



STUDY ON PROCESSING OF BEVERAGE FROM PALM FRUIT (*BORASSUS FLABELLIFER L.*) GROWN IN AN GIANG PROVINCE

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ABSTRACT

The study was conducted to process beverage from sugar palm fruit (*Borassus flabellifer L.*, *Arecaceae*) in An Giang Province. The research is to identify the proper parameter of processing rock sugar palmyra palm drink. Investigation factors include the maturity of palm pulp, pulp size, blanching time, acid concentration (acid ascorbic:acid citric) and mixing ratio (fruit pulp:sugar solution). The results showed that the medium ripeness of palm fruit (mainly harvested after 4 weeks of fruiting) is suitable for this processing. Palm pulp cube (0.75×0.75×0.75 cm) blanched for 1 min in boiled water giving the highest sensory points and good quality. The study obtained a defined parameter of fruit pulp and sugar solution with the ratio of 40:60. It contributes with nice color, delicately flavor sugar palm beverage but cost effective. In addition, the proportion of citric and ascorbic acid supplemented is 0.05%, it is not only enhanced the flavor but also created an effective preservation complying with current microbiological criteria regulations.

1. INTRODUCTION

Palm tree - *Borassus flabellifer L.*, *Arecaceae*. belongs to *Palmaceae* family (Vietnam Encyclopedia, 2011). They are mainly grown in An Giang, Kien Giang provinces and in the Cam mountain area of Tinh Bien district, An Giang province.

This tree is well-known as a local specialty which has a sweet, cool taste juice and a white, soft palm pulp. The popular sugar palm product is jaggery, a sugar made from the juice of palm flower by the local Khmer people in Tri Ton, Tinh Bien, An Giang province with a specific flavor. After harvesting, palm juice is used to

produce the jaggery, and sold as a fresh drink or processed into local specialty cakes. However, the limitations of these products (except the jaggery) are the short shelf-life and non-labelling attached so they are locally served only. This is the cause of low value and economic inefficiency of sugar palm tree. Moreover, sugar palm juice is easily spoiled by the activity of microorganisms which form a cloudy juice with a sour taste and containing alcohol. Palm juice makers are overusing artificial additives both in category and quantity without following food safety regulation to prevent spoilage process leading food safety issues. This is adversely

Vietnam implemented administrative restructuring on July 1, 2025, introducing significant changes to its administrative units. Nevertheless, this article continues to use the old names of provinces, cities, communes, and wards to reflect the data and context at the time of the study

affecting to the recent consumer trend and reducing the market value of sugarpalm.

A female sugar palm can bear about 10-20 bunches (e.g. 200-300 fruits) per year. The fruit has three sweet jelly fruit sockets, ice-like-cube shapes and white-pale translucent, also contains a sweetish liquid. Its pulp has the specific flavor and the highly nutritional value. In 100g of fresh pulp, there are 1.24 g protein, 0.8 g fat, 1.2 g ash, 22.5 g total carbohydrates (including 9.5 g reducing sugar, 13 g non-reducing sugar, 12.6 g starch and 0.5g maltose) and a considerable amount of calcium (8.76 mg), ascorbic acid (1.16 mg) (Vengaiyah et al., 2015).

Nowadays, sugar palm products are very popular; however, the research on new products development is limited. Therefore, the diversification of sugar palm products is a vital necessity. This might solve the output issue and increase the commercial value for sugar palm products. This new sugar palm drink is a promising beverage, containing high nutrient content, satisfying safety and hygiene standards and also brings convenience of the ready-to-drink, easy-to-use products or a nice gift-giving to customers and tourists of An Giang.

This study aims to investigate the optimal parameters of type of palm pulp used, size shaping, blanching time and mixing ratio. This is

to create a good new product, convenient to use and high sensory value. More importantly, its physical, chemical and microbiology criteria are standardizing by adhering TCVN 6297: 1997.

2. MATERIALS AND METHODS

The raw material –sugar palm fruit (*Borassus flabellifer* L., Arecaceae.) was purchased from Tinh Bien - An Giang province.

