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Submission date: 07-Feb-2023 05:55PM (UTC+0700)
Submission ID: 2008438147
File name: Green_Betel_Leaf_Extract,_Mangosteen_rind_and_Lime_Solution.pdf (431.54K)
Word count: 5882
Character count: 29335

The Effect of Green Betel Leaf Extract, Mangosteen Rind Extract, and Lime Solution Addition as Natural Preservative on Coconut Sugar Quality

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Abstract

Coconut sap is raw material of coconut sugar that easily damage due to microbial activity. This damage can be prevented by using a natural preservative, called laru. Laru divided into two type, that are natural and synthetic laru. This research was using natural laru that made by mixture of green betel leaf extract, mangosteen rind extract, and lime solution. The aim of this research are to determine the precentage of mixture of green betel extract and mangosteen rind extract toward total natural laru, to determine the amount of addition of natural laru, and to determine the effect of the combination between the percentage of mixture of green betel leaf extract and mangosteen rind extract toward natural laru total by the amount of addition of natural laru which produce the best quality of coconut sugar. This research was used Completely Randomized Design Experimental that consist of 8 treatments combination with three times replications. Factor tested in this research were the precentage of mixture of green betel extract and mangosteen rind extract (1:1) toward total natural laru (v/v) that were 0%; 10%; 30%; and 50%, and the amount of natural laru addition into ± 1 liter sap that were 5 ml and 10 ml. The observed variables were reducing sugar, water content, sucrose, texture, ash content, and total unsoluble solid. The combination of green betel extract and mangosteen rind extract toward total natural laru 30% with 5ml/liter addition of natural laru into sap resulted the best quality of coconut sugar. This coconut sugar has chracteristics of reducing sugar is 4.09% db, total sucrose is 87.5% db, water content is 9.97% wb, texture is 0.12 mm.dt/g, total unsoluble solid is 1.16%, ash content is 2.65% db, brown in colour (score 2.73), sweet in taste (score 2.68), and overall preference was accepted (score 3.07), respectively and quality of the product was met to Indonesian Nasional Standard for coconut sugar.

Keywords: Coconut sugar, coconut sap, green betel, mangosteen rind, liquid natural preservation.

1. INTRODUCTION

Sap is liquid which comes out by cuting palm tree flowers such as arenga, coconut, borasus, and nipha. Coconut sap was easly fermented by microbial activity such as by *Saccharomyces cerevisae* that convert of sucrose to reducing sugars (Goutara and Wijandi, 1980 *in* Marsigit, 2005) and lead to decreased the quality of coconut sugar. To prevent the fermentation occurred, it can be done by adding a preservative (called laru), either synthetic or natural laru.

The synthetic laru that used by farmer (local term: *penderes*) is natrium metabisulfit ($Na_2S_2O_5$). In the othe hand, natural laru that used by *penderes* usually is a mixture of lime solution with mangosteen rind or dried jackfruit wood bark. Other natural materials also have been used to improve the quality of coconut sugar. Marsigit (2005) reported that the castor bean and candlenut seeds can improve the quality of coconut sap and coconut sugar quality in Bengkulu. Yasni *et al*. (1997) reported that the kusambi bark juice can inhibit the sap damage. The other natural ingredients that can be used as preservative is green betel leaf. Asriningtias (2011) and Adisti (2012) reported on their reseach that green betel leaf that mixed with lime can be used as a natural preservative for coconut sap and able to produce good quality of coconut sugar.

The *penderes* generally use natural laru in liquid form. However, the production method, concentration, and the amount of natural laru addition has not been standardized, consequently the quality of coconut sugar was vary even from the same *penderes*. The mixture of green betel leaf extract and mangosteen rind with lime solution is an innovation to be used as a natural preservative coconut sap. The using percentage of natural laru of green betel extract and mangosteen rind extcract with lime solution has not been

standardized. Therefore, research on natural laru formulation with mixing green betel extract and mangosteen rind extract with a lime solution toward the quality of coconut sugar is needed.

The purpose of this study are: 1) to determine the percentage of green betel leaf and mangosteen rind extract toward total natural laru that produce the best quality of coconut sugar, 2) to determine the amount addition of natural laru that produce the best coconut sugar, and 3) to determine the effect of combination treatment between the percentage of green betel leaf and mangosteen rind extract toward total natural laru and the amount addition of natural laru that produce the best quality of coconut sugar.

