International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:5, No:9, 2011

Comparison of Physico-Chemical Properties And Fatty Acid Compostion of *Elateriospermum Tapos* (*Buah Perah*), Palm Oil And Soybean Oil

Siti Hamidah, Lee Nian Yian, Azizi Mohd

Abstract**—***Elateriospermum tapos* seed (*buah perah*) is the one of the rich sources of polyunsaturated fatty acids. It contains high percentage of oleic acid which is the important component to develop nervous system and also α-linolenic acid (ALA) which is the precursor of omega-3 fatty acids series to synthesize eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). However, there is less study about this valuable oilseed and exploit its potential. Therefore, this paper is to assess the comparison of physico-chemical properties and fatty composition of *perah* oil to palm oil and soybean oil. From the comparison, *perah* oil shows low peroxide value means it has good oxidative stability and also high iodine values shows that it can be used in paint industry. The study shown that perah oil is comparable to palm oil and soybean oil, so it has high potential to be exploited in the oleochemical, pharmaceutical, cosmetics and paint industries.

Keywords**—** α-linolenic acid, palm oil, *perah* oil, soybean oil

I. Introduction

OVER the past 20 years, there has been a dramatic increase in the scientific scrutiny of and public interest in omega-3 and omega-6 fatty acids and their impact on personal health[1]. The precursor of omega-3 fatty acid is α-linolenic acid (C18:3n-3, ALA) while the precursor of omega-6 fatty acid is linoleic acid (C18:2n-6, LA). Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are converted from the ALA which cannot be synthesized by human, so they are also known as essential fatty acids. Nowadays, consumption of fish or fish oil appears to play an important role in supplying the omega-3 polyunsaturated fatty acid (PUFA) for human health. The fish species rich in omega-3 PUFAs are anchovy (European), bass (stripped), bluefish, mackerel (Atlantic),herring (Atlantic and Pacific), pompano (Florida), salmon (Atlantic, Chinook, Pink and Sockeye), sardines, trout (Lake and Rainbow), sablefish and tuna [2]. They provide an adequate amount of omega-3 PUFAs (2.7-7.5g per meal) and appear to meet the nutritional recommendations of the American Heart Association [3]. However, the safety issue in consumption of fish should be taking in consideration even though fish can supply DHA, EPA, certain minerals and vitamins. The potential health risk related to the consumption of fish may be because of the presence of some environmental contaminants which are carcinogenic or non-carcinogenic such as polychlorinated biphenyls (PCBs), heptachlor, methyl mercury, dioxin and so forth in some species of fish. Even though these substances are present in low levels in fresh water such as lakes, rivers and oceans (sea water) but it can be accumulated into aquatic food chain through bioconcentration and biomagnification. As we know that, human will be exposed to these all environmental contaminants is through the utilization of fish on frequent basis. Among all the contaminants as mentioned above, polychlorinated biphenyls and methylmercury have the longer half lives in humans' bodies. The accumulated methyl mercury will be stored in muscles while the fat soluble environmental contaminants such as PCBs are stored in adipose tissue of the body. The PCBs amount can be reduced by remove the skin of fish and fat before cooking, but the methyl mercury cannot be removed like PCBs through skinning and trimming [3]. Therefore, consumption of fish may carry risk to pregnant women, children and older men. In addition, since fish oil always presents higher amounts of omega-3 fatty acids than seed oils or microalgae, fish therefore, has become a valuable product not only as a valuable ingredients itself in omega-3 enriched products[4]. It is known that the global fish stocks are in danger, so there might be a decrease in fish supply in the future.

Therefore, it is significant to investigate the other sources such as seed oils to be developed as new source to supply omega-3 fatty acids. Vegetable oils or plant oils are the major food sources supply the ALA which is the precursor of omega-3 fatty acids. Plants oils mainly produced from oilseeds, legumes and nuts. To date, there are limited numbers of seed oil containing ALA available in market. Among those include soy bean (8%), canola oil (8.8%) and linseed oil (60%) [5]. Hence, it is fascinating to study the new source of seed oil especially the new local source of oilseed which can supply ALA. In Malaysia, seeds of *Elateriospermum tapos*

Siti Hamidah is with the Faculty of Chemical and Natural Resources Engineering, Universiti Teknologi Malysia, 81310 Skudai, Johor. (phone: 07-5535496; fax: 07-5581463; e-mail: sitihamidah@cheme.utm.my).
Lee Nian Yian is with Faculty of Chemical and Natural Resources Engineering, Universiti Teknologi Malysia, 81310 Skudai, Johor. (e-mail: nianyian913@gmail.com).
Azizi Mohd is with Centre of Lipids Engineering and Applied Research (CLEAR) Laboratory, Department of Chemical Engineering, the Faculty of Chemical and Natural Resources Engineering, Universiti Teknologi Malysia, 81310 Skudai, Johor. (e-mail:azizi@cheme.utm.my).

