ASM Sc. J., 13, Special Issue 6, 2020 for InCOMR2019, 14-22

Physicochemical Properties of Cocoa Butter and Rambutan Seed Fat at Different Roasting Temperature

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Rambutan (*Nephelium lappaceum*) is a tropical fruit in Malaysia and a part of Sapindaceae family. Rambutan seeds are a major waste in canning industry, but has the potential to replace a more expensive cocoa butter for product manufacturing. This study aims to identify the optimum roasting temperature to produce a high yield of rambutan seed fat (RSF). The RSF was compared with the cocoa butter (CB). This physicochemical properties of RSF and CB was characterised based on the Acid Value (AV), Water Activity (a_w), melting point, Total Carotene Content (TCC), colour (L*,a* and b*), Refractive Index (RI), Peroxide Value (PV) and Saponification Value (SV). Rambutan seeds and cocoa beans were roasted at five different temperature which were 125°C, 135°C, 145°C, 155°C and 165°C for 30 minutes. The shells of the beans or seeds were removed and ground to fine powder and then extracted using soxhlet extraction method. The highest yield of RSF (39%) and CB (49%) was recorded at a roasting temperature of 135°C and 155°C, respectively. For roasting performed at 135°C, the analysis of the AV, RI, TCC, SV and colour properties contributed a significant result ($P<0.05$) between the RSF and CB. While for a_w, melting point and PV no significant differences were obtained. For 155°C of roasting temperature, the AV, melting point, TCC, RI, PV and SP parameters shown a significant result ($P<0.05$) on both the CB and RSF. Water activity and colour had no pronounce effect towards the roasted product. This research provides essential preliminary information on general characteristic of CB and RSF for future application in the food and cosmetics manufacturing.

Keywords: cocoa; cocoa butter; rambutan; rambutan seed fat

I. INTRODUCTION

Rambutan (*Nephelium lappaceum*) is a part of the Sapindaceae family and is well-known as one of the tropical fruits in Malaysia. Rambutan contains white flesh covered by a hairy red-coloured or yellow-orange-coloured skin and light brown seed. The fruits have high content of sugars, organic acid and Vitamin C (Chai *et al.*, 2018). About 80% of the total world production of rambutan comes from Thailand, Malaysia and Indonesia. While the fruit is consumed freshly, the flesh of the fruit is widely used for making jellies, juice and jams (Hajar *et al.*, 2017).

Cocoa beans yield about 50-55% of the cocoa butter (CB) which it is mainly used for food processing, cosmetic, pharmaceutical and chemical industries because of its physicochemical properties (Mounjouenpou *et al.*, 2018). Up to 98% of total fatty acids can be found in the CB, in which consisting of oleic acid (37%), stearic acid (33.6%), palmitic acid (24.4%) and linoleic acid (3.4%). CB is also rich in saturated and monounsaturated fatty acids which are responsible for variety in melting points. However, the

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great demand of CB by the industry has causes their costs to be continuously increasing (Jahurul *et al.*, 2014).

Rambutan seeds have high potential to replace the CB as the seeds contain a relatively high amount of edible fat (Lourith *et al.*, 2016). According to Febrianto *et al.* (2016), about 94,500 tonnes/year waste from rambutan seeds from Malaysia, Indonesia and Thailand were produced and underutilised. According to Issara *et al.* (2014), rambutan can produce a high amount of edible fat between 17% and 39%. Previous studies also reported that the main fatty acids contents for rambutan seeds are oleic acid (40.3%) and arachidic acid (34.5%). Besides that, rambutan seed fat (RSF) also contained palmitic acid (6.1%), stearic acid (7.1%), gondoic acid (6.3%), behenic acid (2.9%) and palmitoleic acid (1.5%).Furthermore, CB does not contain as many triglycerides as RSF , hence the later material is more suitable for candle and chocolate manufacturing (Khairy *et al.*, 2016).