2. MATERIAL AND METHODS

Materials

Coconut sap, mangosteen rind, jackfruit bark, and lime were purchased from local market in Banyumas regency. All chemical reagents were purchase from Sigma and Merck, except when stated in the text.

Preparation of laru

Mangosteen rind and green betel leaf were dried on cabinet dryer at 60°C, subsequently crushed into small size and extracted with warm water, filtered to get a filtrate. Mangosteen peel extract and green betel leaf extract (1:1 v/v) then mixture with 10% lime solution in the concentration of 0%, 10%, 30%, and 50%, then homogenized.

Production of coconut sugar

5 ml and 10 mL of laru concentration were putted into container sap before taping. After 10-12 hour, the sap then collect, filterred and heated until it solidified. Solidified sugar then evaluate for physical, chemical and sensory characteristic.

Statistical analysis

Randomized Block Design method was used in this research. All physical and chemical parameters were conducted in triplicate. Data was analyzed with F test. Differences were considered significant at $p<0.05$, and if the data show significantly different, then continued with *Duncan's Multiple Range Test,* 5% level. Sensory parameter were analyzed with Friedman test, and if the data show significantly different, then continued with comparative double test, 5% level.

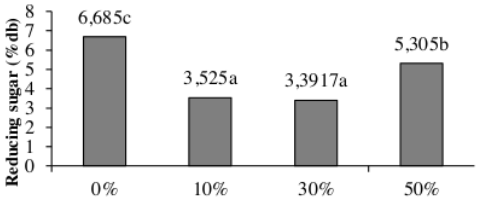
3. RESULTS AND DISCUSSION

a. Reducing Sugar

The average of reducing sugar in the effect of percentage of green betel leaf extract and mangosteen rind extract toward the total natural laru was presented in Figure 1.

The results showed that treatment of lime laru only has high reducing sugar. One of the factor that affect of reducing sugar in the coconut sugar is pH of sap. Data average of sap pH treated by 0%, 10%, 30% and 50%, were 5.33; 7.5; 7.33; and 5.5, respectively. The high of reducing sugar in the treatment 0% laru because of the low pH of coconut sap.

Sap that treated by lime only has a low pH, because lime only was not able to prevent microbial contamination, so the hydrolysis of sucrose was occured that produce sugar reducing and acids. During the hydrolysis of sucrose by yeast, it will produce ethanol and organic acids such as acetic acid, lactic acid, malic acid and tartaric acid and the pH sap was decrease (Safari, 1995).



The percentage of mixture of green betel extract and mangosteen rind extract toward the total laru

Note: Figures followed by the same letter show no significant difference in DMRT 5%

Figure 1. The average of reducing sugar of coconut sugar in the variation concentration of green betel extract and mangosteen rind extract toward the total natural laru.

Treatment of the amount of addition of natural laru 5 mL and 10 mL resulted reducing sugar of coconut sugar were 3.87 (%) and 3.64(%), respectively. The interaction treatment did not significantly affect of reducing sugar in the coconut sugar. This condition might occurred as the affect of pH of sap from each treatment were not significantly different.

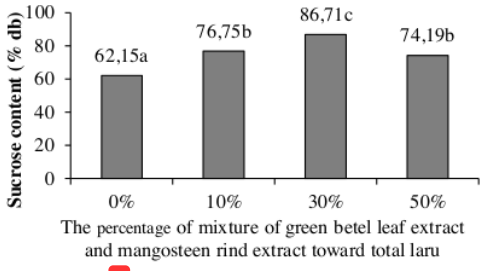
2. Water content

The results of variance analysis showed that the percentage of mixture of green betel leaf extract and mangosteen rind extract on the total natural laru, the amount of addition of natural laru, and the interaction of both treatment gave no significant effect on water content of coconut sugar. The percentage of mixture of green betel leaf extract and extract of mangosteen rind on the total natural laru that were 0%, 10%, 30%, and 50% produced coconut sugar with water content were 11.59%; 12.07%; 10.73%; and 10.91 %, respectively, while the variation of the amount of addition of natural laru 5 mL and 10 mL produced coconut sugar with water content were 11.27% and 11.38%.

