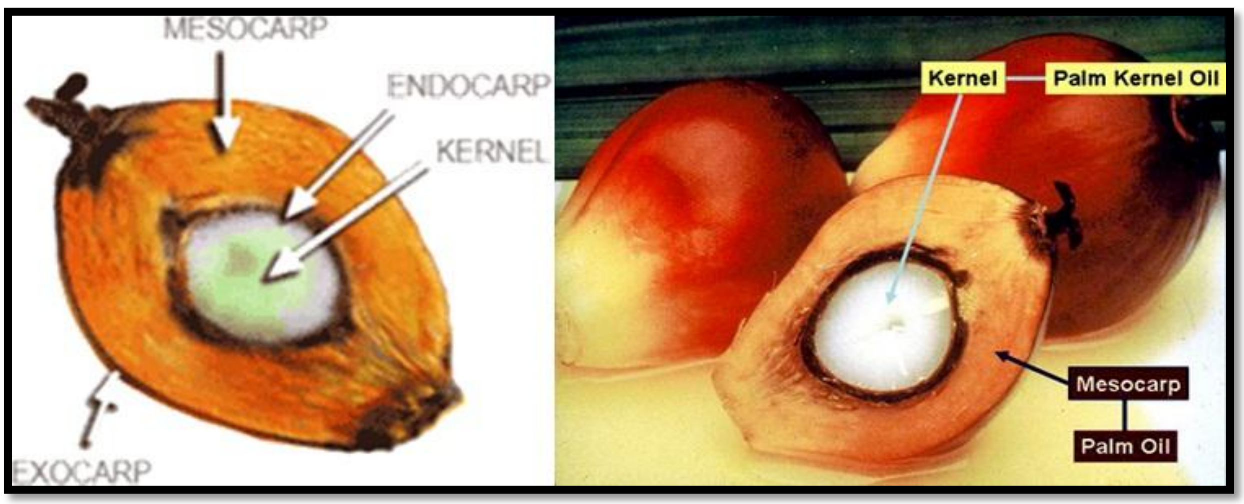

Figure 2.2 Structure of Oil Palm

2.2 Advantages of Palm Oil

Palm oil, as feedstock for biodiesel production, holds many advantages:

A vastly greater yield per area as compared with other plant sources:

Source	Yield (liters/hectare)	Comparison of yields
Palm	5950	1.00
Coconut	2,689	0.45
Jatropha	1,818	0.31
Rapeseed	1,190	0.20
Soybean	446	0.07

(Source: Pahl, 2005)

Palm oil produces more than 5,675 liters per hectare (600 gallons per acre) while soy oil produces approximately 475 liters of biodiesel per hectare (50 gallons per acre).

1. Palm oil has the lowest per-unit production costs of all vegetable oils (next in line is soy, with a production cost that is 20% higher).

2. The palm oil extraction process is a relatively simple one.

3. The relative oxidation rate of palm oil at 37°C / 98.6°F is 40-65 OSI (h) at 97.8°C, with a relative stability of 20, as compared with 13-15 OSI for soybean oil, with a relative stability of 6; and 16-20 OSI with a relative stability of 6 for rapeseed oil. As extensive oxidation can cause fuel quality to degrade during storage, the higher OSI of palm oil renders it more stable with respect to oxidation than other oils, and therefore comprises an important advantage.

4. Blends of composed of 4.2 parts SBO (Soy Bean Oil) with 1 part palm oil behave as RSO (Refined Soy Oil), resulting in a significant price benefit.

5. Palm oil is rich in beta-carotenes and is considered as the richest natural source of carotenoids, which are known to be an effective antioxidant.

6. Palm oil has a high melting point and a low content of trans fatty acids, two attributes that are particularly attractive to the food industry.

7. Studies have shown that the effects of palm oil and palm olein on blood cholesterol levels are similar to those of olive oils.

8. A diet that includes palm oil raises the level of 'good' HDL cholesterol, yet does not raise the level of LDL or total cholesterol. Moreover, it may even lead to lower plasma levels of LDL (which is most commonly linked to heart disease).

9. Studies suggest that the tocotrienols found in palm oil may be able to reverse blockage of the carotid artery as well as platelet aggregation, and thus reduce the risk of strokes, arteriosclerosis and other phenomena associated with heart disease.

10. Studies suggest that a palm-oil enriched diet produces a reduced tendency for blood clotting.

11. Palm oil maintains a high level of substitutability with other soft oils.

12. Palm oil has the highest market penetration level of all vegetable oils.

13. Palm oil has been the most competitively priced vegetable oil in the global market for