The experiments were conducted in triplication. Data was subjected to statistical analysis of variance (ANOVA) test and Fisher’s Least Significant Difference (LSD) test to compare between treatments at 5% significance level by using Statgraphics Centurion XV.

Processing was conducted with selected sugar palm according to their ripeness to ensure the uniformity of freshness and remained the intact. The pulp was removed from mesocarp (hard skin), exocarp and endocarp (silk skins) then cut into square cube and blanched in boiling water (100 °C) designated time to inactivate enzymes. They were put into a pre-pasteurized glass bottle then added hot sugar solution (21 Bx) and mixture of citric acid:ascorbic acid (1:1). Products were covered immediately and pasteurized in boiling water (100 °C) for a time. Finally, they were rested about 2 days at room temperature.

Table 1: Analysis methods

N_o	Properties	Analysis methods
1	Moisture content	Drying at 105 °C to constant weight
2	Total dissolved solids content	Using Brix meter
3	Total acid content	Titrate by NaOH 0.1N solution
4	Total sugar content	Bertrand method
5	Viscosity	Viscometer
6	Hardness	Rheotex structure measuring machine
7	Color	Colorimeter
8	Microbiological indicators	Colony counting method
9	Sensory test	using comparison test and Hedonic test

2.1. Analyze the basic chemical composition of raw materials according to ripeness

Materials will be analyzed the basic properties and chemical composition as soon as they were delivered to the laboratory. Ripeness was classified into three levels which were young fruits (harvested after 3 weeks fruiting), medium ripped fruits (harvested after 4 weeks fruiting) and ripped fruits (harvested after 5 weeks fruiting).

The analytical criteria include water content, fat content, total sugar content and total acid content.

The different ripeness of sugar palm after classifying into three categories will be processed into beverage product to identify the maturity most suitable for processing.

2.2. Investigate the effect of pulp size and blanching time on product quality

The experiments were designed with 2 randomized variances pulp size and blanching time.

- Sugar palm pulp cut into size 0.5x0.5x0.5 cm, 0.75x0.75x0.75 cm and 1x1x1 cm.

- Blanching time carried out at 0.5 minutes, 1 minute and 1.5 minutes.

The analytical criteria included hardness and color value (L) of the pulp after blanching. Sensory evaluation will conduct based on attributes of color, flavor, texture and overall acceptability.

2.3. Investigate the effect of acid concentration and mixing ratio on product quality

The experiments were designed with 2 randomized variances.

- Food acid concentration added in sugar solution (citric acid:ascorbic acid with the ratio of 1:1): 0.05%, 0.06% and 0.07%.

- Mixing ratio of the pulp and sugar solution (w/v): 30:70, 40:60 and 50:50.

Analytical criteria of finished product were viscosity and pH and evaluate sensory attribute of color, flavor, texture and overall acceptability.

3. RESULTS AND DISCUSSION

3.1. Effect of maturity of raw materials on product quality

The quality of this beverage depends on maturity of sugar palm pulp, the more ripped fruit added, the higher hardness and weight.

Young fruit exocarp is yellow – gray and endosperm is thin, translucent and succulent. Its harvesting time is about 3 weeks after fruiting.

Medium ripe fruit has a purple brown exocarp and palm flesh is slightly turbid, fairly hard, quite thick and containing a little water. Harvesting time is about 4 weeks after fruiting.

Ripe fruits form a dark purple exocarp, a thick hard flesh but cloudy and dry. Harvesting time is about 5 weeks after fruiting.



Figure 1: Palm fruits (*Borassus flabellifer* L., Arecaceae) according to maturity

Table 2 shows that dry matter content such as total sugar and total acid of palm flesh increased with the maturity of fruit.

Table 2: Chemical compositions according to maturity of palm fruit.

