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Physicochemical and Nutritional Composition of Rambutan Anak Sekolah (*Nephelium lappaceum L.*) Seed and Seed Oil

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Abstract: Rambutan anak sekolah (*Nephelium lappaceum L.*) seed from Malaysia, were analyzed for physicochemical and nutritional composition including proximate composition, mineral contents, solid fat content profiling, triacylglicerol and fatty acid composition. The seeds were abundant in fats (38.9%) and the amount of protein and carbohydrate are 12.4% and 48% respectively. Some chemical properties of seed oil were acid value (0.37%), iodine value (37.64%) and saponification value 157.07. Oleic acid (40.45%) and arachidic acid (36.36%) was the major fatty acid. Triacylglycerol composition of rambutan seed oil was also identified by using HPLC and it shown that AOO (*arachidoyl-dioleoylglycerol*) was the major compound (49.84%). The Solid fat content profiling of rambutan seed oil shown that it have potential application for food based on fatty product. The mineral elements of seed oil were also involved in this study. The result indicated that rambutan (*Nephelium lappaceum L.*) seed have a potential as a source of oil or carbohydrate for the human diet and also for food product application.

Key words: Rambutan (*Nephelium lappaceum L.*), seed oil, exotic fruit, food application

INTRODUCTION

The rambutan (*Nephelium lappaceum L.*) known as an exotic fruit originally found in Southeast Asia. Belongs to the family *sapindaceae*, rambutan in same group with sub-tropical fruits lychee and longan (Solis-Fuentes and Duran-de-Bazua, 2003; Marisa, 2006). Previous study by Morton (1987) and Ong *et al.* (1998) shown that this fruit is an important crop in Asia, where it is consumed fresh, canned and appreciated for its refreshing flavour and exotic appearance. Meanwhile in some countries such as Malaysia and Thailand, rambutan industrially processed to obtain juices, jams, jellies, marmalade, etc. During the increase of feedstock of rambutan for industry, it means that rambutan seed as a waste while processing in industry also increase. The problem of industrial waste are becoming harder to solve and much effort will be needed to develop the nutritional and industrial potential of by products (El-Adawy and Taha, 2001).

Recently, vegetable fat and oils are become very popular issue. Researchers have been done the widespread application of vegetable fat and oils. Their application as a raw material and inputs for industrial food, medicines and cosmetics production were established owing to the essential compounds from a nutritional point of view and because they possess important functional properties (Padley *et al.*, 1994; O'brien, 1998; Solis-Fuentes and Duran-de-Bazua, 2003). Furthermore, due to the availability natural vegetable fats are increasingly being utilized as renewable source of industrial feedstocks and fuel (Dyer *et al.*, 2008). These applications require extensive studies on the physico-chemical properties of oils in order to ensure their suitability as raw materials. Many studies on seed oils properties and their application from variety of plants are reported in previous literature (Cherciara *et al.*, 2010; Stupp *et al.*, 2008; El-Adawy and Taha, 2001; Onimawo *et al.*, 2000). Concerning the applications of rambutan seed and seed oil in food industry, due to the lack of research about the properties of rambutan seed and seed oil, the study about the prospectus of rambutan seed intensively need to be done. Therefore, this work concerns to the characterization of the properties of Rambutan seed oil (*anak sekolah species*) extracted by using solvent extractions. Deeper analysis more on triacylglycerol composition and the properties of fatty acid will be done, in order to ascertain further application of Rambutan (Anak sekolah species) seed oil.

MATERIALS AND METHODS

Ripe and fresh rambutan (*Naphelium lappaceum L.*) variety anak sekolah, were obtained from MARDI (Malaysia Agricultural Research And Development Institute), Selangor. They were sorted and peeled manually using a sterile kitchen knife. The seed was drying at 60°C for 48 h. The dried seed were milled to pass through 0.5 mm sieve. According to the Julio *et al.* (2010) and Kheiri and Mohd (1987) the ground seed

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were packed in sealed plastic bags and stored at -4°C until their processing and analysis.

