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Physicochemical Properties and Anti-Nutritional Factors in Seed Oils of *Shorea macrophylla* and *S. palembanica*.

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Bachelor of Science with Honours
(Resource Chemistry)

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Physicochemical Properties and Anti-Nutritional Factors in Seed Oils of *Shorea macrophylla* and *S. palembanica*.

Sahlinah Binti Abdul Rakman

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This final project report is submitted in partial fulfilment of the requirement for the degree of Bachelor of Science with Honours in Resource Chemistry

Faculty of Resource Science and Technology

UNIVERSITY MALAYSIA SARAWAK

2019

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ABSTRACT

Seed oils from several *Shorea* species are known to have potentials to be used in food and pharmaceutical manufacturing industries. Studies in determining the proximate composition, nutritional, anti-nutritional factors and fatty acid profile of seed oils are essential to know the nutraceutical values of the seeds. This study was carried out to determine the proximate composition., nutritional, anti-nutritional factors and fatty acid composition of seed oils ini *Shorea macrophylla* and *S. palembanica* from Sarawak. The effieciency of Piteba oil expeller and Soxhlet extractor to isolate oils from the seeds has been compared. The oil was subjected to derivatisation and then analysed on gas chromatography-flame ionisation detector (GC-FID). The moisture and ash content of *Shorea* seeds were ranged 27.77% to 50.44% and 11.50% to 48.56%, respectively. Oxidative stability of the oils based on the free fatty acid (FFA), peroxide value (PV) and iodine value (IV) are found highest in *S. macrophylla* oils that were extracted by Soxhlet extraction method. Evaluation of anti-nutritive factors such as oxalate, phytate and saponin are found highest in *S. Palembanica* compared to *S. macrophylla*. The percentage of saturated fatty acid acid composition in *S. macrophylla* seed oil extracted from expeller and Soxhlet extraction were 7.67% and 66.38%, respectively, the monounsaturated fatty acid contents were 38.98% and 5.53% and 53.32% and 28.09% of polyunsaturated fatty acid respectively. Fatty acid profile from *S. palembanica* seed oils that were extracted from expeller and Soxhlet extraction methods are found to be 9.24% and 72.11% of saturated fatty acid, 50.83% and 21.50% of monounsaturated fatty acid and 39.93% and 6.39% of polyunsaturated fatty acid.

Keywords: *Shorea*, Seed oil, Fatty acid, Anti-nutritive factors, Gas Chromatography-Flame Ionisation Detector.

ABSTRAK

Sifat Fizikokimia dan Faktor Anti-nutrisi Minyak Biji dari *Shorea macrophylla* dan *S. palembanica*.

Biji daripada beberapa spesies *Shorea* telah dikenal pasti boleh digunakan dalam industri pengeluaran makanan dan farmasi. Kajian mengenai komposisi proksimat, faktor anti-nutrisi dan profail asid lemak adalah penting untuk mengetahui nilai nutrisi yang terkandung dalam biji tersebut. Oleh itu, kajian ini dijalankan untuk menentukan komposisi proksimat, faktor anti-nutrisi dan profail asid lemak yang terkandung di dalam biji *S. macrophylla* dan *S. palembanica* dari Sarawak. Perbandingan dalam tahap kecekapan antara pengeluar minyak Piteba dan pengekstrak Soxhlet untuk menghasilkan minyak telah dijalankan. Minyak yang telah diekstrak ditukar kepada asid lemak metil ester sebelum dianalisis menggunakan Kromatografi Gas-Pengesan Pengionan nyalaan (KG-PPN). Kandungan kelembapan, abu dan lemak dalam biji *Shorea* adalah 27.77% hingga 50.44%, 11.50% to 48.56% dan 8.88% ke 30.82%. Nilai stabiliti pengoksidaan didapati tinggi pada minyak *S. macrophylla* yang diekstrak menggunakan pengekstrak Soxhlet berdasarkan nilai asid lemak asid, nilai peroksida dan nilai iodin. *S. palembanica* mempunyai tahap faktor anti-nutrisi yang lebih tinggi berbanding S. palembanica berdasarkan kandungan oksalat, fitat dan saponin. Kadar peratusan komposisi lemak tepu bagi minyak yang diekstrak menggunakan pengeluar minyak piteba dan pengekstrak Soxhlet bagi *S. macrophylla* adalah 7.7% dan 66.38%, asid lemak mono-tidak tepu adalah 38.98% and 5.53% dan lemak asid poli-tidak tepu adalah 53.32% and 28.09%. Profail asid lemak tepu daripada *S. palembanica* yang diekstrak menggunakan pengeluar minyak piteba dan pengekstrak Soxhlet adalah 9.24% dan 72.11%, 50.83% and

21.50% o untuk asid lemak mono-tidak tepu dan 39.93% and 6.39% untuk asid lemak poli-tidak tepu.

Kata kunci: *Shorea*, Minyak biji, Asid lemak, Faktor anti-nutrisi, Kromatografi Gas-Pengesan Pengionan nyalaan (PPN).

