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PRODUCTION OF COCOA PULP SYRUP BY UTILIZING LOCAL SUGAR SOURCES

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Abstract*. The pulp of the cocoa fruit still has not economically viable yet. Its potency to be processed into fruit syrup is expected to increase its value added. Local sugar from palm and canes is still traditionally utilized to produce brown sugar. This study aimed to make fruit syrup by utilizing cocoa pulp and local sugar sources in West Sumatra with several variants (palm sugar, sugarcane, and market white sugar). The effects of sugar concentration on the quality of the syrup were also studied. Sensory evaluation by the hedonic method was performed and statistical analysis data were carried out using SPSS. Microbiological analysis and shelf-life testing also have been done. The results of this study showed that respondents preferred syrup with palm sugar to sugarcane because of its light brown color and distinctive sweetness. The microbiological test reported that the syrup could only be consumed for less than the 5th day in a sealed glass bottle if it was placed at room temperature. Meanwhile, the syrup placed in the refrigerator (5 ^{0}C) could keep until the 5th day.*
Keywords: *cocoa; cocoa pulp waste; local sugar; pulp; syrup*

1. Introduction

Cocoa pulp has potential for economic value development because mostly cocoa seeds (often called “beans”) are mainly used by chocolate processing industries. Several research reported cocoa pulp for bioethanol production (Roini *et al*., 2019; Purwati *et al*., 2016; Yumas *et al*., 2014; Saputri *et al*., 2021), ruminant feeding (Utami, *et al*., 2021; Natsir *et al*., 2018), fermented alcoholic beverage (Dias *et al*., 2007) and as an adjunct for beer production (Nunes *et al*., 2020). Cocoa pulp covers the seeds of cocoa fruits. It contains 82–87% water, 10–15% fermentable sugars (glucose, fructose, and sucrose), 2–3% pentosans, 1–3% citric acid, 1–1.5% pectin, and about 1–2% of other hemicellulosic polysaccharides. Those molecules contribute well to the growth of microorganisms which plays a role in the fermentation process. Moreover, proteins, amino acids, vitamins (mainly vitamin C), and minerals are also present. (Schwan *et al*., 2014; Guirlanda *et al*., 2021). The relatively high content of pectin and other polysaccharides (0.2–3% hemicelluloses, 0.7–0.9% cellulose, and 0.1–0.3% lignin) make the pulp viscous, which limits the diffusion of air into the bean mass. The pH of the pulp varies between 3.0 and 4.0, depending on the content of citric acid (Schwan *et al*., 2014; Bickel *et al*., 2021).

Cocoa pulp was observed to be a substrate for the development of different microorganisms and fungi is larger diversity than bacteria. Spontaneous fermentation possibly occurred, and it is a prevalent process in the food industry. The use of cocoa as an industrial raw material is

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advantageous compared to other potentially suitable tropical fruits, as it is an abundant product derived from an established culture. (Nunes *et al*., 2020). For those reasons, it is possible for cocoa pulp in producing syrup with or without white sugar.

Survey results to the brown sugar centers in Lawang and Tigo Balai villages showed that problems faced by small sugarcane factory workers did not only need technological innovation but also product diversification. They must diversify products from cane juice to maintain market price stability of brown sugar, especially facing "price games" by collector traders. Processed cane juice products in West Sumatra are now only in the form of brown sugar. Caramel and brown sugar products are started to be introduced to the market, but they are not local products (Firdaus *et al*., 2019). Sari *et al*. (2015) reported that typical sugarcane from Indonesia contains at least 9% sucrose. Meanwhile, Arenga's sap from Arenga pinnata contains sucrose between 10 and 20% which is ideal to produce sugar (Dalibard, 1999).

Over the years, various kinds of processing fruit and its by-product has been studied to increase farmer's income, value development of agro-waste, minimize production losses, or introduce new products to the market (Kurniawan *et al*., 2018; Nurfaillah, *et al*., 2018; Guirlanda *et al*., 2021; Rahardjo, *et al*., 2022; Tlais *et al*., 2020).