(*buah perah*) had been discovered as the new source of oilseeds that contain high percentage of PUFAs especially ALA. Therefore, it has the potential to be developed into new and cheap seed oil of ALA.

Elateriospermum tapos (*E. tapos*) is a species of plant of the family *Euphorbiaceae* and the sole member of its genus (*Elateriospermum*) and tribe (*Elateriospermeae*). *Elateriospermum tapos* is a monoecious tropical canopy species which can be found in Southeast Asian (Peninsular Thailand, Peninsular Malaysia, Sumatra, Java as well as Borneo tropical rain forest [6]. In Malaysia, this species found to be dominated in Jengka Forest Reserve, Peninsular Malaysia [7]. To locals throughout Southeast Asia, *Elateriospermum tapos* is more popularly known as *perah* or *pogoh nut* (Malaysia), *kedui* or *tapos* (Indonesia) and *look-kra* or *look-pra* (Thailand) [6].

II. USES OF ELATERIOSPERMUM TAPOS

The buah perah tree also known as the tree of value. The perah seeds are oval shape and black in colour as shown in Fig.1, the size are approximately 30mm to 40mm. Meanwhile, the outer layer of the seeds is very hard, thin and smooth where the content inside is white in colour. The *perah* seeds only consumed after boiled or roasted.

Fig 1 Seeds of *Elateriospermum tapos* (*buah perah*)

The people in Sumatra, Indonesia use the seeds to add fragrance to the *sambal* after seeds being pounded with some water. The Sakai (jungle tribes in Malaysia) will pound the seeds with some water before the seeds being buried into bag and the fermented *perah* seeds have very strong flavor and applied into their meals. In addition, *perah* tree was well known as medium hardwood timber and can be fully utilized in timber industries especially in construction field. Moreover, perah latex has the medicinal use which the *Bidayuh* in Sarawak, Malaysia use the latex to heal their crack wounds on the soles of their bare feet because they involve in the paddy planting which cause their feet always in wet earth. Furthermore, the oil of perah seeds is seldom extracted to use in daily life, usually it only being extracted to be used as cooking oil or lamp oil.

III. SUPERCRITICAL CARBON DIOXIDE EXTRACTION (SC-CO_2)

Many methods are used to recover the oil from the seed oil. The most common one is solvent extraction which usually organic solvent such n-hexane. However, public concerns and government about the environment and human health hazards of organic solvents and residues in oil or oilseed -derived products and the possible solvent contamination of the final products have catalyzed the need for the development of new and clean technologies for the processing of food products. Supercritical fluid extraction using carbon dioxide as a solvent has provided an excellent alternative to the use of chemical solvents. Mishra et al. [8] had reported that for food commodities, CO_2 is chosen because it has moderate critical temperature and pressure (31.1℃, 1070psig) and is inert, inexpensive, non- flammable, environmentally acceptable, readily available and safe. The favorable transport properties of fluids near their critical points also allow deeper penetration into solid plant matrix and more efficient and faster extraction than with conventional organic solvents [9]. In addition, Hui Cao et al. [10] stated that supercritical fluid have the density of a liquid and solubilize solids like a liquid solvent, but have the diffusion power of a gas and permeate through solid materials very easily. The power of solubilization increases with the density of fluid and the high densities of supercritical fluid are possible at high pressures and allow it to dissolve large quantities of organic compounds [11]. Therefore, the supercritical fluid extraction using carbon dioxide as solvent extraction has number of advantages over conventional extraction, namely low temperature and pollution free operation, inert solvent, selective separation and fractionation of tailor-made end product, as well as extraction of high-value product, or of new product, with improved functional or nutritional characteristics [10].Last but not least, supercritical fluids are known to provide good reaction media due to their high diffusivity, capacity to homogenize a reaction mixture and controlled phase separations and distribution of products [12].