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LIST OF ABBREVIATIONS

AA:	Arachidonic Acid
ALA:	α-Linolenic Acid
AOAC:	Association of Official Analytical Chemistry
CBE:	Cocoa Butter Equivalence
DHA:	Docosahexanoic Acid
EFA:	Essential Fatty Acid
EPA:	Eicosapentanoic Acid
FAME:	Fatty Acid Methyl Ester
FFA:	Free Fatty Acid
FTIR:	Fourier-Transform Infrared Spectroscopy
GC-FID:	Gas Chromatography- Flame Ionization Detector
HDL:	High Density Lipid
IV:	Iodine Value
LA:	Linolenic Acid
LDL:	Low Density Lipid
MUFA:	Mono-Unsaturated Fatty Acid
PUFA:	Poly-Unsaturated Fatty Acid
PV:	Peroxide Value
r.p.m:	Rotation Per-Minute
SFA:	Saturated Fatty Acid
TFA:	*trans* Fatty Acid
UFA:	Unsaturated Fatty Acid

CHAPTER 1

INTRODUCTION

1.1 Project Background

Dipterocarpaceae is a family of 16 genera and accounts for 695 known species (Christenhusz and Byng, 2016). This family plays important role in the economy since it predominates the timber market internationally (Poore, 1989). Dipterocarpaceae has 16 genera and one of them is Genera of *Shorea.* Genera of *Shorea* have been classified into four section, which are *Shorea*, *Rubroshorea*, *Richietoides* and *Anthoshorea*. Symington (1943) reported that the tribes commercially known as balau, red meranti, yellow meranti and white meranti which considered as the highest export wood is belongs to red meranti (Itoh, et al., 2004). *Shorea* is also popular for its '*engkabang*' seed. Traditionally, the engkabang fat was use as flavouring in rice (Blicher-Mathiesen, 1994). Since the establishment of the colonies in Sarawak, it was exported mainly for the manufacturing of lubricant and candle (Kaur, 1998; Blicher-Mathiesen, 1994). Shea butter is also one of the cocoa butter equivalences (CBE) at that time but the engkabang fat does not need the fractionation before use, thus the price of processing the engkabang is much cheaper than shea butter. The demand of engkabang fats increased in 1950 to 1970 caused by the increase of the price for cocoa butter (Blicher-Mathiesen, 1994). CBE is the composition of fats that is similar to the butter. Fatty acid is the basic building blocks of fat that have two types of fatty acids, saturated fatty acid (SFA) and unsaturated fatty acid (UFA). The fatty acids can be characterised by using Gas

Chromatography-Flame Ionisation Detector (GC-FID) in the form of fatty acid methyl esters (FAMEs).

1.2 Problem Statement

Vegetable oils are broadly used in pharmaceutical, cooking, confectionary and cosmetics. Dugo et al (2007) narrated the demand for vegetable oils started to increase from 2006 due to their cholesterol lowering effect which can prevent cardiovascular disease. Research activities have been focused in searching vegetable oils from different kind of plant. In Malaysia, the search of vegetable oil has not been done extensively even there are abundant of forest resources which can be source of nutrients. Gruere et al (2009) stated the limited scientific information and knowledge about sources of vegetable oil is because it is abundant locally but not globally. *Shorea* oil seeds has been used traditionally for flavouring and cooking but there is limited information regarding the fatty acid composition. The fact that *Shorea* oil seeds are traditionally for consumption, it will serve as a great potential to be commercialised and developed as cooking oils.

1.3 Objectives of the project

The objectives of the project were:

a) to conduct the proximate analysis of seed oils from *S. macrophylla* and *S. palembanica*,

b) to compare the capability of Soxhlet extractor and seed oil expeller to extract seed oil from *Shorea* seeds,

c) to characterise the composition of fatty acids in seed oils of *S. macrophylla* and *S. palembanica*, and

d) to assess the oxidative stability and anti-nutritive factors of seed oils from two *Shorea* species.

CHAPTER 2

LITERATURE REVIEW

2.1 Family of Dipterocarpaceae

Dipterocarpaceae is one of the popular plant family which distributed pantropically from northern South America to Africa, Sri Lanka, Seychelles, India, China, Thailand, Philippines, Indonesia and Malaysia (Ashton, 1980). The number of identified species under the dipterocarpaceae family is 695 species (Christenhuz and Byng, 2016). Poore (1989) stated that dipterocarpaceae family plays important role economically in most of the South East Asian's countries dominating the timber market internationally. Gamage et al. (2006) described this family stand tall where mostly the members are large forest emergent trees, having heights commonly 40 to 70 meters.

The dipterocarpaceae family is divided into 3 subfamilies (see Figure 2.01), which comprises of monotoideae distributed across Africa, Madagascar and South America, pakaraimoideae found in Guaianan highlands, South America and dipterocarpoidea*e*, the largest sub-families that distributed in South Asian countries such as Sri Lanka, India, Indonesia, New Guinea, China, Thailand and Malaysia (Symington, 1943). Dipterocarpoideae is divided into two tribes with one of the tribes Dipterocarpea*e* consist *Shorea* genus (Gamage *et* al., 2006; Jong and Kaur, 1979).