Chemical composition (%)	Maturity		
	Young	Medium ripe	Ripe
Moisture	94.51 ± 0.48	93.82 ± 0.97	93.38 ± 0.53
Total sugar	4.91 ± 0.13	5.34 ± 0.39	5.96 ± 0.78
Total acid	0.13 ± 0.01	0.16 ± 0.01	0.18 ± 0.01

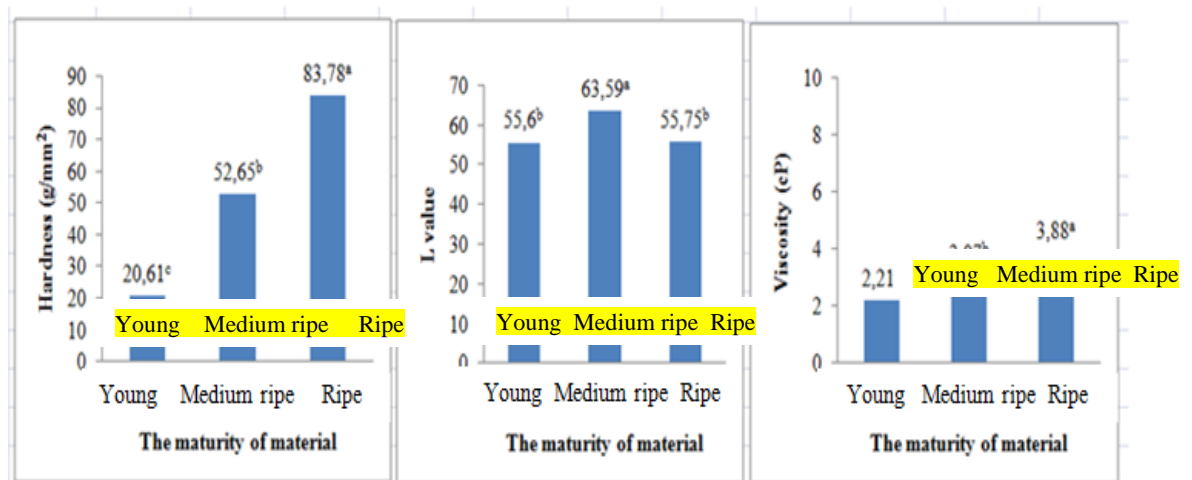


Figure 2: The physical properties of sugar palm pulp according to its maturity.

The increase in hardness of the pulp and viscosity of the juice was proportionate to palm pulp ripeness (Figure 2). There were statistically significant differences between samples demonstrating that hardness of processed palm pulp was greatly influenced by its initially structural characteristics. It showed products

made from ripe fruit was giving the highest hardness value. It created high viscosity the result of high content sugar and hydrolysis reaction of pectin in ripe pulp capable of releasing protopectin hydrolysate during heat treatment.

Table 3: Effect of maturity of the pulp on sensory values of the beverage.

Maturity	Color	Flavor	Texture	Overall acceptability
Young	3.30 ^b	3.40 ^b	2.57 ^c	5.67 ^c
Medium	4.30 ^a	3.90 ^a	4.10 ^a	7.53 ^a
Old	2.90 ^c	3.07 ^c	4.00 ^b	6.10 ^b
P	0,0000	0,0001	0,0000	0,0000

Note: Within the same column, the values with different letters are significant difference at $p < 0.05$.

Table 3 shows that the sensory panel was remarkably different depending on palm pulp maturity. Sensory scores of color, flavor and texture of products mixed with young sugar palm was not high due to residues, faint aroma of sugar palm and a low viscosity of the juice. The low scores also caused from palm pulp's color which was a translucent white, and tender texture. In contrast, products processed from ripe palm pulp formed an opaque color, a firm texture, faint aroma and high viscosity of the juice, so it had a low score of overall acceptability.

However, medium ripe pulp was considered as the proper material for the drink. It obtained the highest scores of color, flavor and texture when it compared to samples processed from young and ripe fruit. Indeed, medium ripe pulp produced a clear and bright white color, crispy structure the pulp and brought a specific flavor with appropriate viscosity for the juice.

3.2. Effect of pulp size and blanching time on product quality

Blanching will help remained the original color of raw materials, improved texture and osmosis ability, inactivate enzymes and eliminated surface microorganisms.

