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Investigation of rambutan sugar granule production process and its sensory quality

Kannikar Charoensuk[1]*, Tongjaun Vipatjarernlap[1] and Priyaporn Anartngam[2]

[1]Department of Product Development and Management Technology, Faculty of Agro-Industrial Technology, Rajamangala University of Technology Tawan-ok, Chanthaburi campus, Thailand
[2]Department of Applied Science and Biotechnology, Faculty of Agro-Industrial Technology, Rajamangala University of Technology Tawan-ok, Chanthaburi campus, Thailand

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Rambutan (*N. lappaceum* Linn.) is originated in the Malayan archipelago, which includes Indonesia, Malaysia and Southern Thailand. The fruit is relatively rich in sugar, vitamin and mineral contents. In order to develop rambutan sugar granule, firstly, the juice was separated from the aril (edible portion) through the screw press conveyer. The obtained juice had the soluble solid and pH level of 18.5±0.5 °Brix and 4-5, respectively. The honey like rambutan syrup was made by dehydrated the rambutan juice in the open saucepan at 90-100 °C, which was until the soluble solid content reached 65-70 °Brix, then, granulation of rambutan syrup was performed by the addition of 0.5-1 kg of the fine granules sucrose as seed per 1 kg of rambutan juice at 70 °C. Sucrose seeding could induce rambutan sugar granule formation. Drying process of rambutan sugar granule was done in the oven at 50°C for 24 h. The moisture content and water activity (*Aw*) of the rambutan sugar was 2.35-4.45 %w/w and 0.53-0.65, respectively. Sugar contents of rambutan sugar also have been analyzed, which revealed that it contained fructose: glucose and sucrose of 6.6: 3.7: 85.7%w/w, respectively. The color of rambutan sugar was yellow-brown with its light (L*), redness (a*) and yellow (b*) value of 77.69, 2.33 and 17.28, respectively. Consumer rated this product to very much like as similar as whole cane sugar (7.28-7.55 from 9- point Hedonic scale), and, significantly higher than sucrose. Since, the price of fresh rambutan approximated 20 baht (0.8 USD) per 1 kg, thus the fix cost of 1 kg of rambutan sugar would be in the range of 130-230 baht (4-6.5USD), which depended on the amount of seed granule.

Keywords: rambutan sugar, rambutan syrup, sugar granule

Introduction

Rambutan (*N. lappaceum* Linn.) is originated in the Malayan archipelago, which includes Indonesia, Malaysia and Southern Thailand (Indian Institute of

***Corresponding author**: Kannikar Charoensuk, **email:** cc_kannikar@hotmail.com

Horticultural Research, 2012). The fruit forms in clusters; each fruit has a seed surrounded by an aril which is covered by the pericarp and spinterns (1-1.5 cm long). The fruit is relatively rich in sugar, vitamin and mineral contents; a minimum soluble solid content of 16 °Brix may be determined, and may reach the level as high as 17 to 21 °Brix which depending on cultivars (Kadar, 2013; Landrigan *et al*., 1998). Attainment of red color is the main harvest index. The postharvest factors can diminish the appearance and flavor of the fruit with severely limited shelf life after 2-3 days at 40°C and 40 % RH. Loss of appearance is largely due to spintern drying, although color loss can also contribute to the fruit's decline (O' Hare, 1992). As the result, the price of rambutan can fluctuate depending on the time taken between harvesting and selling to the consumers. Therefore, the rambutan sugar granule development could thus be considered as an alternative to elevate the fruit price.

Sugar generalized name for sweet, many of which are use in food, and, there are various types of sugar derived from different sources such as sugarcane, beet root, maple and plam.