This research aimed to study the effect of variation in local sugar sources and their composition in the form of caramel as well as the effect of the stabilizing agent on syrup quality. The variation in local sugar sources was caramel from cane juice, caramel from palm juice, and white sugar. Meanwhile, variations in sugar concentration were conducted in the range of 60 to 70%. The addition of stabilizing agent was also required to stabilize the emulsion of the fat and water to keep the syrup product in its stable condition, such as there is no melting and separation between fat and water, and to provide a compact texture. The stabilizer used in this study was CMC (*Carboxymethyl Cellulose*). The test conducted on the quality of the syrup product encompasses organoleptic, microbiology, and shelf-life test.

2. Methods

2.1. Materials

Cane juice caramel was taken from Lawang village, Agam district. Palm juice caramel was prepared by adding some distilled water to palm sugar and followed by a melting process. The palm sugar was from Ujung Gading village, Pasaman district. Cocoa pulp was taken from a cocoa farmer in Lubuk Minturun village, Padang city. Cocoa pulp was separated from the seeds and collected using waterproof plastic packaging immediately after the experiment was run. Meanwhile, white sugar, citric acid, salt, and CMC were bought from the market.

2.2. Preparation of Cocoa Pulp Syrup

Cocoa pulp taken from the farmer was blended to get its crude juice. The crude juice was then filtered using a chiffon cloth. The filtrate was placed in the pan and then mixed with cane juice caramel (with sugar concentrations varied at 60, 65, and 70%), citric acid 0,3%, and CMC 0,2 %. The mixture was heated to 65 ^{0}C and kept for 30 minutes then wait for it to come to room temperature. The cold cocoa pulp syrup is then packed in a bottle. The organoleptic test (taste, flavor, and color) with millennial respondents aged around 21 years, shelf-life test, and microbiological analysis were carried out on syrup products. The same procedures were performed on cocoa pulp filtrate with palm juice and white sugar. The following is a flow chart of the cocoa pulp syrup-making process. (Figure 1).

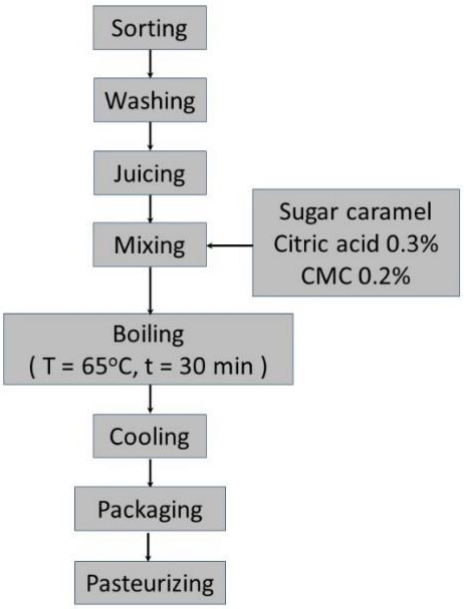

Figure 1. A flow chart of the cocoa pulp syrup-making process

a. Sensory Evaluation (I. Ben Thabet *et al.*, 2009)

The evaluation was performed by 15 untrained panelists aged around 21 years old. Hedonic organoleptic testing was applied using a score sheet. The elements to be assessed in the cocoa pulp syrup include color, flavor, and taste. Panelists were asked to evaluate each sample on a 5-point hedonic scale (1-dislike extremely, 2-dislike, 3-neither like nor a dislike, 4-like, and 5-like extremely) in an experiment.

b. Statistical Analysis (I. Ben Thabet *et al.*, 2009)

Statistical analyses were carried out using SPSS. Data were subjected to analysis of variance (ANOVA). Duncan's test was performed at the level of $p < 0.05$ to evaluate the significance of differences between mean values. Microbiological analysis and shelf-life testing (Sandi *et al.*, 2013)

c. Microbiological Analysis and Shelf-Life Testing

Microbiological analysis was conducted using the *total plate count* method (TPC). It is used to estimate the total *Salmonella*, bacteria, and fungi number in cocoa pulp syrup samples. TPC analysis used Plate Count Agar (PCA) as media by planting 1 ml of each of 9 cocoa pulp syrup samples into a petri dish, then incubated for 24 h. TPC calculation results as colonies (CFU/ml). A static test was used for shelf-life testing. Each sample was placed in a sterilized and sealed glass bottle. Those samples were stored under two conditions of temperature. (Temperate: 25^{o}C and Chilled: 5^{o}C).