Based on these data, there was a tendency of higher percentage of mixture of extracts on total laru and the number of addition of laru produce low of water content of coconut sugar. It was agree when compared to the data of reducing sugar which was lower also. Reducing sugar affects the water content in coconut sugar because sugar reduction will absorb more water than sucrose. Kusnandar (2010) stated that the hygroscopic properties of a reducing sugar caused by the presence of polyhydroxy group capability of hydrogen bonds with water. The water content of palm sugar base on SNI is a maximum of 10%. From the data of the water content, coconut sugar that met to SNI was A3M1 only that is 9.97%.

3. Sucrose content

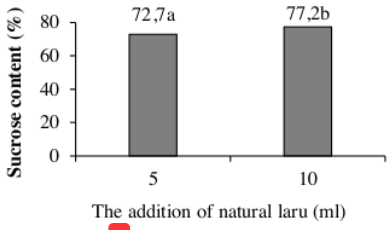
The results of variance analysis showed that the percentage of mixture of green betel extract and mangosteen rind extract toward the total natural laru, the amount of addition of natural laru, and the interaction of both treatment gave significant effect on sucrose level of coconut sugar. Sucrose level obtained from treatment of percentage mixture of green betel extract and extract of mangosteen rind toward the total natural laru are presented in Figure 2.



Note: Figures followed by the same letter show no significant difference in DMRT 5%

Figure 2. The average of sucrose content of coconut sugar in the percentage of green betel extract and mangosteen rind extract toward the total natural laru.

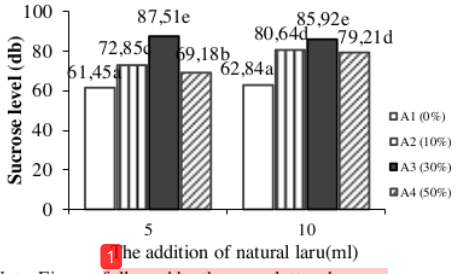
The results showed that the higher of percentage of mixture of green betel extract and extract of mangosteen rind of the total natural laru lead higher amount of the sucrose level. Sucrose levels associated with reducing sugar content and pH of sap. Higher of sucrose indicates that reducing sugar is low. Sucrose data at variation percentage of mixture of green betel extract and mangosteen rind extract toward the total natural laru is related with the pH and reducing sugar. The highest sucrose content of coconut sugar resulted by the teratment of the percentage mixture of green betel extract and extract of mangosteen rind toward total natural laru by 30%. Green betel leaf extract contains kavikol components as the main chemical component of essential oil of green betel leaf that responsible to the distinctive smell of the green betel and antibacterial, that is 5 times stronger than ordinary phenol (Heyne, 1987). According to Walker (2007) in Anastasia (2010), mangosteen rind contains xanthones which already proven used as an antioxidant, anti-inflammatory, antimalarial and antimicrobial. In the other hand, lime will release OH- ions that will bind to the H^+ ions in the sap, thus will reduce the number of H^+ ions that can affect the lower pH of sap, so that microbial growth can be inhibited. Sucrose level obtained from treatment of the amount of addition of natural laru was presented in Figure 3.



Note: Figures followed by the same letter show no significant difference in DMRT 5%

Figure 3. The sucrose level of coconut sugar in different amount of natural laru addition

The results showed that the more number of addition of natural laru in the sap, lead to the higher levels of sucrose. This is beacuse the greater number of additions laru means more amount of lime, green betel extract and extract of mangosteen rind which acts as a preservative, so that damage in sap can be prevented. The sucrose level of coconut sugar on the various interactions of treatment are presented in Figure 4.



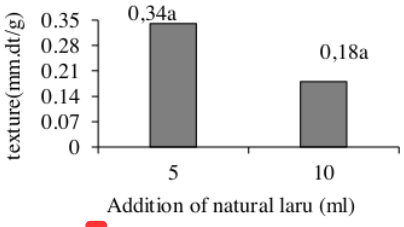
Note: Figures followed by the same letter show no significant difference in DMRT 5%

Figure 4. The sucrose level of coconut sugar at various interaction treatment.