Rambutan kernel fat solvent extraction: The previously conditioned seed drupes were extracted using an organic solvent. Oil extraction from seeds was extracted using hexane. Dried *Naphelium lappaceum L.* (50 g) were placed into a cellulose paper cone and extracted with 500 ml hexane using a soxhlet extraction apparatus for 8 h. The solvent was removed via a rotary vacuum distillation at 40-50°C. The result of micelle was distilled in a rotary evaporator apparatus with a vacuum system to removing traces of the solvent and obtaining the rambutan seed oil.

Nutrient and physicochemical composition of rambutan kernel: Sample of the seed was analyzed to determine crude protein (6.25 x N, micro Kjedahl), moisture content, total ash and total fat was determined according to the method of AOAC (1990). Carbohydrate was determined by difference Pearson (1976), while Water Activity (Aw) water activity was determined by using water activity meter.

Mineral elements: For mineral determination, the samples were digested in concentrated HNO_3 according to the method of AOAC (1990). The digest was quantitatively transferred to a 25 ml volumetric flask with deionized water and made up to volume with deionized water. A blank digest was carried out in the same way. All minerals were determined using inductively coupled plasma atomic emission spectrometry (ICP-AES) (Varian model-Liberty Series 2) against aqueous standards. The mineral concentration was expressed as mg mineral/100 g oil dry weight.

Seed oil physicochemical analysis: The various analyses were obtained according to the Association of Official Analytical Chemists. Acid value (% FFA) of *Naphelium lappaceum L.* oil was determined according to AOAC Official Method Cd 3a-63. Percentage Free Fatty Acids (FFAs) were calculated using lauric acid as factor. Iodine value and saponification value of kernel oil were determined according to AOAC Official Method 993.20,1997 and 920.160,199 respectively. Solid Fat Content (SFC) was determined by NMR was based on direct ratio measurement between the solid and liquid parts of the sample observed in the NMR FID.

Fatty acids composition by gas chromatography mass spectrometry (GC-FID): The fatty acid composition was determined by GC-Flame Ionization Detection (FID). Methyl esters were obtained by hydrolysing the triglycerides of the oils with hexane-methanol for the fatty acid methylation process. This fatty acid analysis using GC 14A gas chromatography (Shimadzu; Kyoto, Japan) equipped with a Flame Ionization Detector (FID). Nitrogen was used as the carrier gas and the total gas flow rate was 1.3 kg/cm^2. The oven temperature was initially set at 30°C for 1 min. This temperature was then increased to 160°C at 15°C/min and later to 200°C at 2°C/min. It was held isothermally for 5 min at 250°C. Overall running time was 45 min. Fatty acid compositions calculated were based on the percentage peak area of the GC chromatogram. All analyses were performed in duplicates and average values were reported.

Triacylglycerols composition: The Triacylglycerols (TAGs) profile was obtained by a reverse phase high performance liquid chromatography (HPLC) (Perkin Elmer Series 200, USA). The chromatogram was carried out using Agilent Technology Chemstation software. The TAGs were separated using a commercially packed Hypersil ODS column (125 mm x 4 mm) with a particle size of 3 μm and were eluted from the column with a mixture of acetonitrile/acetone (65/35) at a flow rate of 0.5 ml/min; the TAG was detected with a refractive index detector. Ten microliter of 0.05 g oil diluted in 1 ml (acetonitrile/acetone 65/35, v/v) was injected into the HPLC. The total run time was 45 min.

All samples were prepared in triplicate. The means and standard deviation of three determinations of each parameter were calculated.

RESULTS AND DISCUSSION

Result related to physicochemical properties and nutrient content of *Naphelium lappaceum L.* seed and its oil are shown in Table 1. The seed of *Nephelium lappaceum L.* contained a high of crude fat which places this seed as a potential source of seed oil. They contained 38.9% fat compared to the Nzikou *et al.* (2006) which is sunflower oil (32%) and palm kernel oil (36%) Implying that rambutan seed oil (*Nephelium lappaceum L.*) has a potential for fat/oil contributor which is may have alternative uses in industry and for human consumption.