3. Results and Discussion

The effect of variation in local sugar sources and concentration on the taste, flavor, and color of cocoa pulp syrup were evaluated by 15 sensory panelists. A spider plot was created to provide a graphic representation of the quantitative descriptive analysis (Figure 2).

Figure 2 shows the preference of panelists. Generally, most panelists preferred cocoa pulp syrup with white sugar and palm sugar (in the second position) to sugarcane. This finding is possibly related to people's habit consumes white sugar since childhood. In addition, the ages of panelists were around 21 years old (young people) who might not be worried about the risk of degenerative diseases. Figures 3,4 and 5 show the results of average evaluation by a hedonic scale of 9 cocoa pulp syrup samples by panelists for each attribute (taste, flavor, and color).

The best rating of taste attribute for like criteria (Figure 3) was obtained by cocoa pulp syrup with 65% white sugar. Meanwhile, panelists considered cocoa pulp syrup with 60 and 65% sugarcane to be the least preferred syrup among the others. The score of like criteria for cocoa pulp syrup with palm sugar was 33.3%, 46.67%, and 40.0% for each concentration of 60, 65, and 70%. It means that panelists preferred the sweet taste of syrup. This finding is consistent with Drewnowski *et al.* (2012) who state that "the sweet taste gives higher satisfaction because sweet taste receptors are not only expressed in the mouth".

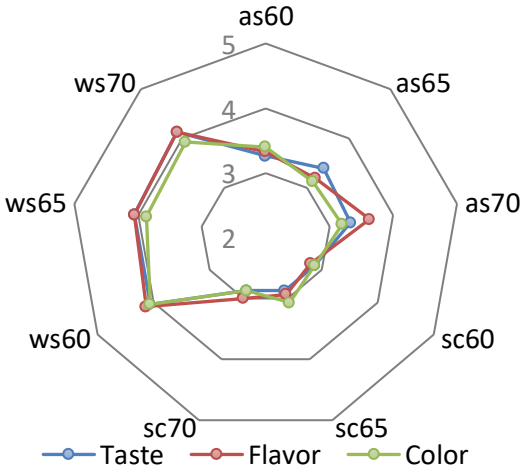

Figure 2. Spider plot to sensory scores of cocoa pulp syrup with variation local sugar (ws: white sugar, sc: sugarcane, and as: palm sugar)

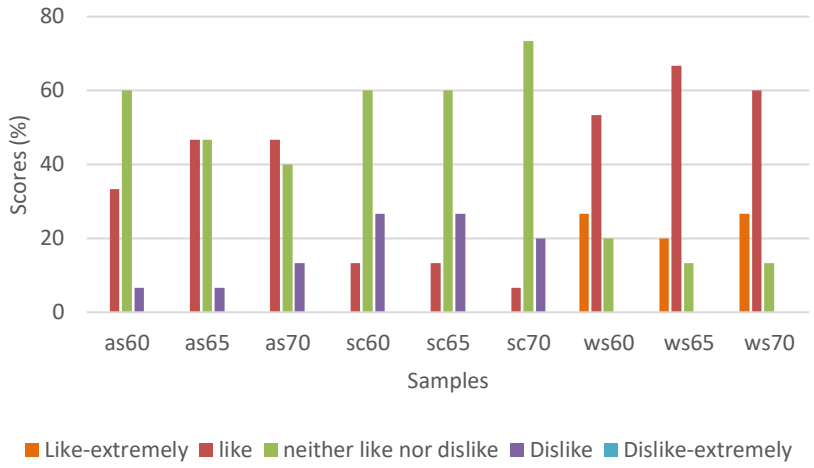

Figure 3. Hedonic evaluation of different samples with variation local sugar and concentration for taste attribute