The results showed that the precentage of mixture of green betel leaf extract and mangosteen rind extract with more amount of addition of natural laru, caused more increase levels of sucrose. This caused by more natural laru levels can inhibit the hydrolysis of sucrose in the sap. The treatments resulted high levels of sucrose in coconut sugar was the percentage of mixture of green betel leaf extract and mangosteen rind of the total natural laru by 30% with the addition of 5 mL/L.

4. Texture

Results of variance analysis indicate that the treatment of percentage of mixture of green betel leaf extract and mangosteen rind extract on the total natural laru had no significant effect. While the treatment of amount addition of natural laru and the interaction of both treatment gave significantly effect. Texture measurement of coconut sugar was done by using a penetrometer. The lower score of texture (mm.dtg) showed that the harder texture of coconut sugar. Scores texture of coconut sugar obtained from treatment of mixture precentage of green betel leaf extract and mangosteen rind extract to total laru natural from 0%, 10%, 30%, and 50% were 0.25; 0.27; 0.38; and 0.14 (mm.dt / g), respectively. Texture of coconut sugar is associated with water content. The higher number of water content, so the texture would be not hard. Water content from each treatments was not significcantly different, so the the texture is not significcantly different too. The average score of texture at variation of the amount of addition natural laru showed by Figure 5.

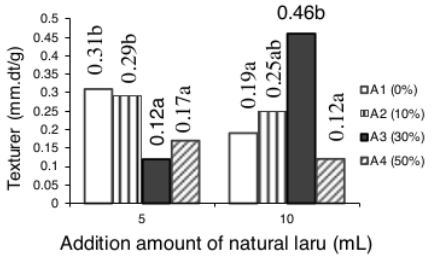


Note: Figures followed by the same letter show no significant difference in DMRT 5%

Figure 3. The average score of texture of coconut sugar at various amount of natural laru addition.

The results showed that coconut sugar with addition of natural laru 10 mL/L sap tend to have a hard texture. This is because in laru addition as much 10 mL/L, lime solution and mixture of extracts percentage was also higher, so can prevent sucrose hydrolysis come reducing sugar in sap. Lower level of reducing sugar causes lower hygroscopic characteristics of coconut sugar. Som the texture of sugar is harder (score of texture is low). Kusnandar (2010) stated that hygroscopic characteristic of reducing sugar caused by polyhidroxy group which able to make bond of hydrogen and water. The Average score of coconut sugar

texture at various treatment combinations showed by Figure 6.



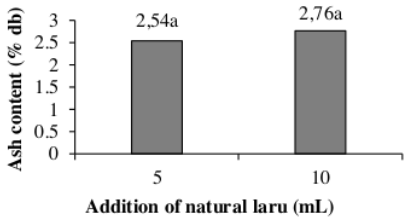
Note: Figures followed by the same letter show no significant difference in DMRT 5%

Figure 6. The Average score of coconut sugar texture at various treatment combinations

The result showed that higher addition amount of natural laru and percentage of mixture of green betel leaf extract and mangosteen rind extract on total natural laru, the texture score of coconut sugar was decrease (harder). The higher addition amount of natural laru and percentage of green betel leaf extract and mangosteen rind extract can help prevention of sucrose hydrolysis in sap, so the formation of reducing sugar can be prevented. The treatment that produce hard texture in coconut sugar is the percentage of mixture of green betel leaf and mangosteen rind extract on total natural laru by 30%, with amount addition 5 mL/L sap and percentage of mixture of green betel leaf extract and mangosteen rind extract on total natural laru by 50% with addition amount 10 mL/L of sap. Both treatment statistically was not significcantly different.

5. Ash Content

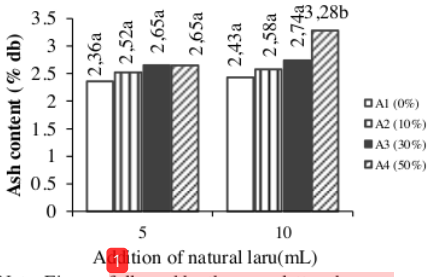
The average score of ash content from treatment percentage of mixture of green betel leaf extract and mangosteen rind extract toward total natural laru 0%, 10%, 30%, 50% were 1,54; 1,61; 1,63; dan 1,82 %, respectively. Those score of ash content was unsignificcantly different at each percentage, allegedly because the number of anorganic substances in natural laru is not different in each percentage. Ash is an inorganic substance waste products of combustion of an organic material (De Man, 1997). The average score of ash content at various addition amount of natural laru showed by Figure 7.