IV. COMPARISON OF CHARACTERISTICS BETWEEN *PERAH* OIL, PALM OIL AND SOYBEAN OIL

A. Physico-chemical Properties

The comparison of physic-chemical properties of the perah oil, palm oil and soybean oil had been reported by Ooi, Y.Y., et al. [6], Azlan, A. [13], et al. and Nehdi,I [14] as shown in the Table I. The physical and chemical properties as studied by Ooi, Y.Y., et al., the *perah* oil is comparable to other commercial edible oils such as palm oil and soybean oil. One of the most important quality parameters in oil industries which determine the level of deterioration of oil is free fatty acid (FFA) [15]. In Malaysia, the FFA percentage of palm oil mills had been limited to 5% and this value will increase of the fresh fruit bunches are not processed soon after harvesting [16]. In the study of Iwuoha, C.I. et al. [17], the percentage of FFA for crude palm oil is 5.632%. Therefore, as shown in Table I, *perah* oil has 4.12% of FFA which is lower than palm oil, mean the level of deterioration is lower if compare to palm oil but higher if compare to soybean oil (0.86% of FFA). In addition, *perah* oil also contains high acid value and this may be due to some hydrolytic reaction occurred during the extraction [18]. Therefore, to obtain better quality of oil and for edible purposes, the *perah* oil must undergo refining process. Besides this, *perah* oil also shows the significant value of iodine value and peroxide value as shown in Table I. Iodine value is the measurement of the degree of unsaturation of oil while peroxide value is to measure the oxidative stability in presence of high temperature, light and oxygen. *Perah* oil shows low peroxide value if compare to palm oil and soybean oil means that *perah* oil is better in quality and low tendency to go rancid, hence it has good oxidative stability. Generally, according to Gotoh, N. et al. [19], oil with less than 30mEq peroxide/kg has been considered safe to be consumed by human being. On the other hands, *perah* oil contains high iodine value due to the high content of unsaturated fatty acids as shown in Table II. The high iodine value and oxidative stability shows that the seeds uphold good qualities of edible oil and semi-drying oil purposes [20].As result shown in Table I, *perah* oil has high saponification value which indicates that perah oil has the potential to be developed into cosmetics products such as shampoos, liquid soap [21].

TABLE I
COMPARISON OF PHYSICOCHEMICAL PROPERTIES BETWEEN PERAH OIL [6], PALM OIL [13] AND SOYBEAN OIL [14]

Physicochemical properties	***Perah* oil [6]**	**Palm oil [13]**	**Soybean oil [14]**
Acid value	8.21 ± 0.06	0.84 ± 0.00	1.72 ± 0.08
Iodine value	106.77 ± 0.37	60.27 ± 0.89	122.56 ± 0.98
%FFA (as oleic acid)	4.12 ± 0.03	-	0.86 ± 0.08
Saponification value	150.90 ± 0.32	200.05 ± 0.42	179.45 ± 0.68
Peroxide value	0.46 ± 0.16	7.98 ± 0.01	1.52 ± 0.05
Refractive index	1.45 ± 0.01	-	1.477 ± 0.002
Color			Dark Yellow
a*	3.03 ± 0.01	-7.43 ± 0.01	-
b*	2.75 ± 0.04	24.23 ± 0.00	-
L*	38.96 ± 0.08	85.77 ± 0.01	-
Physical state at room temperature	Liquid	Liquid	Liquid

-, not determined

B. Fatty Acid Composition

From Table II investigation done by Ooi, Y.Y. et al. had shown that *perah* seed oil contains high percentage of unsaturated fatty acids where oleic acid (32.53%), linoleic acid (31.81%) and followed by ALA (17.14%). The high percentage of oleic acid in *perah* seed allow it to be used as medicinal purpose because oleic acid plays crucial role in nervous cell construction and also fundamental role in cardiovascular disease prevention [22]. The high content of unsaturated fatty acids (82.16%) shows that *perah* seed oil has high nutritional value and allow it to be developed into commercially use like soy bean oil, palm oil, olive oil and etc. The physical properties of the membrane such as fluidity and permeability will be affected by the total unsaturated fatty acids [22]. In addition, the *perah* seed oil (17.14%) also shows the significant value of ALA which is higher than palm oil (0.27%) and soybean oil (8.18%). Therefore, *perah* oil can be exploited as the new source of vegetable oil which contains high ALA, the precursor of omega-3 fatty acid.