In Figure 4, cocoa pulp syrup using white sugar still showed good acceptance by panelists compared to palm sugar and sugarcane. White sugar, palm sugar, and sugarcane have different compositions of saccharides. Maryani, *et al.*, 2021 reported that the simple sugars found in palm sugar were sucrose 89.94%, glucose 3.61%, and fructose 3.50% while sugarcane only contained sucrose 94.75%. Sucrose has an important role related to flavor and aroma. The effect of sucrose on aroma release is dependent on the level of concentration added. (Paravisini *et al.*, 2016). In figure 3, cocoa pulp syrup with 65% white sugar was evaluated as sensorial acceptable in flavor attribute for mostly panelists, and cocoa pulp syrup using sugarcane become the least preference again.

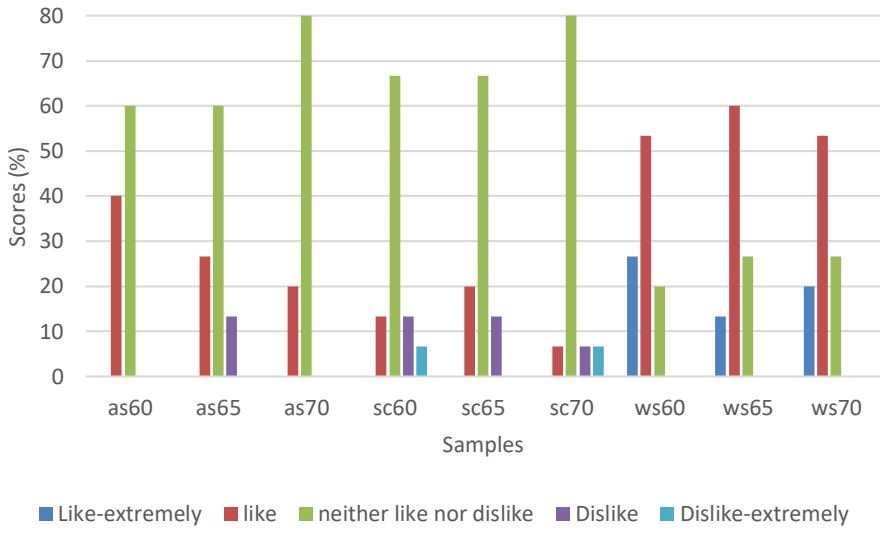

Figure 4. Hedonic evaluation of different samples with variation local sugar and concentration for flavor attribute

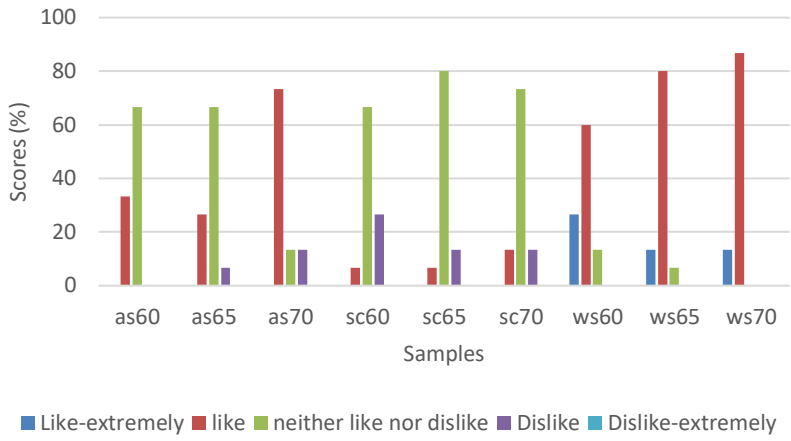

Figure 5. Hedonic evaluation of different samples with variation local sugar and concentration for the color attribute

The last attribute for hedonic evaluation was color. In the pulp-making process, the heating method was used for caramelization occurs. explained that sugar can give color to the food product by Milliard reaction and caramelization. Caramelization occurs when carbohydrates are exposed to high temperatures. This reaction often occurs during the preparation of traditional sucrose syrups and caramel. In Figure 5, the highest panelists like criteria preference of the color result from cocoa pulp syrup were using 70% white sugar. It was 86,67% for 70% white sugar and the least was 6.67% for 60% and 65% sugarcane. Panelists preferred about 73.33% for like criteria in the color attribute of cocoa pulp syrup using 70% palm sugar.

