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MiniReview

Rambutan seed fat as a potential source of cocoa butter substitute in confectionary product

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Abstract

This review of literature provides an overview on the compositional data of Rambutan (*Nephelium lappaceum* Linn.) and rambutan seed fat for usage in chocolate product. It is a seasonal fruit native of west Malaysia and Sumatra. It is harvested when the fruit have reached optimum visual and organoleptic quality. Rambutans rapidly deteriorate unless proper handling techniques are employed. The rambutan fruits are deseeded during processing and these seeds (~ 4-9 g/100 g) are a waste by-product of the canning industry. And some studies was showed that rambutan seed possesses a relatively high amount of fat and these fats are similar to those of cocoa fat, although have some different physical properties. In the present research about rambutan seed fat continued increasing due to from previous research was found that this fat can use as substitute in cocoa butter for chocolate products. Therefore, the extracted fat from rambutan seed not only could be used for manufacturing candles, soaps, and fuels, but it also has a possible to be a source of natural edible fat with feasible industry use.

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Introduction

Cocoa butter (CB) is an important component in chocolate production. Triglycerides (triacylglycerols) are the main component present in cocoa butter, oils and fats. Moreover, cocoa butter is the only continuous fat phase in chocolate products (Lannes *et al*., 2003). Nowadays; the cocoa price is increasing continuously day by day. Therefore, researchers have been efforts to find other fats to replace cocoa butter in chocolate manufacturing for many reasons such economic and technological (Dewettinck and Depypere, 2011). In addition, from previous study found that rambutan fats (RF) are similar of cocoa fat, although in some physical properties in rambutan fat shown different. So, the rambutan fats can be usually used in the sweets products. The lipid food group is refers from the word of “fat”, and it is including used to mean both fats and oils. The ‘invisible’ fat; i.e. un-separate oil and fats in foods such as grains, nuts, dairy products, eggs, and meat etc. are the normal fat that our intake around more than 50% (FAO, 1977). Moreover, oilseeds such as sesame seed, soy bean, cotton seed and oil are a source of normally fat and oil obtained (Gutcho, 1979; Birker and Padley, 1987; O’Brien, 1998). Fats and lipids are key composition in food, cosmetics, and pharmaceuticals etc., as main bodies of end products, or as matrices in which cosmetic and pharmacological fine chemicals are dispersed (Gunstone and Padley, 1997). In general, the vegetable and animal fats and oils are natural fats and lipids resources which contain various molecular species having different some chemical and physical properties. Fats and oils are alike in both made up of fatty acid molecules. Because of these fatty acids differ in their molecular structure, so their behavior during processing will show in different also (Ghotra *et al*., 2002). According to Sato (2001) shown that fats and lipids crystallization behavior have two major significances in industrial: 1) process of end products made of fat crystals, such as chocolate, margarine, shortening, and whipping cream, etc., and 2) the separation of specific fats and lipids materials from natural resources. The physical, chemical and nutritional properties of fats and oils are limiting factors for their usage in industry sectors. Thus, obtaining nutritionally products in the food industry will highly depend on the physical and/or chemical characteristics of the fat and oil formulations (Bertoli *et al*., 1995; Solís-Fuentes *et al*., 2004). In addition, in the food manufacture, physical and chemical characteristics, thermal behavior and phase changes

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are the particularly important factors (Bertoli *et al*., 1995; O'Brien, 1998).