Table 4: Physical properties of products effecting by material size and blanching time.

<i>Factor</i>		<i>Hardness (g/mm²)</i>	<i>L value</i>
<i>Material size (cm)</i>	0.5 × 0.5 × 0.5	43.86 ^c	64.11 ^a
	0.75 × 0.75 × 0.75	49.03 ^b	63.01 ^b
	1.0 × 1.0 × 1.0	52.79 ^a	62.51 ^b
	<i>P</i>	0.0000	0.0005
<i>Blanching time (min)</i>	0.5	49.98 ^a	62.62 ^b
	1	48.03 ^{ab}	63.05 ^b
	1.5	47.68 ^b	63.96 ^a
	<i>P</i>	0.0593	0.0030

Note: Within the same column of each factor, the values with different letters are significant difference at $p < 0.05$ by LSD test.

The table 4 shows that there is a statistically significant difference of hardness values between different material sizes. The hardness of palm pulp significantly decreased when its size was reduced for instance, the small cutting pulps were likely to be tender or less firmness than the larger cutting sizes. Different pulp sizes might have different reaction during heat treatment period as its different contact surface leading to a different pulp's hardness.

Regarding the effect of blanching time on the firmness of different pulp sizes, the data showed its hardness parameters decreased in inverse proportion to blanching time due to the heat treatment, but there was not statistically significant difference. The cause was the difference treatment of blanching time between samples just 30 seconds because there was a significant difference between samples blanched at 0.5 and 1.5 min.

The brightness of pulp flesh after blanching was influenced by its original size and blanching time. The larger size samples received lower brightness value while the longer blanching time gained a higher brightness value. This seems that

the blanching heat was inactive browning enzymes of palm pulp and enhanced the brightness. However, there was no statistically significant difference between 0.75 and 1.0 mm pulp size or blanching times of 1.0 and 1.5 min.

Table 5: The effect of material size and blanching time on sensory value of products.

	<i>Factor</i>	<i>Color</i>	<i>Flavor</i>	<i>Texture</i>
<i>Material size</i> (<i>cm</i>)	0.5 × 0.5 × 0.5	3.53 ^b	3.73 ^c	3.61 ^c
	0.75 × 0.75 × 0.75	3.89 ^a	4.08 ^a	4.00 ^a
	1.0 × 1.0 × 1.0	3.81 ^a	3.87 ^b	3.82 ^b
	<i>P</i>	0.0000	0.0000	0.0000
<i>Blanching time</i> (<i>min</i>)	0.5	3.58 ^c	3.71 ^c	3.61 ^b
	1	3.92 ^a	4.09 ^a	3.97 ^a
	1.5	3.72 ^b	3.88 ^b	3.86 ^a
	<i>P</i>	0.0000	0.0000	0.0000

Note: Within the same column of each factor, the values with different letters are significant difference at $p < 0.05$ by LSD test.

The small-size-cut materials were more likely lost a large amount of soluble matter (Le My Hong, 2005). This led to the reduce in flavor and aroma of the pulp after blanching when they was pasteurized at the same setting parameter and the texture was softer than the large-size-cut materials. In addition, cutting or shaping to small size need more time to process and needed skill making it evenly while making the bigger. Also small-size pulp was less attractive to sensory panelist so the acceptable evaluation score was low. As a result, sensory scores of color, flavor and texture of samples cut into 0.5×0.5×0.5 cm were the lowest with statistically significant difference of 5% compared to the other samples at different cutting sizes. In contrast, samples with dimensions of 1.0×1.0×1.0 cm were a bit large prone to loss a little soluble substance at the blanching stage but quality change was inconsiderable after heat treatment process. Because of the large size and high amount of dry

matter content, the color was fairly dark and unattractive caused from the interchangeability of matters between pulp’s substances and syrup during diffusion process. This happen was established the equilibrium concentration of solid part and aqueous or between molecules to form a completed quality. However, this process might be not taken place completely during stability period enabling to product was lack of specific natural flavor of sugar palm.