The ANOVA analysis was carried out on significance differences for especially like criteria on taste, flavor, and color attributes by panelists. The result of each statistical analysis is shown in following table 1.

Table 1. The ANOVA analysis result of like criteria for taste attribute

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	107.378[a]	22	4.881	1.365	.148
Intercept	308.267	1	308.267	86.238	.000
Samples	93.867	8	11.733	3.282	.002
Panelist	13.511	14	.965	.270	.996
Error	400.356	112	3.575		
Total	816.000	135			
Corrected total	507.733	134			

a. R Squared = .211 (Adjusted R Squared = .057)

The results in Tables 1, 2, and 3 described that the panelist's ratings were significantly different ($p < 0.05$) for the flavor, taste, and color hedonic test of cocoa pulp samples with a variation of local sugar and concentration. It revealed that cocoa pulp syrup with different kinds of local sugar and concentration gave different tastes, flavors, and colors. As a result, panelists

were evaluated with significantly different ratings. Furthermore, it is supported by Duncan's test which the result showed a significant difference in rating in all treatments.

Table 2. The ANOVA analysis result of like criteria for flavor attribute

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	214.519[a]	22	9.751	3.469	.000
Intercept	398.696	1	398.696	141.855	.000
Samples	200.770	8	25.096	8.929	.000
Panelist	13.748	14	.982	.349	.985
Error	314.785	112	2.811		
Total	928.000	135			
Corrected total	529.304	134			

a. R Squared = .405 (Adjusted R Squared = .288)

Table 3. The ANOVA analysis result of like criteria for the color attribute

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	89.363[a]	22	4.062	1.181	.279
Intercept	229.452	1	229.452	66.718	.000
Samples	73.481	8	9.185	2.671	.010
Panelist	15.881	14	1.134	.330	.989
Error	385.185	112	3.439		
Total	704.000	135			
Corrected total	474.548	134			

a. R Squared = .188 (Adjusted R Squared = .029)

The effects of variation in local sugar sources and their concentration on the growth of fungi, bacteria, and *salmonella* in cocoa pulp syrup at room temperature are given in Figures 6 to 8. Generally, fungi, bacterial, and *salmonella* tests in these studies showed that the syrup placed at room temperature could be consumed safely only till the fifth day.

Fungi started to grow on the second day for all variations of local sugar sources and their concentration at room temperature, except for 70% white sugar in concentration which lasted until the fifth day (Figure 6). The growth of fungi found in syrup with palm sugar juice was more than in syrup with sugar cane and white sugar. It is related to the carbon source in the syrup. Glucose and sucrose were found to be suitable sources of carbon for fungi (Sati *et al.*, 2006). As reported by Maryani *et al.*, 2021 palm sugar consists of sucrose, glucose, and fructose while sugarcane only contains sucrose. The highest fungal growth was found in syrup with palm sugar 60%. The microorganism that lives in the syrup is Clostridium. According to SNI No. 3544 regarding syrup, the number of fungi that can be consumed is a maximum of 100 CFU/ml, while in this study, the highest number of fungi was 88 CFU/ml.

The same results were also identified for bacterial and *salmonella* growth tests as shown in Figures 7 and 8 respectively. Bacterial growth started on the fifth day which was marked by the presence of white spots on the syrup. This is caused by the activity of microorganisms. Bacteria

preferred glucose as a carbon source and support a faster growth rate compared to other sugars (Bren *et al*., 2016). Microorganisms present in the syrup can be observed using Nutrient Agar by using a Petri cup with incubator temperature. The largest number of bacteria until the 30th day was 104 CFU/ml. According to SNI No. 3544 regarding syrup, the number of bacteria that can be consumed is a maximum of 500 CFU/ml.