The roasting process has a pronounce impact to the physicochemical properties of food material. According to Chai *et al* (2018), roasting process is required to help loosen the shell that covered the bean/ seed while improving the flavour of cocoa bean. Application of high temperature helps cocoa beans to produce aromatic smell. Besides, roasting can reduce the water content, volatile acids and tannin compounds (Krysiak, 2011). Chemical changes usually occur in the nib at temperature 120°C and 135°C. According to Mounjouenpou *et al* (2018), the best pair of temperature and duration to roast cocoa beans were 120°C/ 57 min and 140°C/40 min with extraction yield about 25%. Hence, in order to demonstrate the capabilities of RSF as an alternative material to replace CB, the effect of roasting temperature shall be investigated. The objectives of this study are to determine the optimum roasting temperature in order to get a high yield of RSF and CB; and to determine the physicochemical properties based on the optimum roasting temperature.

II. MATERIALS AND METHOD

A. Raw materials

Cocoa beans were purchased from Koperasi Pengusaha Koko Bukit Kerayong, Kapar, Selangor while rambutan fruits were obtained at local market in Kuala Pilah, Negeri Sembilan, Malaysia. The rambutan fruits' skin were peeled and the flesh were removed. The seeds were washed and wrapped with aluminium foil before stored at -20°C for further experiments. Figure 1 shows the flowchart for preparation of raw materials and analysis of physicochemical properties conducted in this study.

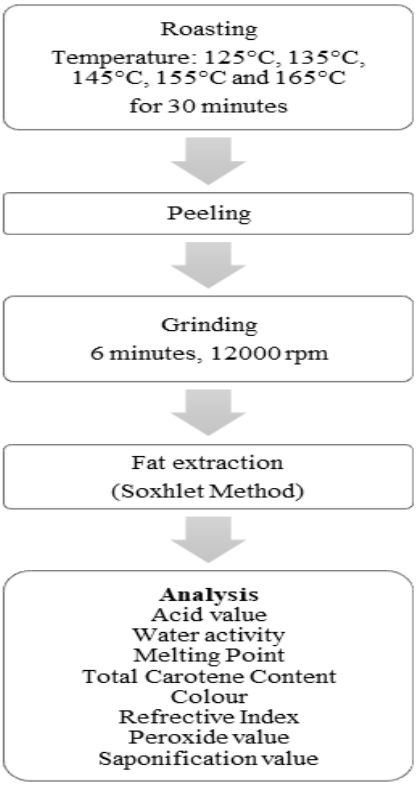

Figure 1. Flowchart for preparation of raw materials and physicochemical analysis of RSF and CB

1. Preparation of Rambutan Seed Fat and Cocoa Butter

The rambutan seeds and cocoa beans were roasted at different temperature which are 125°C, 135°C, 145°C, 155°C and 165°C. After roasted, the shells of the rambutan seeds and cocoa beans were removed and then they were ground to a fine powder. The rambutan seeds and cocoa bean powder were then weighed exactly 5 g into an extraction thimble. Cotton was put loosely in the thimble and the thimble then placed into a Soxhlet extractor. After that, about 150 mL of petroleum ether was filled in the dried bottom flask after the flask has been weighed and all the apparatus were connected to the condenser. The extraction started and performed for 8 hours on an electrothermal extraction unit after the tap water was connected and run. The boiling point of petroleum ether was set at 50°C. After the extraction was completed, the flask containing petroleum ether was then evaporated using boiling water bath and then the flask was put in the oven for 1 hour at

105°C to dry the extract. Then, the flask was cooled in the desiccator before it was weighed. Duplicate extractions were performed and the percentage of fat in rambutan seeds and cocoa beans were achieved by using the formula below (Romano et al., 2014):

$$\% \text{ Fat in sample} = \frac{\text{weight of fat in sample (g)}}{\text{weight of sample (g)}} \times 100$$

Weight of fat in sample = (weight of flask + fat) – weight of flask

B. Physicochemical Analysis

1. Determination of Acid Value (AV)

First, about 25 mL of diethyl ether and 25 mL of ethanol were mixed in the in a conical flask. About 1 g of oil was dissolved in the solution followed by the addition of 1 mL of Phenolphthalein indicator. The solution was then neutralized with 0.1M NaOH until the pink colour persists for at least 30 seconds. Acid Value (AV) can be defined as the number of milligrams of Potassium Hydroxide that needed to neutralize the free fatty acids in 1 gram of sample (Williams, 1966). It can be obtained by using the formula below:

Acid value = (56.1 × Titre (mL) × Normality of NaOH) / Weight of sample (g)

2. Determination of Water Activity (a_w)

For determination of water activity, AQUA-LAB water activity was used. Water activity (a_w) is the ratio of the partial pressure of water in the atmosphere in equilibrium with the substrate to that of the atmosphere equilibrium with pure water at the same temperature. The scale for a_w is from 0 to 1 where 1 is the a_w for pure water (Man, 2008).