Products made from the material size 0.75×0.75×0.75 cm, blanched in 1 min receiving the highest score and had a statistically significant difference at the 95% confidence level (Figure 3) comparing to the remaining samples. It was because this material size was the appropriate shape for processing ensuring intact quality after heat treatment and getting harmonious flavor after resting. Sensory evaluation results are relatively consistent with

the measured data which sensory variation was in line with the research of Pham Hong Quyen

(2012) studying coconut juice and copra product.

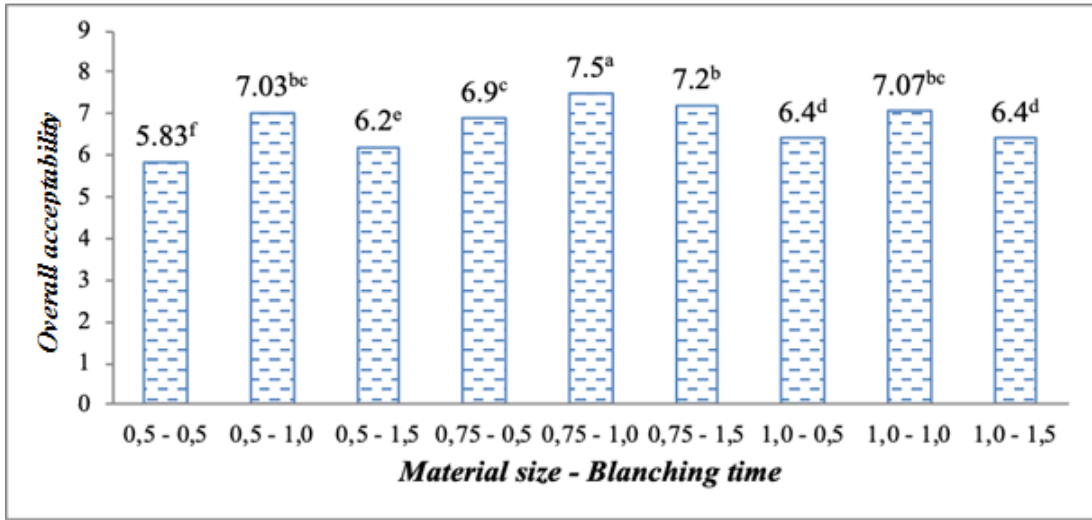


Figure 2: Overall acceptability of product according to material size and blanching time.

Thus, the material was shaped at dimensions of 0.75×0.75×0.75 cm and blanched in 1 min bringing the highest sensory scores of color, flavor, texture and reduce the cost for the blanching process but secured product quality.

3.3. Effect of acidity regulator concentration (acid citric and acid ascorbic) and mixing ratio on quality of product

The mixing ratio between palm fruit and sugar solution is one of the crucial parameters having a great effect to product sensory value and its quality.

Table 6: Effect of acid concentration and mixing ratio on pH and viscosity of product.

Factor		pH	Viscosity (cP)
Acid concentration (%)	0.05	6.39 ^a	36.55 ^a
	0.06	6.12 ^b	35.53 ^a
	0.07	5.71 ^c	35.43 ^a
	<i>P</i>	0.0000	0.6257
Fruit flesh: sugar ratio (w/v)	30:70	5.76 ^a	23.82 ^a
	40:60	6.08 ^b	36.63 ^b
	50:50	6.37 ^c	47.06 ^c
	<i>P</i>	0.0000	0.0000

Note: Within the same column of each factor, the values with different letters are significant difference at $p < 0.05$ by LSD test.

Table 6 shows the changes in pH and viscosity of the finished product based on different ratios of palm pulp and syrup (sugar solution) and the concentration of the acidity regulator added. The results indicated that the pH value of the product was obviously affected by pH and mixing ratio. The higher concentration of food acids used indicated that the more food acids added in the syrup so released a high amount of ions H⁺ to the solution leading the decrease in pH value of product. The difference in pH between samples using food acids at different concentrations was statistically significant at the 95% confidence level. However, the addition of acid did not create a difference in viscosity between samples because this quality is not influenced by food acids.