Chocolate is a complex suspension containing around 70% of solid particles from sugar and cocoa, in a continuous fat phase. It is a solid state at room temperature (~25°C), and on the other hand, it can melts at oral temperature (~37°C) to generating a smooth suspension of solid particles in cocoa butter (Fernandes *et al*., 2013). There are different types of chocolate (dark, milk and white), according to their composition in terms of milk fat and cocoa butter, therefore it resulting to the final products have different compositions of carbohydrate, fat and protein (Beckett, 2000). Amount of fat around 25-35% is contained in the most chocolate product, although ice-cream coatings are much higher and some special products like cooking chocolate are lower in fat (Zzaman and Yang, 2013). However, actually the level of fat present will depend on the process being used and this affects the texture of the finished chocolate products. So, high-quality tablet of chocolate is probably to have a higher fat content and a lower particle size than a chocolate that is used to coat a biscuit making (Beckett, 2000; Afoakwa *et al.*, 2007). Afoakwa *et al.* (2008) described that during chocolate processing; a high quality of product is obtaining from composition and the crystallization of cocoa butter play an important role. The crystalline state and the proportion of solid fat are important in determining the melting character in finished products during chocolate manufacturing. Differential scanning calorimetry (DSC) is used to characterize changes in chocolate melting profiles and investigate the relative amounts of each crystallization state (Tabouret, 1987; Ziegleder and Schwingshandl, 1998; Walter and Cornillon, 2001, 2002) and peaks corresponding to latent heat, which it is observed the temperature ranges related to melting point of specific polymorphs in the chocolate products (McFarlane, 1999).

Efforts to understand for need of consumer during the development of food products is very vital in companies preferences including their perception of sensory and non-sensory characteristics of foods to assure product that can distribute and success in the market (Moskowitz and Hartmann, 2008; Tuorila and Monteleone, 2009). The sensory evaluation by consumers, their overall liking through their perception of food products and many of research have shown that the sensory properties of food are the most important factors in food choice of consumer (Torres-Moreno *et al*., 2012). Many research has been shown that, nowadays, non-sensory attributes is affect to consumer likes and food selection such as brand, price or nutritional knowledge, which all of them is information acquired about the product, attitudes and beliefs (such as convenience or health properties) or past experiences from many customer (Sheperd *et al*., 1991; Jaeger, 2006; Costell *et al*., 2010).

Background of rambutan seed

The rambutan, (*Nephelium lappaceum* Linn), is a fruit considered exotic to people outside of its native range. To people of Malaysia, Thailand, Phillippines, Vietnam, Borneo, and other countries of this region, the rambutan is a relatively common fruit the same way as an apple is common to many people in cooler climates (Zee, 1993; Morton, 1987). This may change for the rambutan over time as availability and distribution. Rambutan is adapted to warm tropical climates, around 22 – 30°C, and is sensitive to temperatures below 10°C. The tree grows well on heights up to 500 metres (1,600 ft) above sea-level and does best in deep soil; clay loam or sandy loam rich in organic matter Morton (1987). The aril is attached to the seed in some commercial cultivars, but "freestone" cultivars are available and in high demand. There is usually a single light brown seed, which is high in certain fats and oils (primarily oleic acid and arachidic acid) valuable to industry, and used in cooking and the manufacture of soap. A rambutan root bark, and leaves have various uses in medicine and in the production of dyes. In some areas rambutan trees can bear fruit twice annually, once in late fall and early winter with a shorter season in late spring and early summer. In other areas like Costa Rica there is a single fruit season, with the start of the rainy season in April stimulating flowering and the fruit is usually ripe in August and September. In Thailand, rambutan trees were first planted in Surat Thani in 1926 by the Chinese Malay K. Vong in Ban Na San. An annual rambutan fair is held during August harvest time (Morton, 1987).

Harvest maturity

Rambutan is classification in non-climacteric fruit and it will not continue to ripen once removed from the tree. Hence, this fruit must be harvested when they have reached an optimal eating quality and visual appearance (O'Hare, 1995). Wanichkul and Kosiyachinda (1982) have reported that during time between 16 and 28 days after colour-break, this fruit can acceptable appearance. Although the pulp may be acceptable outside of this period, the fruit is often unmarketable due to the poor colour of the skin. However, the rambutan is generally harvested on the basis of its skin colour, flavour should also be at an optimum (Watson *et al*., 1988). Red cultivars

Table 1. Summarize the nutritional value of rambutan seed (*Nephelium lappaceum* L.)