3. Determination of Melting Point

Cocoa butter (CB) and Rambutan seed fat (RSF) was filled into a capillary tube by 1 cm capacity. The capillary tube then was cooled at temperature -4°C for 2 hours. The thermometer was hanged in the middle of the beaker with the capillary tube containing RSF attached and tied to the thermometer. The tube then was submerged in 700 ml of water in position the top end of the fat is 1 cm below the water level. The water was heated at 100°C for 1 minute. When the fat starts to slip out of the tube the initial temperature was recorded, and the final temperature was taken when all the fat has slipped out. The temperature obtained is referred as the melting point.

4. Determination of Total Carotene Content (TCC)

Cocoa butter (CB) and Rambutan seed fat (RSF) carotene content was analysed by Ultraviolet-Visible (UV-Vis) spectrophotometer at 446nm using MPOB Test Methods which a Compendium of Test[s] on palm oil products, palm kernel products, fatty acid, food related products and others. The cocoa butter (CB) and rambutan seed fat (RSF) was weighed accurately to 0.1g and then homogenized in the 25ml with n-hexane using volumetric flask that diluted to the mark. The solution was transferred into a 1cm quart cuvette and the absorbance was measured at 446nm against n-hexane. The carotene content of RSF is defined and calculated as β-carotene in parts per million (ppm). The calculation was as follows:

Carotenoids content = [V × 383 × (As-Ab]/(100×W)

Where:

V = The volume used for analysis
383 = the extinction coefficient for carotenoids
As= The absorbance of the sample
Ab = The cuvette error
W = The weight of the sample in g

5. Determination of Colour

|The CB and RSF was utilised visually and instrumentally by use of a Minolta chromameter. The instrumental data were corrected for zero-time and unmediated site readings. In addition, Euclidean distances were calculated using all data generated by the chromameter.

6. Determination of Refractive Index (RI)

The determination of refractive index was carried out using a refractometer and a sodium vapour lamp. A 3-4 drops of distilled water was placed using a syringe on the main prism surface and the secondary prism was covered. The

thermometer scale was set at 20°C and the refractometer was set at 1.3330 (Brix 0%). While looking through the eyepiece, the roller below scope rod was used. All the colour spectrum was removed to yield a black and yellow colour. The separation of yellow-black colour was aligned correctly into the centre of X (above is yellow, below is black). To measure the RI, the secondary prism was opened, and 3-4 drops of sample was placed on main prism and the secondary prism was closed with caution. Solid-TC was selected to get result in % brix.

7. Determination of Peroxide Value (PV)

A 1 g of the liquid oil sample was weighed and added into a clean dry boiling tube. While sample is still in a liquid, 1 g of potassium iodide powder and 20 mL of solvent mixture consisting of 2 volumes of glacial acetic acid and 1 volume of chloroform were added. The mixture in boiling tube was placed in boiling water bath to boil the liquid vigorously for 30 seconds. After that, the whole content was poured immediately into a conical flask containing 20 mL of 5% potassium iodide solution. The boiling tube was then rinsed twice with 25 mL of distilled water and poured back into the conical flask. The mixture was titrated with 0.002 M of sodium thiosulphate using 3 drops of 1% starch solution as an indicator until yellow colour of the reactant was disappeared. At the same time, a blank titration determination was also carried out. The calculation was as follows: (Kaleem et al., 2015).