Both the pH value and viscosity of the product were significantly affected by the ratio of palm

pulp and syrup. During pasteurization and resting period, the equilibrium concentration of products' substances might occur between palm pulp's matter and soluble molecules of syrup through the diffusion process. Specifically, sugar particles and food acids solution will disperse into the pulp, meanwhile solvent molecules of palm pulp attended to dissolve to the solution and formed viscosity. Hence, the soluble content affected viscosity and sensory attributes parameters. Samples with 30:70 mixing ratio containing a low quantity of the pulp proportion were not having the high amount soluble molecules, thus forming a low viscosity product. Whereas the ratio with 50 % pulp and sugar produced the highest viscosity index, therefore, the high quantity of sugar palm portion created the lower pH and higher viscosity which made a statistically significant difference to the other mixing ratio parameters.

Table 7: Effect of acid concentration and mixing ratio on sensory values of product.

Factor		Color	Flavor	Texture
Acid concentration (%)	0.05	4.28 ^a	3.79 ^a	3.86 ^a
	0.06	4.23 ^a	3.74 ^a	3.79 ^a
	0.07	4.11 ^a	3.61 ^b	3.80 ^a
	<i>P</i>	0.1922	0.0010	0.1206
Fruit flesh: sugar solution (w/v)	30:70	3.88 ^c	3.73 ^b	3.40 ^c
	40:60	4.57 ^a	4.06 ^a	4.34 ^a
	50:50	4.18 ^b	3.34 ^c	3.70 ^b
	<i>P</i>	0.0000	0.0000	0.0000

Note: Within the same column of each factor, the values with different letters are significant difference at $p < 0.05$ by LSD test.

Product sensory values changed according to food acid concentrations used and the mixing ratios shown in Table 7. The quantity of food acids used did not make a statistically significant difference in the color and state of the product at the 5% significance level. The reason was that

the properties of citric acid and ascorbic acid were odorless, colorless and dissolved in water creating a transparent aqueous solution. However, the product's flavor was significantly affected by the amount of acid added. Product with food acids at 0.07%, concentration created

a quite sour taste, so the sensory panel was lower than other samples at different food acid concentrations. Besides, there was no significant differences in flavor between the samples at 0.05% and 0.06%.

Palm pulp and syrup ratio significantly affected to product’s sensory parameters and had a statistical difference between the samples in each attribute. At the ratio of 30:70, products showed low sensory points caused by a high proportion water content. The product color was less attractive and the taste was unpleasant so this ratio is improper for the product.

In contrast, the given sensory scores of 50:50 mixing sample were low due to the result of the high amount pulp added, which formed a fairly

dark color, strong and unharmonious flavor. Product’s appearance had an opaque white color creating from high amount dissolved substances of palm pulp during pasteurization. In brief, 50:50 mixed ratio was not considered because this mixed design affected to the natural transparent characteristic of product.

The 40% pulp and 60% syrup ratio gained the highest sensory scores for color, taste and a stable state of product. This is similar to the research of “coconut juice and copra” conducted by Pham Hong Quyen (2012). Products mixed with a large proportion of copra formed a slightly cloudy color and an unpleasant taste due to the containing of many dissolved substances after pasteurization.