TABLE II
COMPARISON OF FATTY ACIDS COMPOSITION BETWEEN PERAH OIL [6], PALM OIL [13] AND SOYBEAN OIL [14]

Fatty acids	*Perah* oil [6]	Palm Oil [13]	Soybean Oil [14]
Saturated fatty acid			
Myristic acid	0.06 ± 0.01	9.19 ± 0.03	0.12 ± 0.03
Palmitic acid	13.40 ± 0.07	33.84 ± 0.00	15.65 ± 0.03
Stearic acid	3.59 ± 0.02	3.68 ± 0.00	4.98 ± 0.23
Arachidic acid	0.22 ± 0.01	0.32 ± 0.01	0.55 ± 0.07
Lignoceric acid	0.07 ± 0.01	ND	ND
Monounsaturated fatty acid			
Palmitoleic acid	0.11 ± 0.01	0.17 ± 0.00	0.12 ± 0.03
Oleic acid	32.53 ± 0.17	39.65 ± 0.03	20.98 ± 0.23
Polyunsaturated fatty acid			
Linoleic acid	31.81 ± 0.10	0.73 ± 0.01	50.17 ± 0.83
γ – Linoleneic acid	0.13 ± 0.02	10.92 ± 0.00	-
α – Linoleneic acid	17.14 ± 0.21	0.27 ± 0.02	8.18 ± 0.53

ND, non detectable; -, not determined

V. BENEFITS OF ALPHA-LINOLENIC ACID (ALA)

ALA is one of the polyunsaturated fatty acids which play important roles in human metabolism, not only playing structural roles in phospholipid bilayers but also acting as precursors to bioactive molecules [23]. Recent studies have shown that dietary ALA deficiency induces more marked abnormalities in celebral structures than in others, as the frontal cortex and pituitary gland are more severely affected [24]. Furthermore, through slightly changing the efficacy of sensory organs and influencing certain cerebral structures, ALA deficiency decrease the perception of pleasure [25]. There are many studies about the effect ALA towards the health of cardiovascular, but it seen not clear and less attention being paid on this issue. Geleijnse, J.M. et al. [26] reported that intakes of n-3 fatty acids above the Adequate Intake (AI) may confer additional health benefits, especially with respect to cardiovascular health noted by Institute of Medicine (IOM). Many advisory boards consider ALA intakes greater than 1.5g/d important for human health [27]. However, many studies seen not provide evidence support to the issue that ALA is essential for cardiovascular health disease and the effect of ALA still need long term trials investigation. Therefore, the safety or the toxicology of the *perah* oil consist high ALA must be tested before being consumed by the human being.

VI. Conclusion

The physic-chemical properties and fatty acids composition of *perah* oil studied in Table I and Table II had shown that *perah* oil can be developed into new source of vegetable such as soybean oil, palm oil, olive oil and etc. Finally, *perah* oil also has the potential to be made into the product of cosmetics, pharmaceutical and so forth.

Acknowledgment

We thank for Universiti Teknologi Malaysia for giving the support in doing this study. Our study in this area also collaborates with the Centre of Lipid Engineering and Applied Research (CLEAR) laboratory, thank you for all the guidance and support.

References

[1] O. Covington, M.B., M.D. (2004). Omega – 3 Fatty Acids. J. of America Family Physician. 70, 133 – 140.

[2] Hepburn, F.N., Exler, J., Weihrauch, J.L. (1986). Provisional tables on the content of omega-3 fatty acids and other fat components of selected foods. J. of the American Dietetic Association. 86(6), 788 – 793.

[3] Kris-Etherton, P.M., Harris, W.S., Appel, L.J.(2002). Fish consumption, fish oil, omega-3 fatty acids and cardiovascular disease. J. of the American Heart Association. 106, 2747 – 2757.

[4] Rubio – Rodríguez, N., Beltán, S., Jaime, I., m. De Diego, S., Teresa Sanz, M., Carballido J. R. (2010). Production of omega – 3 polyunsaturated fatty acid concentrates: A review. J. of Food Science and Emerging Tevhnologies. 11, 1 – 12.

[5] O'Brien, R.D. (2004). Fats and Oils, Formulating and Processing for Applications. Second edition. CRC Press, Washington, DC.

[6] Ooi, Y.Y., Salimon, J. (2006). Characteristics of Elateriospermum tapos seed oil as a new source of oilseed. J. of Industrial Crops and Products. 24, 146 – 151.

[7] Osada, N., Takeda, H., Kawaguchi, H., Furukawa, A., Awang, M. (2003). Estimation of crown characters and leaf biomass from leaf litter in a Malaysian canopy species, Elateriospermum tapos (Euphorbiaceace). J. of Forest Ecol. Manage. 177, 379 – 386.

[8] Mishra, V.K., Temelli F., Ooraikul B. (1993). Extraction and Purification of ω3-Fatty Acids with an Emphasis on Supercritical Fluid Extraction: A Review. J. of Food Research International. 26, 217 – 226.