Peroxide value = (Vs -Vb)/weight of sample x T x 103

Where;

T = Molarity of sodium thiosulphate
Vs = Volume in ml titration for sample
Vb = Volume of ml titration for blank

8. Determination of Saponification Value (SV)

A 1 g of oil and 15 mL of ethanoic potassium hydroxide was mixed in flaks attached to a reflux condenser. The sample was heated on a water bath for 1 hour with occasional shaking in order to dissolve the sample. After it was cooled, the addition of 1 mL of 1% phenolphthalein indicator was done followed by titration with a 0.5M hydrochloric acid until the endpoint was reached which resulted in a light pink colour developed. A blank determination was also carried out as control.

The SV can be obtained by using the formula below (MPOB Test Method, 2004):

$$\text{Saponification Value} = \frac{(b - a) \times M \times 56.1}{\text{Sample weight (g)}}$$

Where;

a = sample titre value,
b = blank titre value,
M = molarity of the HCl,
56.1 = molecular weight of KOH

9.Statistical Analysis

The results obtained were reported as mean of triplicate determination ± standard deviation. The statistical analysis was performed using T-Test ANOVA and Statistical Package and Social Sciences (SPSS) version 15.0 software. Statistically significant differences were considered at the level of $p < 0.05$.

III. RESULT AND DISCUSSION

Table 1 shows the percentage yield fat of rambutan seeds and cocoa beans which were roasted at different temperature. As stated in introduction, the range of temperature was selected based on the previous study by Mounjouenpou *et al* (2018). Other research also showed that the crucial factor on yields is temperature (Chandra *et al.*, 2009). According to Table 1, the percentage yield fat of rambutan seeds at different roasting temperature give no significant difference. The rambutan seeds roasted at 135°C gave the highest yield. An increase in temperature from (125°C to 145°C) has led to an increase of oil yield. At temperature 155°C and above, the yield of rambutan seeds was decreased.

Table 2 that shows the percentage fat yield of cocoa beans at different roasting temperature also showed no significant differences. However, the yield percentage of cocoa beans roasted at 155°C was the highest but decreased when reached 165°C. This occurrence might be due to oil decomposition at high temperature (Pinelo *et al.*, 2005). During the rise of roasting temperature, the rate of weight loss was increases because of volatile compound being released, thus, the activation yield will decrease (Nzikou *et al.*, 2006). According to Wei *et al* (2009), softening of plant tissue and increase the solubility of RSF and CB were

observed at high temperatures and pressures. The rate of diffusion will improve, thus gave a higher rate of extraction (Ping *et al*, 2012).

Table 1. Percentage Yield Fat of Rambutan Seed and Cocoa Bean

Temperature (°C)	Yield (%)	
	Rambutan Seeds	Cocoa Beans
125	36.8090±0.6381[a]	47.3960±2.5012[A]
135	38.8910±2.1637[a]	47.6015±2.5067[A]
145	38.1630±3.1155[a]	48.5050±6.4474[A]
155	37.2170±0.0410[a]	49.2220±6.5563[A]
165	38.4590±2.1421[a]	46.0310±2.2203[A]

Note: value expressed as mean obtained from three replications.
The lower-case superscript letter indicates significant different ($p<0.05$) for rambutan seeds yield at different roasting temperature.
The upper-case superscript letter indicates significant different ($p<0.05$) for cocoa beans yield at different roasting temperature.

Table 2: Physicochemical analysis of RSF and CB at 135°C and 155°C roasting temperature

Analysis	**135 °C**		**155 °C**	
	Cocoa Butter (CB)	**Rambutan Seed Fat(RSF)**	**Cocoa Butter (CB)**	**Rambutan Seed Fat(RSF)**
AV (mg KOH/g)	2.8017± 0.0024[b]	6.2959± 0.3545[a]	2.0435± 0.8634[B]	57.0538± 0.5496[A]
Water activity	0.4512± 0.0804[a]	0.3889± 0.1136[a]	0.4722± 0.1436[A]	0.4045± 0.1119[A]
Melting point (°C)	39±0.00-40±0.00[a]	46±0.00-50±0.00[a]	29±0.00 - 30±0.00[B]	44±0.00-47±0.00[A]
RI	1.4629± 0.0002[b]	1.4648± 0.0001[a]	1.4628± 0.0002[B]	1.4721± 0.0064[A]
TCC (mg/kg)	0.0422± 0.0028[b]	0.1001± 0.0250[a]	0.0757± 0.00[B]	0.0967± 0.00[A]
PV (g/g)	7.6672± 0.3049[a]	8.0176± 1.3925[a]	12.4144± 0.5290[A]	5.4053± 0.7247[B]
SV (mg KOH/g)	158.3890 ± 11.8520[a]	124.9098± 12.4223[b]	201.1185 ± 12.7835[A]	139.3150± 8.5694[B]