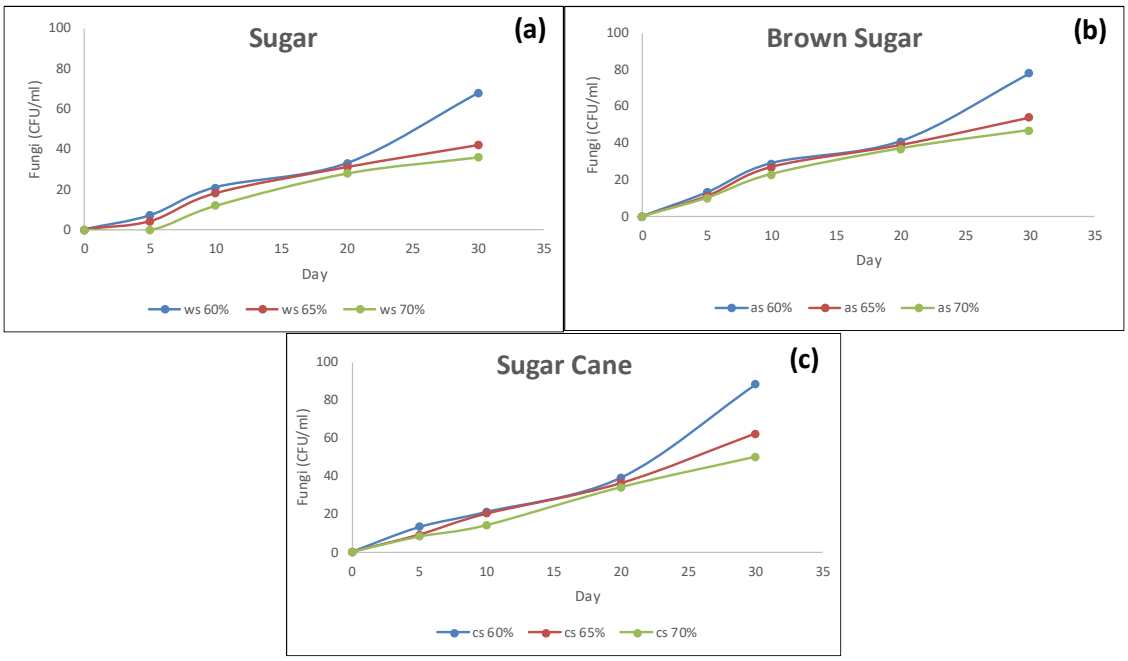

Figure 6. The effects of variation in local sugar sources and their concentration on the growth of fungi in cocoa pulp syrup at room temperature.