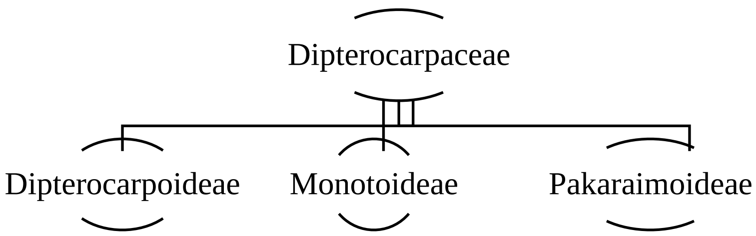

Figure 2.01: *Dipterocarpaceae* sub-family (Symington, 1943).

2.1.1 *Shorea* Genus.

The name *'Shorea'* is came from Sir John Shore, who was the Governor General of British East India Company. *Shorea* known locally as lauan, luan, lawaan, meranti, seraya, balau, bangkirai and Philippine mahogany. The import of *Shorea'*s derived wood had been tax, where the red meranti has the highest amount of tax than others (Itoh *et al*., 2004). *Shorea* is native to Southeast Asian regions that has a wide range of species. Borneo is one of the hotspots of the species diversity *Shorea* genus.

Ashton (1989) stated that in seasonal area the species flower annually with different intensities every year and in non-seasonal area, there are two types of flowering happen which is sporadic flowering that occurs annually or mast flowering (large gregarious flowering) that happened at the time interval 3 to 10 years. Timber of *Shorea* mainly from red meranti has been the major export of Sarawak, Sabah and Kalimantan-Indonesia (Blicher-Mathiesen, 1994). In addition, this genus also popular for its non-timber product among the locals such as nuts, damar, resins and champor (Shiva and Jantan, 1998).

2.1.1.1 *Shorea macrophylla* (Engkabang Jantung)

S. macrophylla locally known as Engkabang Jantong, Kawang Jantong, Engkabang amat, Engkabang ayer, Engkabang ringgit and Abang taha (Browne, 1955). ‘Jantong’ or ‘Jantung’ is referring to the heart shaped of the winged seed. *S. macrophylla* is an endemic species in Sarawak (Ashton, 1998). This species is the main export supply of illepe nuts because 85 to 90% of the crops are from this species (Blicher-Mathiesen, 1994). Chai (1998) reported that the name of *Shorea macrophylla* was from the combination of *Shorea gysbertsiana* and *Hopea macrophylla*.

Browne (1955) reported, this species might be the fastest growing among the *Shorea.* The mature tree can attain 120 cm diameter at breast height (DBH) and 50 m in height in tropical rain forest, its natural habitat while on the favourable site, it may reach DBH of 89 cm after 40 years (Ng and Tang, 1974; Ashton, 1964). The species is light red colored timber with a density of 270-600 kg/m^3 (Soerianegara and Lemmens, 1993).

S. macrophylla is naturally distributed in Borneo especially in western Sarawak and West Kalimantan and East Kalimantan (Appanah and Turnbull, 1998). The tree species are found scattered next to rural areas and longhouses where it had been planted for its nut. *S. macrophylla* is very popular because the tree is almost free from heart-rot compared to other timber species and it produces the largest nuts among the *Shorea* species (Chai, 1998; Smythies, 1958). It is also found near the river which makes it easier for the people to collect (Smythies, 1958). *S. macrophylla* is one of the dipterocarp species that the fruiting and flowering sequences are irregular in 3 to 4 years interval (Appanah and Turnbull, 1993).

2.1.1.2 *Shorea palembanica* (Engkabang Asu)

Shorea palembanica is locally known in Sarawak as engkabang asu or kawang asu, in Malay, ‘Asu’ is dog but for this context, it refers to the size of the testicles of a dog. Engkabang Asu, names including pelepak, majau or perawan paya (Peters, 1996).

Rudjiman and Ardiyanti (2002) described this tree species can grow up to 60 meter high with 130 cm in diameter. It also has very large, dark green and denser crown. The heartwood is soft pale pink and the root buttresses is coarse. The flowers has yellow color petal. The seedling is semi persistent, falcate, long stipules which up to 1.25 cm long. This species produces the smallest nut which have the lowest fat percentage. No collection of illepe nuts from this species that has been recorded in Peninsular Malaysia (Blicher-Mathiesen, 1994). The tree can be found on the lower slopes of the evegreen tropical lowland rainforest (Blicher-Mathiesen, 1994). The species are riparian and favors a low lying land.

2.1.1.3 *Shorea seminis* (Engkabang Terendak)

Shorea seminis known locally as engkabang terendak in Sarawak. Rudjiman and Ardiyanti (2002) stated that engkabang terendak is called tengkawang air or tengkawang pelepak in Kalimantan. This tree species is an emergent tree that can have 1.3 meter diameter and can reach up to 30 meter tall. The young leaves are yellowish green. *Shorea* seminis produce a small diameters which constitutes for 30 to 40 stamens. This species is distributed in Sarawak, Brunei, Sabah, Indonesian Borneo and Phillipines and mainly found in the riverbank.