Note: value expressed as mean obtained from three replications.
The lower-case superscript letter indicates significant different ($p<0.05$) of RSF and CB for each analysis at 135°C
The upper-case superscript letter indicates significant different ($p<0.05$) of RSF and CB for each analysis at 155°C

Roasting is one of the conventional methods for condiment oils production, enhance the nutrients available and alter the inactivity of enzymes. The desired flavours and colours could be produced from roasted seeds, so that the appropriate oil can be promoted (Lee *et al*., 2004). Phenolic contents and oil antioxidant activities are also affected by roasting (Chandrasekara & Shahidi, 2011). However, the roasting could cause unpleasant changes in flavouring and formation of toxic compounds (acrylamide content) (Mazaheri *et al*., 2018). Therefore, the RSF and CB that were produced at 135°C and 155°C roasting temperature, respectively, were further analysed for its physicochemical characteristics.

A. Determination of Acid Value (AV)

Acid value (AV) is the number of potassium hydroxide needed for neutralisation, whereas free fatty acid (FFA) utilizes sodium hydroxide for neutralisation. During each stage of fats and oil processing, FFA is an important fat quality indicator. It is a parameter of the efficiency of deodorizer and a tool of process control for other processes. (O'Brien, 2009). AV for RSF at 135°C and 155°C were 6.2959±0.3545mg KOH/g and 57.0538 ±0.5496mg KOH/g, respectively. From the results shown, the AV of RSF between the temperature at 135°C and 155°C was significantly different. Lourith *et al* (2016) obtained AV of RSF was 4.35±0.00 mg KOH/g. However, AV for cocoa beans at 135°C was 2.8017±0.0024 and at the temperature 155°C consisting of 2.0435±0.8634. It seemed that the result for AV of cocoa beans between 135°C and 155°C was significantly different. Jahurul *et al* (2018) reported that the acid values of cocoa butter ranging from 2.1 to 2.7%. High FFA indicate a poor deodorizer vacuum, inadequate steam sparging, or air leaks if the product colour is high with an oxidized oil flavour. As the increase of AV, the rancidity also increases. The deodorized oil FFA level that has become standard in the United States is 0.05% maximum, but most interval standards require a 0.03% maximum (O'Brien, 2009). According to Luma Khairy *et al* (2017), high acid value was obtained in RSF sample (13.66 ± 0.23), while a low acid value was obtained in CB sample (4.68 ±1.29). As a result, it can be explained that the highest of acid value in RSF compared to CB is due to the proportion of monounsaturated fatty acids (MUFA) in RSF was (42.46%) significantly higher than in CB (22.44%).

B. Determination of Water Activity (a_w)

According to Man (2008), water activity (a_w) is the scale of the partial pressure of water in the atmosphere in equilibrium with the substrate to the atmosphere

equilibrium of pure water at the similar temperature. The value of a_w is ranging from 0 to 1 where 1 is the a_w for pure water. Based on the results obtained, for 135°C roasting temperature, the water activity for RSF was 0.3889±0.1136 while CB was 0.4512±0.0804 which also indicate that the a_w were not significantly different. As well for 155°C roasting temperature, the water activity of RSF was 0.4045±0.1119 and CB 0.4722±0.1436 which also not significantly different. Fluids can hold any amount of water. Saturation point is referred to when the highest amount of water for fluid can contain in a solution. Any water that is added will separate as free water once it reaches the saturation point by forming a distinct layer with water below oil since water is denser than oil (Vaisala, 2009). RSF and CB both have low water activity which are below than 0.70 indicated that it is difficult for microorganisms to grow (Sandulachi, 2012).