The seed of rambutan (*Nephelium lappaceum L.*). Contained 12.4% crude protein, relative high carbohydrate content 48.1% and low moisture 3.31%. They are very good source of plant protein and carbohydrate compared to the *Irvingia gabonensis*, 16.7% reported by Onimawo *et al.* (2000) watermelon seed 4.83% and pumpkin seed 4.43% as well reported by El-Adawy and Taha (2001) By this finding, further research on application of rambutan as a source of protein and carbohydrate can be considered, especially in food application. Meanwhile, the content of ash and water activity value was 2.26% and 0.7, respectively.

Physicochemical properties of rambutan (*Nephelium lappaceum L.*) seed oil are listed in Table 1. Saponification value and free fatty acid of this oil was 157.07 and 0.37 respectively. The iodine value, which

Table 1: Physicochemical properties and nutrient content of rambutan (*Naphelium lappaceum* L.) seed and seed oil

Analysis	Result*
Oil content (%)	38.90±0.32
Proteins (%)	12.40±0.22
Carbohydrate (%)	48.10±0.65
Ash (%)	2.26±0.42
Moisture (%)	3.31±0.43
Water activity	0.73±0.001
Saponification Value (SV)	157.07±3.70
Iodine Value (IV)	37.64±0.59
Free Fatty Acid (FFA)	0.37±0.16

*Values are means±standard deviations of triplicate determination

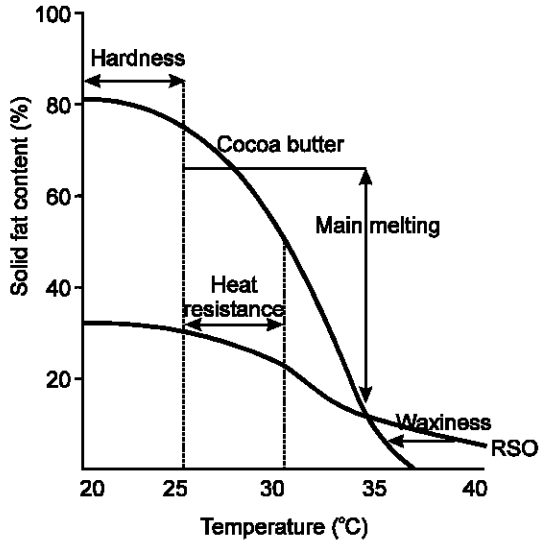

Fig. 1: Solid fat content of rambutan kernel oil and cocoa butter from Matos *et al.* (2009) depending on the temperature. ROS = Rambutan Seed Oil

indicate the unsaturated fatty acid 37.64 and was lower than the value (47.0 I_2/100 g) from previous work by Julio *et al.* (2010). Based on data given, seed oil from rambutan have a wide potential in food application as a raw material for food based on fatty product.

Solid fat content in rambutan seed oil was determined by using NMR. From the Fig. 1 we can described that Solid Fat Content (SFC) in rambutan seed oil was 30.92% for 0°C and 4.18% for 37°C (room temperature).

Table 2: Mineral content of rambutan (*Nephellium lappaceum* L.) seed oil

Mineral	Contents[a] (µg/gram)	DRI[b] (mg/day) IOM (2001)
Mg	51.01±1.80	320,420
Mn	1.62±0.30	1.8
Ni	0.24±0.001	ND
Cu	0.83±0.04	0.90
Zn	40.61±0.70	8
Ca	160.31±7.90	1000
Fe	24.77±4.10	18

[a]values are means±standard deviation of triplicate determination. [b]Dietary Reference Intakes (DRI), sumber Institute of Medicine (IOM) tahun, 2001. ND = Not Determined

The profiling of hardness, main melting and waxiness of rambutan kernel fat was compared with solid fat content of cocoa butter from Matos *et al.* (2009). The curve show that rambutan seed oil have small amount of solid fat content compare to the cocoa butter.

Table 2 shows some of the mineral contents in rambutan seed oil (*Nephelium lappaceum L.*). It was rich in calcium and magnesium with contents of 160.31 and 51.01 mg/100 g, respectively. Concentration of chromium, manganese, nikel, copper, zinc and iron were 0.55, 1.62, 0.24, 0.83, 40.61 and 24.77 mg/100 gram, respectively. These result revealed that the seed oil provide most of mineral for human requirements based on the Dietary Reference Index (DRI) standard from Institute of Medicine (2001).