Note: Figures followed by the same letter show no significant difference in DMRT 5%

Figure 7. The ash content of coconut sugar at various addition amount of natural laru.

The results showed that the amount of addition of natural laru as much as 5 and 10 mL/L of sap was not gave significantly different levels of ash after a further test of DMRT at 5% level. However, the data showed that the addition of natural laru additon of 10 mL/L of sap had ash levels which tend to be higher than the number of addition of natural laru 5 mL/L of sap. This is because the more the addition of natural laru means the more amount of lime added to the sap. Lime is one type of macro mineral (inorganic) (Kusnandar, 2010). The average score of ash content on a variety of coconut sugar interaction of treatment are presented in Figure 8.



Note: Figures followed by the same letter show no significant difference in DMRT 5%

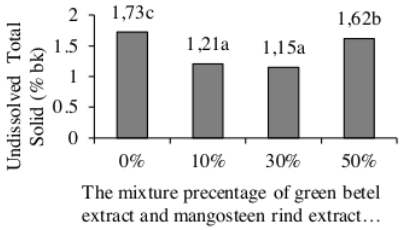
Figure 8. Ash content of coconut sugar at various interaction treatments.

Further test of DMRT 5% gave not significantly different of ash content. But, the data of research showed that more amount of variation of mixture of extracts toward total laru and the addition amount of natural laru tends to give increasing number of ash content.

The highest ash content is coconut sugar that treated by 50% of mixture extracts toward total natural laru and the addition 10 mL/L of laru into sap. The higher amount of ash content is caused by more number of lime and extracts content, so the minerals content in sap is increasing too. Lime, green betel, and mangosteen rind containing minerals that can increase ash level in coconut sugar. Coconut sugar in this research has low ash content and belongs to conditions of SNI-01-3743-1995 that is maximally 2%.

6. Total Undissolved Solid

Result of Variance analysis showed that the percentage mixture of green betel extract and mangosteen rind extract toward total natural laru was significantly different toward total not dissolved solid. The average score of total not dissolved solid at treatments mixture precentage of 0%, 10%, 30%, and 50% toward total natural laru are presented in Figure 9.



The result showed that the highest score of total not dissolved solid is by precentage of extract 0% (laru only consist of lime). The high score of total not dissolved solid at that treatment is might becuase just lime in that components which is lime is not dissolved material in water. Not dissolved materials in coconut sugar also can be as wax, pectins, or chlorophyl which contain in sap (Firmansyah, 1992).

Treatment of addition amount of natural laru and interaction of both treatment was not significcantly different in score of total not dissolved solid. The average score of total not dissolved solid in addition of 5 mL/L of sap and 10 mL/L of sap were 1,38 and 1,46 %db, respectively. While the average score of total not dissolved solid at treatments were 1,57; 1,88; 1,15; 1,26; 1,16; 1,13; 1,65 and 1,5 (% db). The score of total not dissolved solid of coconut sugar in this research was high and were not belonged to SNI of palm sugar.

7. Colours

Result of Friedman test showed that the treatment combination of mixture precentage of green betel leaf extract and mangosteen rind extract toward total natural laru and addition amount of natural laru was significantly different ($\alpha = 5\%$) on color of coconut sugar. The average score of coconut sugar was about 2,2 – 3,44 that has meaning brown – yellowish brown. According to SNI-01-3743-1995, color of coconut sugar are brownish yellow until brown. The obtained coconut sugar color at various treatment combination are presented in Figure 10.

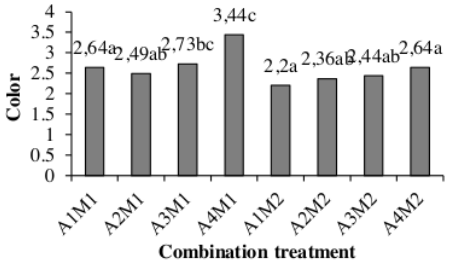


Figure 10. Colour of coconut sugar at various treatment combination.