[9] Cao, H., Jian, B.X., Ming, X. (2007). Comparison of volatile components of Marchantia convoluta obtained by supercritical carbon dioxide extraction and petrol ether extraction. J. of Food Composition and Analysis. 20, 45 – 51.

[10] Ooi, C.K., Bhaskar, A., Yener, M.S., Tuan, D.Q., Hsu, J., Rizvi, S.S.H. (1996). Continuous Supercritical Carbon dioxide processing of palm oil. J. of the Amrican Oil Chemists' Society. 73, 233-237.

[11] Xiao, J.B., Chen, J.W., Xu, M. (2007). Supercritical fluid carbon dioxide extraction of essential oil from Marchantia convoluta: global yields and extract chemical composition. J. of Biotechnology. 10, 141-148.

[12] Phelps, C. L., Smart, N.G., Wai, C.M. (1996). Past, present, and possible future applications of supercritical fluid extraction technology. J. of Chemical Education. 73 (12), p. 1163.

[13] Azlan, A., Prasad, K.N., Khoo, H.E., Abdul-Aziz, N., Mohamad, A., Ismail, A., Amom, Z. (2010). Comparison of fatty acids, vitamin E and physicochemical properties of Canarium odontophyllum Miq. (dabai), olive and palm oils. J. of Food Composition and Analysis. 23, 772-776.

[14] Nehdi, I. (2011). Characteristics, chemical composition and utilisation of Albizia julibrissin seed oil. J. of Industrial Crops and Products. 33, 30-34.

[15] Corley, R.H.V., Tinker, P.B. The oil palm. USA: Blackwell (pp. 450-471).

[16] Tan, C.H., Ghazali, H.M., Kuntom, A., Tan, C.P., Ariffin, A.A. (2009). Extraction and physicochemical properties of low free fatty acid crude palm oil. J. of Food Chemistry. 113, 645-650.

[17] Iwuoha, C.I., Ubbaonu, C.N., Ugwo, R.C., Okereke, N.U. (1996). Chemical and physical characteristics of palm, palm kernel and groundnut oil as affected by degumming. J. of Food Chemistry. 55, 29-34.

[18] Ku, C.S., Mun, S.P. Characterization of seed oils from fresh Bokbunja (Rubus Coreanus Miq) and wine processing waste. J. of Bioresource Technology. 99, 2852-2856.

[19] Gotoh, N., Wada, S. (2006). The importance of peroxide value in assessing food quality and food safety. J. of American Oil Chemistry Society. 83, 473-474.

[20] Eromosele, I.C., Eromosele, C.O., Innazo, P., Njerim, P. (1998). Short Communication: studies on some seeds and seed oils. J. of Bioresource Technology. 64, 245-247.

[21] Akbar, E., Yakoob, Z., Kamarudin, S.K., Ismail, M., Salimon, J. (2009). Characteristics and composition of Jatropha Curcas oil seed from Malaysia and its potential as biodiesel feedstock. European J. of Scientific Research. 29, 396-403.

[22] Nasri, N., Khaldi, A., Fady, B., Trikis, S. (2005). Fatty acids from seeds of Pinus pinea L.: composition and population profiling. J. of phytochemistry. 66, 1729-1735.

[23] Venegas-Calerón, M., Sayanova, O., Napier, J.A. (2010). An alternative to fish oils: Metabolic engineering of oil seed crops to produce omega-3 long chain polyunsaturated fatty acids. J. of Progress in Lipid Research. 49, 108-119.

[24] Eckert, G.P., Franke, C., Nö ldner, M., Rau, O., Wurglics, M., Schubert-Zsilavecz, M., Müller, W.E. (2010). Plant derived omega-3-fatty acids protect mitochondrial function on the brain. J. of Pharmacological Research. 61, 234-241.

[25] Bourre, J.M. (2004). Roles of unsaturated fatty acids (especially omega-3 fatty acids) in the brain at various ages and during ageing. J. of Nutrition, Health and Aging. 8 (3), 163-174.

[26] Geleijnse, J.M., Goede, J.d., Brouwer, I.A. (2010). Alpha-Linolenic Acid: Is it Essential to Cardiovascular Health? J. of Current Atherosclerosis Reports. 12, 359-367.

[27] Gebauer, S.K., Psota, T.L., Haris, W.S., Kris-Etherton, P.M. (2006). n-3 fatty acid dietary recommendations and food sources to achieve essentiality and cardiovascular benefits. J. of Clinical Nutrition. 83, S1526-1535S.