Fatty acid composition of rambutan seed oil is presented in Table 3. Two main fatty acids, oleic and arachidic, add up to almost 80%; present also are palmitic, palmitoleic, stearic, gondoic and behenic acids. However, from the point of view Oleic acid (40.45%) was the major acid and the result from this work higher compare to the others corresponding data reported in the table from Augustin and Chua (1998) Julio *et al.* (2010) and Kheiri and Mohd (1987). Conducts to the previous study about seed oil; numerous studies have shown that intake of olive oil can reduce blood pressure. It was reported by Teres *et al.* (2008) and Zhen-Cheng *et al.* (2010) that oleic acid content was responsible for the reduction of fat in blood pressure induced by olive oil Therefore, the *Nepphelium lappaceum L.* studied here may be a good source of the oil especially oleic acid.

Table 3: Fatty acid composition of *Nephellium lappaceum L.* seed oil

				Percentage (%)		
Fatty acid	Formula	Structure	This work[a]	Augustin and Chua (1998)	Kheiri and Mohd (1987)	Julio *et al.* (2010)
Palmitic	$C_{16}H_{32}O_2$	16:0	5.149	4.36-04.86	4.30	6.1
Palmitoleic	$C_{16}H_{30}O_2$	16:1	1.230	ND	0.38	1.5
Stearic	$C_{18}H_{36}O_2$	18:0	2.310	5.93-07.49	10.34	7.1
Oleic	$C_{18}H_{34}O_2$	18:1	40.450	37.91-40.15	35.83	40.3
Arachidic	$C_{20}H_{40}O_2$	20:0	36.361	36.14-36.77	41.04	34.5
Gondoic	$C_{20}H_{38}O_2$	20:1	4.920	6.92-07.27	3.63	6.3
Behenic	$C_{22}H_{44}O_2$	22:0	2.438	ND	2.24	2.9

[a]Values are means of triplicate determination. ND = Not Determined

Table 4: Triglicerides composition of *Nephellium lappaceum L.* seed oil

Triglicerides	Retention time	Composition (%)
OOO	28.55	1.426
ALnO	29.98	3.035
ALO	34.23	0.976
ALP	36.51	6.327
ALnS	38.36	1.486
AOO	44.19	49.840
AOP	46.46	12.822
ASO	52.79	15.058
ASP	56.30	9.030

O, Oleic acid; A, Arachidic acid; Ln, Linolenic acid; L, Linoleic acid; P, Palmitic acid; S, Stearic acid; OOO, Trioleoylglycerol; AlnO, Arachydoyl - Linolenoyl - Oleoylglycerol; ALO, Arachydoyl - Linoleoyl - Oleoylglycerol; ALP, Arachydoyl - Linoleoyl - Palmitoylglycerol; ALnS, Arachydoyl - Linolenoyl - Steareoylglycerol; AOO, Arachidoyl - Dioleoylglycerol; AOP, Arachydoyl - Oleoyl - Palmitoglycerol; ASO, Arachidoyl - Steareoyl - Oleoylglycerol; ASP, Arachydoyl - Steareoyl - Palmitoylglycerol

The tryacylglycerol composition of *Nepphelium lappaceum L.* showed that the majority of TAGs are in tri and di-unsaturated form was identified (Table 4). Considering the fatty acid composition; the major constituent was Arachidoyl-dioleoylglycerol (AOO) followed by Arachidoyl-Steareoyl-Oleoylglycerol (ASO) and Arachydoyl-Oleoyl-Palmitoglycerol (AOP) with percentage 49.84%, 15.08% and 12.82% respectively. The other TAGs was occurred with percentage below than 10% with composition trioleoylglycerol (OOO), Arachydoyl-Linolenoyl-Oleoylglycerol (ALnO), Arachydoyl-Linoleoyl-Oleoylglycerol (ALO), Arachydoyl-Linoleoyl-Palmitoylglycerol (ALP), Arachydoyl-Linolenoyl-Steareoylglycerol (ALnS) and Arachydoyl-Steareoyl-Palmitoylglycerol (ASP) with percentage 1.42%, 3.03%, 0.97%, 6.32%, 1.48% and 9.03% respectively. Good agreement between the fatty acid and triacylglycerol compositions was also found.

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