C. Determination of Melting Point

Melting point is the temperature where solid materials turns to liquid form. Melting point for 135°C roasting temperature, RSF melting point was 46±0.00-50±0.00 while for CB was 39±0.00-40±0.00a. Then, for 155°C roasting temperature, RSF melting point was 44±0.00-47±0.00 and for CB was 29±0.00-30±0.00. All the melting point from these 4 samples showed that all the samples were significantly different. Both RSF resulted higher melting point than CB. High melting point showed that it contains higher saturated fatty acids. RSF have higher crystal stability rather than CB where reported by Ghotra *et al.,* (2002), RSF hasβand β'crystalline form with the percentage 15.30%. Besides, CB does not contain many triglycerides like RSF. Therefore, the melting point of both RSF from both different roasting temperatures are higher than CB which it is very useful in chocolate manufacture (Issara *et al*., 2014).

D. Determination of Total Carotene Content (TCC)

TCC is known for its wide distribution, structural diversity and functionalities (B. Rorguez Amaya *et al.*, 2004). Many studies have been conducted regarding to β-carotene antioxidants including carotenoids as they are able to prevent chronic disease. Compound in carotenoids or another compound that associated with antioxidants such as Vitamin A which it has ability to increase the activity against free radicals. According to data in Table 2, it was found that the CB from 135° C has 0.0422±0.0028 mg/kg of TCC, while RSF has 0.1001±0.0250 mg/kg. However, for 155°C CB it has 0.0757±0.00 mg/kg and 135°C RSF contain 0.0967±0.00 mg/kg of total carotene content (Table 2). This result showed that the carotene content in the sample might be influenced by the oxidation and thermal process including those experience during storage (Sarmidi, 2011).

E. Determination of Colour

Table 3. Colour of RSF and CB at 135⁰C and 155°C roasting temperature

	135°C		155°C	
	RSF	**CB**	**RSF**	**CB**
L*	37.95± 0.00^{a}	30.12± 0.00^{b}	35.78± 0.00^{A}	27.54± 0.00^{B}
a*	1.90± 0.00 ^{a}	0.83± 0.00 ^{b}	1.63± 0.00^{A}	1.45± 0.00 ^{B}
b*	1.80± 0.00^{b}	3.45± 0.00 ^{a}	9.33± 0.00 ^{A}	5.06± 0.00 ^{B}

Note: value expressed as mean obtained from three replications.
The lower-case superscript letter indicates significant different ($p<0.05$) of RSF and CB for L*, a* and b* value at 135°C
The upper-case superscript letter indicates significant different ($p<0.05$) of RSF and CB for L*, a* and b* value at 155°C

The relationship between the colour values as L*, a*, b* and roasting temperature were presented in Table 3. The L* represents lightness, a* for green to red value and b* represents value for blue to yellow. The measuring head alignment contact pressure and positioning over the reading site is depended to the operator. The operator was responsible for any interlaboratory variety of chromameter results. Therefore, before chromameter is utilized in this way, a validation procedure should be performed to ensure the reliability of results in any bioequivalence study (Schwarb *et al*.,1999).

The findings describing the RSF chromameter analysis showed significant difference. For product roasted at 135°C, the lightness value of RSF is higher than CB. Similar trend was observed on the redness; while for blueness, the RSF value is lower than CB. This indicated that the RSF have the yellow-red-light in colour as compared to the CB as confirmed by naked-eye observation. For roasting temperature at 155°C, the lightness value, redness and blueness of RSF was higher than the CB. The colour of RSF was defined as slightly yellow-red-light in colour as compared to CB.

F. Determination of Refractive Index (RI)

Refractive index is a physical quantity of certain medium where its value indicates the speed of light in the medium. For 135°C roasting temperature, RSF refractive index was recorded as 1.4648±0.0001 and for CB, the refractive index was 1.4629±0.0002. Significant differences also shown in 155°C roasting temperature where refractive index for RSF and CB was 1.4721±0.0064 and 1.4628±0.0002, respectively. The higher the refractive index, the longer the chain of fatty acids in the triacylglycerides (TAG) or the higher the degree of saturation. Low refractive index from CB might be due to the average molecular weight of fatty acid obtained as since CB was known to commonly contain less TAG than RSF (Karim *et al*., 2016). Therefore, the refractive index of the RSF from both different roasting temperatures are higher than CB.