Rambutan juice of 17 % w/w of soluble sugar content which was compared to sugarcane juice of 12-16 % w/w (Dillewijn, 1952). The method for manufacturing sugar granules with a large particle at the core was referred to as seeded granulation (Rahmanian *et al*., 2011). Simple open sourcepan technology

Materials and Methods

Materials

Rambutan (*N. lappaceum* Linn.) cv. Rongrien was purchased from Panksang Market, Chanthaburi Province. Sucrose was a commercial grade and purchased from commercial source**.**

Rambutan juice and syrup preparation

Fresh rambutan, which was stored at 10 - 15 °C, was washed twice with water, peel and remove the seed out, soak its aril with 0.1 % w/v citric acid (the stage must be itemized). Screw press conveyer (Zhengzhou Shuliy Machinery Co., Ltd, Model No. 0086 15093262873, China) was used for crushing fresh rambutan, then fresh juice was obtained. Then weighted, and dehydrated in the open saucepan at 90 - 100 °C until its soluble solid content of 65$\pm$2 °Brix was reached, and rambutan syrup was obtained.

Rambutan sugar granule formation

Immediately, sucrose seed was added to the syrup, and temperature was kept at 70 °C. The experiment was carried out by using completely randomized design including 3 treatments each with 3 replications. The ratio of sucrose/fresh juice of Treatment 1, 2 and 3 was 0:1, 0.5:1 and 1: 1, respectively. Rambutan sugar granule formation was invastigated. Allowed drying process of rambutan sugar granule was in the oven at 50°C for 24 h or until its moisture content of 6 % (w/w) was reached.

Physio-chemical characteristics of rambutan juice and sugar

The yield of the fresh juice was calculated after extraction of the juice and expressed in percentage. The total soluble solids (TSS) of juices were determined with the help of hand refractometer and expressed as °Brix (Ranganna, 1986). The moisture and water activity (*Aw*) of rambutan sugar was estimated using an automatic infrared moisture analyzer (Satorius MA 45) at 105 ± 2°C and Aw meter (Novasina), respectively. Sugar (fructose, glucose, and sucrose) levels were measured according to the HPLC method of (AOAC 2012: 982.14). Briftly, rambutan sugar granule was dissolved with 100 mL of acetonitrile/water (1:1, v/v), and after filtering through Whatman No. 541 filter paper, filtrate was refiltered through a 0.45 μm filter and injected (10 μL) into an 802C Monometric module HPLC system (Gilson, Villiers, France) fitted with an ACS 750/14 mass detector (ACS, Cheshire, U.K.) and an S5 amino column, 250 mm x 4.6 mm i.d. (Phase Separation Ltd., Queensferry, U.K.). Fructose, glucose, and sucrose were quantified on the basis of peak areas and comparison with a calibration curve obtained with the corresponding standards. Color was measured using color meter)NIPPON ZE 2000/ Munsell), giving values expressed on the Lightness (L*), redness (a*) and yellow (b*), tristimulus scale (AOAC, 2000).

Sensory quality of rambutan sugar

Sensory evaluation was conducted in the Rajamangala University of technology Tawan-ok, Chanthaburi campus. Rambutan sugar was evaluated for sensory qualities on the basis of colour (appearance), aroma, taste, texture and overall acceptability by a panel of 10 judges on a 9 - point Hedonic scale anchored from "1 – disliked extremely" to "9 – liked extremely" (Amerine et al., 1965), compared to sucrose and whole cane sugar as reference ideal sweetness were carried out in booths. Sixty-five regular consumers of rambutan

sugar aged between 18 and 55 years, 75% female, were recruited by means of social network announcements. Samples were served in balanced presentation.The data pertaining to physico-chemical characteristics and sensory qualities of rambutan sugar was analyzed statistically by following complete randomized design (Cochran and Cox1967; Mahony MO (1985).

Statistical analysis

Data obtained were analysed using SPSS for Windows. Significance of differences between control and treated samples was evaluated using Duncan's multiple range tests at the 5% level.

Results and Discussion

Rambutan juice and syrup preparation

The rambutan juice with its TTS content of 18 °Brix was separated from the aril portion by screw press conveyer, its yield was obtained 20% of fresh rambutan, and, it was slightly acidic with it corresponding pH value of 4.5. The rambutan syrup was concentrated by boiling process of the fresh juice in open saucepan at 90-100 °C. Finally, TTS of syrup was 65±2 °Brix as shown in table 1. This simple technique may performe suitable for the small and household industry.