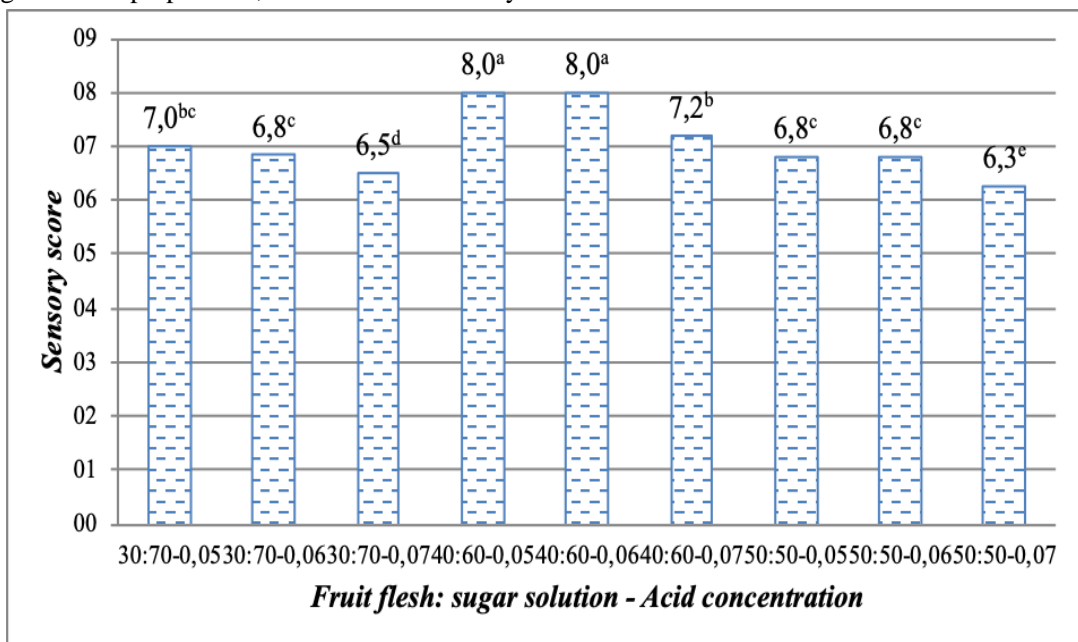


Figure 3: Overall acceptability of product according to pulp:syrup ratio and acid concentration

Thus, the sensory scores of the product had significant changes when there was a change in ratio of pulp and syrup combined with proper amount additive acid. When the small amount of pulp used, it resulted in unattractive color and taste of the drink with low viscosity. In contrast, if the added pulp quantity was too much, which product color formed dark and unharmonious

taste as well as creating a quite high viscosity, so these recipes were the inappropriate for this beverage.

On the other hand, the high volume acid use formed a acidity and unharmonious taste. As a result, the overall acceptability of the products (Figure 3) using food acids at concentration

0.05% and 0.06% combined with the pulp and sugar ratio 40:60 secured the highest score. This was also statistically significant difference with other products recipe at the 95% confidence level. However, the characteristic of raw materials was not suitable for sour flavor beverage, and with the attempting of less using artificial additives to food products, pulp and

syrup mix (40:60) with acid (0.05%) was selected in this study.

3.4. Quality value of beverage product from *Borassus Flabellifer L.*

Pasteurization in boiling water for 20 min helped remaining good quality of the product as well as bringing economically beneficial and a safety use.

Table 8: Quality values of the product.

	<i>Indicators</i>	<i>Unit</i>	<i>Value</i>
Chemical (*)	Total soluble solids content	Brix	16,1
	Saccharose	%	16.0
	Ethanol	%	0
Microbiological (**)	Total aerobic microorganisms	CFU/ml	< 1
	Total yeast, mold	CFU/ml	< 1
	<i>Coliforms</i>	CFU/ml	< 1
	<i>Streptococcus faecal</i>	CFU/ml	< 1
	<i>Pseudomonas earuginosa</i>	CFU/ml	< 1
	<i>Clostridium Perfringens</i>	CFU/ml	< 1
	<i>Staphylococcus aureus</i>	CFU/ml	< 1
	<i>E. Coli</i>	MPN/ml	0

Note: (*) Results from An Giang University Experimental Service Center.

(**) Results from Center of analytical services and experimentation HCMC - Can Tho branch (CASE).

4. CONCLUSION

The study found that the ripe palm fruit is the most suitable for this beverage. Besides, the pulp was shaped in the size of 0.75×0.75×0.75 cm and blanched in 1 min to produce the highest sensory value, reduce the production cost and create a high quality for a ready-to-use beverage. Furthermore, pulp and syrup ratio 40:60 and food acids concentration at 0.05% (citric acid: ascorbic acid ratio of 1:1) are recommended for a considerable proportion. In addition, the

product meets the microbiological criteria according to current regulations.

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