Composition	Quantity
Fat	0.68%
Protein	0.91%
Nitrogen	0.14%
Ash	0.33%
Calcium	9.58 mg/100 g
Iron	0.34 mg/100 g
Magnesium	12.3 mg/100 g
Manganese	1.06 mg/100 g
Potassium	84.1 mg/100 g
Sodium	20.8 mg/100 g
Zinc	0.17 mg/100 g
Phosphorus	16.6 mg/100 g
pH	4.66
Vitamin A	< 40 IU/100 g
Vitamin C	59.4 mg/100 g
SUGAR PROFILE	
Fructose	2.9 %
Glucose	2.9 %
Sucrose	11.4 %
Maltose	< 0.1 %
Lactose	< 0.1%
TOTAL SUGARS	17.2 %
Riboflavin	0.050 mg/100 g
Thiamin	< 0.010 mg/100 g
Fiber	0.05%

Table 2. Main fatty acids in rambutan (*Nephelium lappaceum* Linn.) seed fat

Fatty acid	Average (%)
Palmitic	6.1
Palmitoleic	1.5
Stearic	7.1
Oleic	40.3
Arachidic	34.5
Gondoic	6.3
Behenic	2.9
Non-identify	1.2
SFA	50.7
MUFA	48.1

*SFA- saturated fatty acids; MUFA- monounsaturated fatty acids.

do not necessary reach similar of total soluble solids (TSS) at the same level of colour. As the fruit ripens on the tree as a result the TSS value will increases but the titratable acidity (TA) value is decrease (O'Hare, 1995). On the other hand, fruits harvested too early will have more acidic and lack sweetness while fruits harvested too late can be tender. Generally, depending on cultivar, fruit have a TSS and TA concentration in the range of 17-21% and 0.7-5.5%, respectively, at harvestable maturity (Kosiyachinda *et al*., 1987).

Nutritional analysis of rambutan seed

Some study according to Morton (1987), reported that have to study the rambutan seed that grow in some area which the following information pertains specifically to the rambutan grown in Puerto Rico. Other regions of the world where this fruit is grown have differences in soils, climate, fertilizer, irrigation water and rain chemistry, humidity, wind and the amount and intensity of sunlight which may have a significant impact on the nutritional values in the rambutan seed which resulting to these nutritional values may not be the same outside of Puerto Rico. For that matter, even within Puerto Rico, there are so many microclimates, soil types and pH variations, these results may be viewed only as an example of the nutritional profile of just one of the island's rambutan fruit growers. And then there is the seasonal variation from one crop to the next. The test results included herein were from a particularly sweet crop and there should be some variability of these values each season (Morton, 1987). Generally, the vitamin content and minerals was found on from study analysis which should help people with concerns about the nutritional value of the rambutan. The nutritional value of rambutan seed is shown in Table 1. The nutritional value of rambutan fat grows in various areas that may slightly difference the amount of the value to each other.

Antioxidant and antibacterial activities

Plants contain a large variety of substances possessing antioxidant activity including natural antioxidant compound such as polyphenols, carotene, tocopherol, vitamin C, vitamin E, xanthophylls and tannins (Madhavi *et al*., 1996; Ramirez-Tortosa *et al*., 1999; Thitilertdecha *et al*., 2008; Febrianto *et al*., 2012) and fruit/vegetable that have specific bioactive compounds had concern much attention due to health benefit effect (Febrianto *et al*., 2012). Moreover, these compounds are able to protect the oxidative damage in human body's cell and tissue. The phenolics compound can be found in all parts of the plant for sources of natural antioxidants (Chanwitheesuk *et al*., 2005). According to Thitilertdecha *et al*. (2008) noted that rambutan (*Nephelium lappaceum* Linn.) peel and seed parts were conducted extracts to obtain the antioxidant and antibacterial activities, and more potential activities were found in the peel extracts more than the seed extracts by used methanol solvent for extraction of antioxidant and antibacterial substances which the best solvent for extract when compare with other solvents. It is as a result to providing high extraction yields and also strong antioxidant and antibacterial activities. The natural antioxidant in lipid-containing product and lipid-based product such as oil, fat, margarine, butter, etc. are considered insufficient and/or had been removed on the purification process because it is considered as impurities which would adversely affect in subsequent use (Febrianto *et al*., 2012). In addition, study the effect of fermentation time and roasting process in the rambutan seed fat by Febrianto *et al.* (2012), found that they can improve the antioxidant activity and total phenolics compound of rambutan seed fat. Higher antioxidant activity which is resulted from fermentation process could be enhanced further by applying roasting process also. However, the appropriate fermentation process should not longer than 6 days which resulting to efficiently increase the total phenolic compounds of rambutan seed fat.