Table 1. Physio-chemical of rambutan juice and ryrup

Sample	Content		Color		
	pH	TTS (°Brix)	L*	a*	b*
Fresh juice	4-5	18.5±0.5	12.25 ±0.3	3.95±0.5	3.60±0.2
Syrup	4-5	65±5	77.69±1.0	2.33±0.5	17.08±0.7

Rambutan sugar granule formation

The sugar granule formation had invatigated which related to the ratio of sucrose seed, treatment 2 and 3 had gave yellow-brown sugar, however, only treatment 3 gave cracked and separated sugar granule (Fig. 1(b) and (c)), while treatment 1 (without sucrose seed) gave no such sugar granule formation Fig. 1 (a). Sugar granules of all treatment were also observed their appearance and

granule size under microscope (Olympus, Model BH2) at 4x magnification as shown in Fig. 1 (d), (e) and (f). As the result, seed granules play the function as the core for granule formation; the yellow-brown color which was covered surrounding the granule seeds is rambutan syrup. Seed granule from sucrose in treatment 3 (Fig. 1(e)) exhibited same particularly size while the treatments 2 showed the different particles size which may have the effect to their appearances, it seem also the amount of seed granule may effect to rambutan sugar granule formation as found in cane and beet root sugar (Martins *et al*., 2009). Their Physio-chemical properties as shown in table 2. Treatment 3 had been chosen for futher experiments.

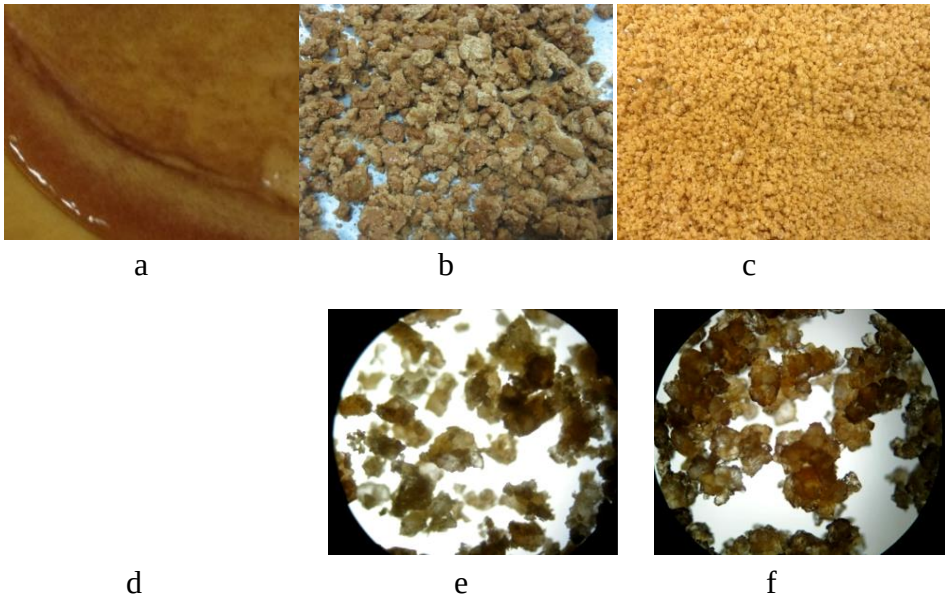

Fig. 1 Sugar granule formation and its corresponding observation of their appearances under microscope at 4 x magnification. (a, d) Treatment 1; without sucrose seed nuclei (b, e) Treatment 2; sucrose seed nucleoid: fresh juice (0.5:1) and (c, f) Treastment 3; sucrose seed nucleoid: fresh juice (1:1).