G. Determination of Peroxide Value (PV)

The peroxide value is a parameter specifically to the content of oxygen as peroxide, especially hydro peroxides in a substance. PV can indicate the presence of oxidation process in fat or oil. It also can measure the quality of oil or fat which was influenced by the percentage of unsaturated fatty acid. Detection of peroxide value act as the initial evidence the rancidity of the unsaturated oil or fat. As the peroxide value become higher, the rancidity will also be increased.

Rancid oil can produce dangerous free radicals in human body which can cause cellular damage and associated with diabetes, Alzheimer etc. Rancid oils can also cause digestive distress and deplete the body of vitamins B and E. Their chemical edible is comprised of saturated and unsaturated fatty acids and glycerides (Okparanta *et al.*, 2018). When the fat or oil exposed to the high temperature, it will be forming unpleasant flavour and odour due to deterioration of the oil or fat. Based on the result, the peroxide value for 135°C CB and RSF was 7.6672±0.304 g/g and 8.0176±1.3925 g/g, respectively. However, for CB and RSF roasted at 155°C the value was 12.4144±0.5290g/g and 5.4053±0.7247 g/g, respectively. The PV recorded was closely related to the standard value of 10 meq/kg. It has been previously reported that, the PV for RSF was 1.0 g/g (Lourith *et al.,* 2016). This result showed the PV was significantly different for CB roasted at higher temperature. It might be caused by the contamination of moisture, bacteria and enzymes, light, heat, air and certain metals in the sample during analysis. To slow down the development of the rancidity to the vegetable fat or oil, an antioxidant such as vitamin C or E can be added as preservatives.

H. Determination of Saponification Value (SV)

In fats and oils, saponification value (SV) is a measure of alkali-reactive group. It is used to predict the type of glycerides in a sample. The short-chain fatty acids contain in glycerides have higher saponification values than longer chain fatty acids (O'Brien, 2009). The SV of RSF roasted at 135°C was 124.9098±12.4223 mg KOH/g while those roasted at 155°C produced 139.3150±8.5694 mg KOH/g. These values were comparable to those reported by Kheiri *et al* (1987) obtained SV ranging from 157-190mg KOH/g. On the other hand, Harahap *et al.,* (2011) and Solis-Fuentes et al (2010) found that the SV of RSF was 157.0713mg KOH/g and 186.14 mg KOH/g respectively. Meanwhile, the SV of CB for 135°C roasting temperature recorded a 158.3890±11.8520 mg KOH/g and for roasting temperature, 155°C a 201.1185±12.7835 mg KOH/g was obtained. The SV of CB was 194.4 mg KOH/g which was similar to the SV of RSF (Chaiseri *et al*., 1989). Meanwhile, Jahurul *et al* (2018) reported that the SV for CB could be in the range of 195.7-195.9 mg KOH/g. From the results shown, the SV between RSF and CB has significant difference for both temperature of 135°C and 155°C.

IV. CONCLUSION

This study provides preliminary knowledge on the common physicochemical properties of CB and RSF for potential application in the food and beverages and cosmetics manufacturing. The optimum roasting temperature to produce a high yield of RSF was recorded at 135°C, and at 155°C for CB. Some physicochemical properties (e.g. AV, RI, TCC, SV) of RSF and CB based on their optimum roasting temperature showed some significant differences ($p<0.05$). Hence, roasting temperature may play a great role in altering the physico-chemical properties of RSF and also the more commonly used CB. More studies need to be carried out to determine the suitability of RSF as a cost-effective alternative material for CB.

V. ACKNOWLEDGEMENTS

We would like to express our deep gratitude to Mr. Azman Tharim and Ms. Nor Shamsina Daud, lab assistant of Food Technology laboratory, Universiti Teknologi MARA, Negeri Sembilan Branch, Kuala Pilah Campus for their help in preparing laboratory resources and assistance in keeping our progress on schedule.

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