Rambutan seed fat

Native in Southeast Asia, rambutan (*Nephelium lappaceum* Linn.) belongs to the same family (*Sapindaceae*) as the sub-tropical fruits lychee and longan (Marisa, 2006). Rambutan is a seasonal fruit native of west Malaysia and Sumatra. It is cultivated widely in Southeast Asian countries. For commercial crop in Asia, This fruit is important. Normally this fruit is consumed fresh, canned, or processed, and appreciated for its refreshing flavour and exotic. The rambutan fruits are deseeded during processing and these seeds (~ 4-9 g/100 g) are a waste by-product of the canning industry (Tindall, 1994). Some studies had reported that rambutan seed possesses a relatively high amount of fat with values between 14 g/100 g and 41 g/100 g. (Sirisompong *et al*., 2011). And other information on the seed had showed that rambutan possesses a relatively high amount of fat between 17% and 39% (Morton, 1987; Zee, 1993). Furthermore, due to the demand of human consumption was increase continued for propose in industry. Therefore, the extracted fat from rambutan seed not only could be used for manufacturing candles, soaps, and fuels, but it also has a possible to be a source of natural edible fat with feasible manufacturing use (Solís-Fuentes *et al*., 2010).

Chemical composition of rambutan seed

Generally, fat and oil will contain the main component are triglycerides which each of fat/oil will show different the fatty acid composition for each other. Some research was analyzed the fatty acid in rambutan seed fat which according to Solís-Fuentes *et al.* (2010), the main fatty acid composition in rambutan seed fat was shown in the Table 2. Two main fatty acids, oleic and arachidic, add up to almost 75%; present also are palmitic, stearic, gondoic, palmitoleic, and behenic acids. Around 50% of the fatty acids in rambutan seed fat are saturated, including a high percentage of arachidic acid, a fatty acid with a long chain and a resulting to high melting point. However, the % weight and proximal analysis in the rambutan seed also was investigated and important information which both of them. Table

Table 3. Weight and percentage of the constituent portions of rambutan fruit

Portion of the fruit	Weight (g)	%
Whole fruit	27.4	100
Rind	13.2	45.7
Pulp	11.7	44.8
Seed	2.53	9.5
Embryo	1.60	6.1

Table 4. Amino acid composition of rambutan seeds as compared to the FAO Reference Protein

Amino acid	Rambutan seed (% recoveries)	FAO references protein
Essential		
Isoleucine	3.29-3.34	4.2
Leucine	5.48-5.78	4.8
Lysine	5.07-7.13	4.2
Methionine	1.35-1.63	2.2
Phenylalanine	2.49-3.32	2.8
Tryptophan	b	1.4
Valine	4.21-5.11	4.2
Histidine	1.29-1.68	-
Non-essential		
Alanine	4.65-4.83	
Arginine	4.63-5.75	
Aspartic acid	7.24-9.80	
Cysteine	1.45-1.82	
Glumatic acid	10.85-14.95	
Glycine	8.51-9.92	
Proline	1.96-2.93	
Serine	4.44-5.56	
Threonine	3.59-5.41	
Tyrosine	2.58-3.29	