Table 2. Physio-chemical of rambutan sugar granule

Treatments	**Description**	**Content**		**Color**		
		Moisture (%)	***Aw***	**L***	**a***	**b***
Treatment 1 (0:1)	Sludge	30.0	0.87	55.84	2.33	17.08
Treatment 2 (0.5:1)	Sugar granule	4.45	0.65	37.50	5.25	22.27
Treatment 3 (1:1)	Sugar granule	2.34	0.53	77.69	2.33	17.08

Sugar content of rambutan sugar granule

Sugar content of rambutan sugar granule of treatment 3 had analized by HPLC (AOAC 982.14) revealed that it contained fructose, glucose and sucrose of 6.6, 3.7 and 85.7 %w/w, respectively. Interestingly, monosaccharide; fructose and glucose were found in rambutan sugar granule which those absent in table sugar. The amount of monosaccharide presented was about 10% w/w, which fructose was higher than glucose of with their ration of 2:1. This similar ratio was found in honey and stingless bee honey (Doner, 1977), which low in glycemic index (GI) that may be helpful in blood glucose management (Abdulrhman et al., 2011; Abdulrhman et al. 2013). However sucrose was found as the core sugar in rambutan sugar granule.

Sensory quality of rambutan sugar granule

Rambutan sugar granule of treatment 3 was evaluated for sensory qualities on the basis of color (appearance), aroma, taste, texture and overall acceptability by a panel of 10 judges on a 9 - point Hedonic scale, compared to whole cane sugar and sucrose. As the result……shown in table 3

Table 3. Sensory test of rambutan sugar granule

Samples	**Sensory test**				
	Color^{ns}	**Aroma**	**Taste**	**Texture^{ns}**	**Overall Acceptibility**
Rambutan sugar	6.98	7.15^{a}	7.28^{a}	7.28	7.37^{a}
Whole cane sugar	6.51	6.86^{a}	7.40^{a}	7.29	7.48^{a}
Sucrose	6.94	5.97^{b}	6.57^{b}	7.77	6.72^{b}

Cost of rambutan sugar production

Since the rambutan sugar production cost depended on the price of fresh rambutan which average 20 baht (0.7 USD) per 1 kg. As a result, fresh rambutan juice yield separation by screw press conveyer obtained 20% w/w of fresh rambutan. Therefore, 1 kg of rambutan juice separated from 5 kg of fresh rambutan lead it cost was aproximated 100 baht (3 USD). Thus, the fix cost of 1 kg of rambutan sugar of treatement 2 and 3 was 230 baht (6.5USD) and 130 baht (4 USD), respectively, while, treatment 1 was 666 baht (19 USD) Table 4.

Table 4. Cost of rambutan sugar

Treatments		Rambutan juice (kg)	Sucrose		Product weigh (kg)	Total cost (baht)	Cost/1 kg (baht)
			Weight (kg)	Cost (baht)			
Treatment (0: 1)	1	1 (100)*	0	0	0.3	100	666
Treatment (0.5: 1)	2	1 (100)*	0.5	15	0.5	115	230
Treatment (0: 1)	3	1 (100)*	1.0	30	1.0	130	130

Remark: 1) The price of rambutan juice was 100 baht shown in parenthesis (100)*, which calculated from 5 kg of fresh rambutan price.
2) The price of sucrose was 30 baht per kg.
Calculation: cost of rambutan sugar (product) per kg

$$= \frac{\text{cost of provided seed granule + cost of 5 kg rambutan}}{\text{Total weight of rambutan sugar (0.3- 1.0 kg)}}$$

Conclusion

The most common sugar is sucrose a crystalline table top and industrial sweetener used in foods and beverages. We demonstrated herein the rambutan **s**ugar granulation process with the simple open saucepan technology. Rambutan sugar; an alternative sugar, yellow-brown, water soluble compounds which contains monosacccharide; fructose and glucose while absent in table sugar. According to the sensory quality of rambutan sugar which the regular consumer rated this product to very much like as similar as whole cane sugar, and significantly higher than table sugar. Therefore, rambutan sugar may be used in place of table sugar in order to take advantage of its nutrition components and taste. However, its price may be the concerned factor.

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