The result showed that there was increasing of score at the increase of mixture precentage of extract and decreasing of addition amount of natural laru. The high score of color showed that more brownish-yellow, while the lower score of coconut sugar sign that the color is blackish-brown. The highest score of color is owned by A4M1 coconut sugar or coconut sugar with precentage of mixture of green betel extract and mangosteen rind extract toward total laru as much as 50%, with addition amount of natural laru 5 mL/L of sap. One of factor that influencing color of sugar is pH score. In treatment A4M1, pH of sap was 6 which indicates that were not belonged to high level of pH. If sap has too high of pH, so the color of coconut sugar would be blackish-brown. The high score of pH can be caused by excessive addition of lime, because lime is base material. According to Catrien *et al* (2008), Maillard reaction are better occured in base condition.

8. Bitter taste

Aroma and taste of coconut sugar is appear beacuse of caramelisation reaction. So that, the coconut sugar would be produce aroma and taste of caramel. Betel leaf has scent of aromatic and taste are little hot (Tampubolon,

1981). Chavicol as main chemical component at volatile oil is responsible scent and special taste of betel. While, the mangosteen rind contains high amount of tannin, so that it has astringent flavor. Giving natural laru of green betel and extract and mangosteen rind extract is feared to give astringent flavor in coconut sugar, which can cause the consumer doesn't like the sugar.

The result of Friedman test showed that the treatments combination of percentage mixture of green betel leaf extract and mangosteen rind extract toward total natural laru and addition amount of natural laru was not significcantly different toward the bitter taste in coconut sugar. Although the adding of mixture precentage was high, this was not siggnificcantly different on bitter taste in coconut sugar. There are possibilty of compound of green betel extract and mangosteen rind extract which able to give bitter taste is already degradated by high temperature during coconut sugar procecing.

9. Sweet taste

The result of *Friedman* test showed that the treatments combination of percentage mixture of green betel extract and mangosteen rind extract on total natural laru and addition amount of natural laru was not significantly different on the bitter taste in coconut sugar. The average score of sweet taste score was in range 2,6-3,2 (sweet-too sweet). Sweet score was tend to be high at coconut sugar with mixture precentage of green betel extract and mangosteen rind extract toward total natural laru are 0% with the addition amount of natural laru as much as 10 mL/L of sap. Poedjiadi (1994) *in* Adriani (2011) stated that fructose has sweeter taste than glucose, and also sweeter than sugar cane and sucrose.

10. Overall preference

The result of *Friedman* test showed that the combination treatment of mixture of green betel extract and mangosteen rind extract toward total natural laru and the addition amount of natural laru was significantly different (α 5%) on overall preference of coconut sugar. The average score of overall preference score of coconut sugar were in range 2,42 – 3,16 (aceptable). The overall preference score of coconut sugar at various treatment combination are presented in Figure 11.

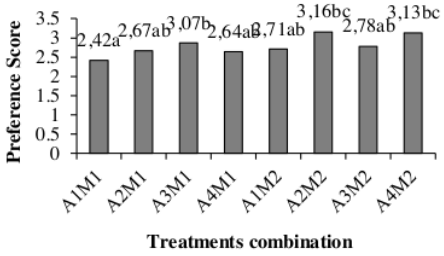


Figure 11. Overall preference score of coconut sugar at various treatment combinations.

The research result showed that the highest overall preference score is owned by A2 coconut sugar that is composed by mixture precentage of green betel and mangosteen rind toward total natural laru as much as 10%, with the addition amount of natural laru 10 ml/litre of sap and 50% with addition amount of natural laru 10 mL/L of sap. Both treatment statistically is not significcantly different, so that the best treatment which more effective and efficient to produce coconut sugar with highest overall preference is A2M2. The high overall preference level of panelist is suitable with sensory characteristics, that are the color is yellowish-brown, no bitter taste, and high sweet taste level.