3 was summarized the percentages in weight of the anatomical parts of the rambutan fruit (*Nephelium lappaceum* Linn.). The almond-like decorticated seed weights, in average, 6.1% of the whole fruit. In addition, the proximal analysis of the rambutan seed was investigated. Augustin and Chua (1988) reported that the seeds contained 34.1-34.6% of moisture. The ash, protein, fat (petroleum ether extract) and crude fibre contents of the seeds on a dry weight basis were found to be 2.6-2.9%, 11.914.1%, 37.1-38.9% and 2.8-6.6% respectively. Rambutan seeds have a low protein content in comparison to winged bean seeds which contained 29.3-39.0% protein (Kantha and Erdman 1984), a comparable protein content to that of corn kernels which contain 10.1% protein (EI Alally *et al.*, 1969) and a high protein content compared to plam kernel and mango seed kernel which contain 8.3% (Tang and Teoh, 1985) and 6.1-6.8% protein, respectively (Augustin and Ling, 1987). Amino acid composition in the rambutan seed protein is shown in Table 4.

Physical properties of rambutan seed

Fats containing highly saturated or long chain

Table 5. Classification of fats and oils according to crystal habit

Beta type	Beta-prime type	Alpha type
Soybean	Cottonseed	Acetoglycerides
Safflower	Palm	
Sunflower	Tallow	
Sesame	Herring	
Peanut	Menhaden	
Corn	Whale	
Canbra	Rapeseed	
Olive	Milk fat (butter)	
Coconut	Modified lard	
Palm	kernel Sardine	
Lard		
Cocoa-butter		

fatty acids which commonly have a higher melting point than unsaturated or short chain fatty acids. Unsaturated fatty acids have different isomeric forms that have different melting points. They naturally expose in the cis-form, but can be converted to the trans-form during partial hydrogenation processing (Dziezak, 1989). Crystalline forms in which fats may exist categorized as alpha, beta and beta-prime. Weiss (1983) classified a number of fats according to their crystallizing nature shown in Table 5. Due to have a reported that rambutan seed fat have some physical properties such as characteristic of melting in the room temperature like a cocoa butter, but it was found that cocoa butter have a temperature range of melting point and crystallization occur narrow than rambutan seed fat. Beside, cocoa butter does not contain many triglycerides and majority composed as plamito oleosterin (Pérez-Martinez *et al*., 2007). According to Ghotra *et al.* (2002), and Mcclements and Decker (2007) reported that rambutam seed have crystalline form β and β' in the amounts of 84.70 and 15.30%, respectively. It was shown that the rambutan seed fat had a crystal stability. In general the crystallization of rambutan seed fat is usually analyzed by using differential scanning calorimetry (DSC). According to Solís-Fuentes *et al.* (2010) described the crystallization curve and melting cure of rambutan seed fat. The melting point of rambutan seed fat also observed by the last peak of heating curve (~ 45^{o}C) showed higher than the cocoa butter which normally useful in the chocolate manufacture.

Solid fat content of rambutan seed

Solid fat content (SFC) is a significantly indicator of hardness. The lowest of SFC in fats almost used in the chocolate industry resulting in the softer texture of the products, because of chocolate made with softer fat containing low crystals less than with a hard fat. The SFC profile was affected to relative tendency of chocolate hardness, which it also resulting in the pure fat system is value consideration. The solids profile of rambutan seed fat was affected in the amount of solid fat content by temperature. Rambutan seed fat is softer than cocoa butter at low temperatures and has a harder consistency at higher temperatures. This behavior is probably due to the composition difference (Solís-Fuentes *et al.*, 2004). So, rambutan fat would be useful in filled chocolate manufacture as a softer filling fat compatible with cocoa butter (Lannes *et al*., 2003).

Conclusion

The physical properties and sensory and consumer perception are important factors influencing in the confectionary products. Although rambutan seed fat are similar to those of cocoa butter and can use to substitute cocoa butter in chocolate, the use of rambutan seed fat in food and other industry branches will need to be approved by regulatory authorities in each country. However, for the effort the alternative to fine other fat to substitute cocoa butter in chocolate product is highly consider, which resulting to the final product quality. Further studies require integration of texture and aroma profile in rambutan seed fat and do the sensory evaluation for study consumer acceptance in the chocolate product that produce by rambutan seed fat.

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