The mixture of green betel extract and mangosteen rind extract with lime solution was an inovation of natural laru of coconut sap. The precentage and amount of addition of natural laru that has been equated is expected to give information to *penderes* for producing coconut sugar with better quality and appropriate according to SNI 01-3743-1995. Factor that had observed in the research were the precentage of mixture of green betel extract and mangosteen rind extract (1:1) on total natural laru (v/v) that were 10%; 30%; and 50%; and the addition amount of natural laru into ±1L of sap that were 5 mL and 10 mL. The treatments combination of mixture precentage of green betel extract and mangosteen rind extract on total natural laru with the addition amount of natural laru, which has been porduced the best coconut sugar was 30% with 5 mL/L of sap. That sugar compared to standard of SNI 01-3743-1995. The comparison of characteristics of coconut sugar with SNI 01-3743-1995 are presented in Table 1

Table 1. The comparison of characteristics of coconut sugar with SNI 01-3743-1995

Composition	A3M1	SNI
Sucrose (%wb)	86,29	Min. 77
Reducing sugar (%wb)	3,09	Max. 10
Water content (% wb)	9,97	Max. 10
Texture (mm dt/g)	0,12	Normal
Undissolved total solid	1,12	Max. 1
Ash content (%bb)	1,64	Max. 2
Sweet taste	Sweet	Normal, specific
Colour	Brown	Yellow until brownish

Sucrose is main component of coconut sugar which it amount is expected high. Sucrose give seet taste and help to form crystal in coconut sugar, so the sugar can be solidified. Sucrose content in A3M1 coconut sugar was quitely high and belongs to SNI 01-3743-1995, because there's possibility that the origin sap of A3M1 has not hydrolized too much. This case is supported by the data of pH of A3M1 sap, that is 6,67 and low reducing sugar level. That pH score still fill the condition of sap processing into coconut sugar. Muchtadi et al (2010) stated that sap that used to make coconut sugar has pH 5,5-7,0. The reducing sugar in A3M1 coconut sugar is associated with pH score. The pH of A3M1 coconut sugar is 6,67 that is belongs to good score. The addition of natural laru of mixture of green betel extract and mangosteen rind extract can defend the pH, so the early pH of sap was not too low.

Water content is associated with texture and reducing sugar. The high amount of reducing sugar causes high amount of water content. It can be happened because the reducing sugar absorp more water in sucrose (Kusnandar, 2010). So that, in A3M1 it has low reducing sugar, and followed by the water content that low too. The water content of A3M1 is belong to criteria of SNI 01-3743-1995. The low water content of A3M1 make hard texture of A3M1, that is 0,12 mm.dt/g.

Ash content of A3M1 coconut sugar already fullfill the criteria of SNI, this happened because the natural laru used in liquid form, so can reduce the ash content. Liquid natural laru are alleged easily mixed with sap so it will not make sediment of laru.

Sweet taste of coconut sugar formed because of sucrose, glucose, and fructose. The coconut sugar has specific taste and aroma which influenced by organic acids in coconut sap (Sardjono, 1989 *in* Firmansyah, 1992). Colour of A3M1 coconut sugar is brown. The color of sugar is formed because of Maillard reaction. Maillard reaction is non enzymatic browning which happened because reaction of reducing sugar and free amine from amino acids or protein. According Meynier *et al*. (1995) in Ho et al. (2008), colour and aroma of food are influenced by pH. Mailard reaction is more intensive in base condition and high temperature (Catrien et al., 2008).

CONCLUSSIONS

The precentage of mixture of green betel extract and mangosteen rind extract on total natural laru which produced the best quality of coconut sugar was 30%. The addition amount of natural laru into ±1L of sap which produced the best quality of coconut sugar was 5 mL/L of sap. The treatment combination of mixture of green betel extract and mangosteen rind extract on total natural laru with addition amount of natural laru which produce the best quality of coconut sugar was 30% with 5 mL/L of sap. The coconut sugar had characteristics reducing sugar of 4,09% db, sucrose content of 87,50% db, water content of 9,97% wb, texture of 0,12 mm.dt/g , total undissolved solid of 1,16%, ash content of 2,65% db, colour score of 2,73 (brown), sweet score 2,68 (sweet), bitter taste score of 3,42 (slighlty bitter), and overall preference score of 3,07 (like).

ACKNOWLEDGEMENT

The authors would like to thank to the Ministry of Research, Technology and Higher Education (Kemenristek-Dikti), Indonesia for financial support of the research.

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