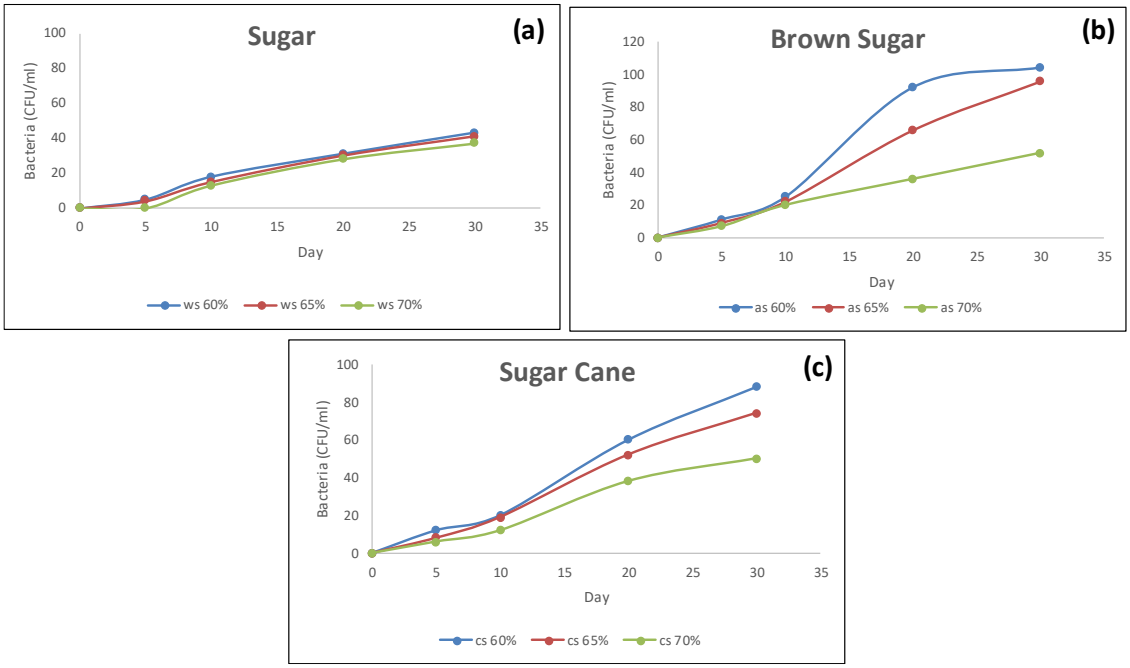

Figure 7. The effects of variation in local sugar sources and their concentration on the growth of bacteria in cocoa pulp syrup at room temperature.

The effects of variation in local sugar sources and their concentration on the growth of fungi, bacteria, and salmonella in cocoa pulp syrup at 5 ^{0}C temperature were given in Figures 9 to 11. Figure 9 showed that fungi started to grow on the fifth day for all variations of local sugar sources and their concentration at 5 ^{0}C temperature, except for white sugar and 70% concentration which lasted until the tenth day. These figures confirmed that the storage condition has a significant effect on the shelf-life of the syrup.

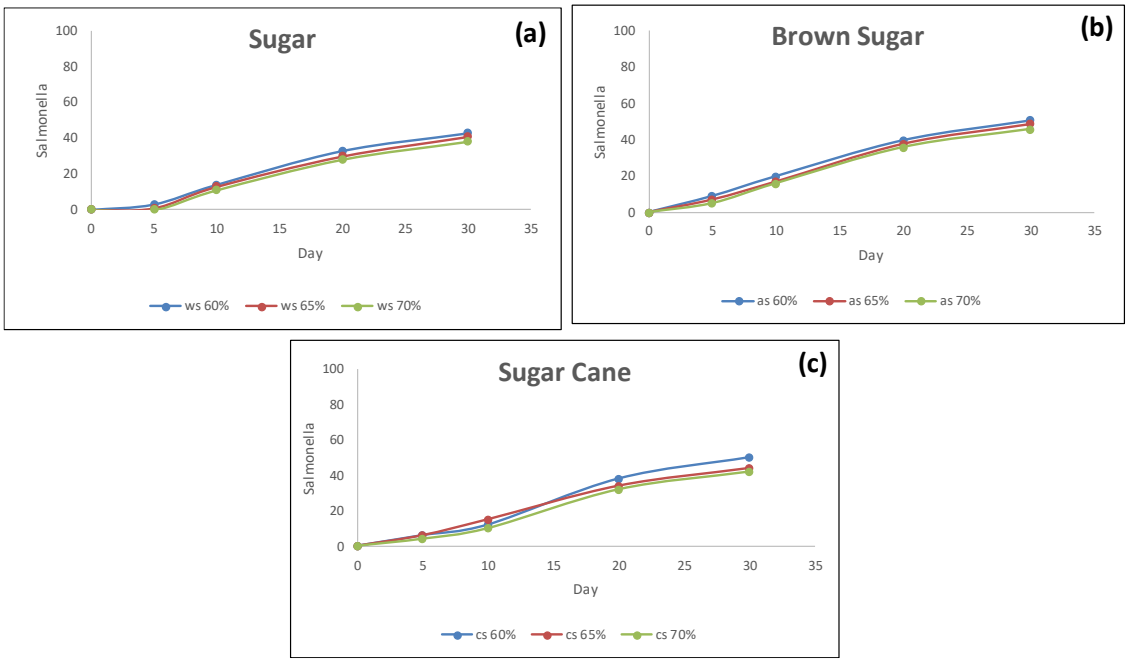

Figure 8. The effects of variation in local sugar sources and their concentration on the growth of salmonella in cocoa pulp syrup at room temperature.

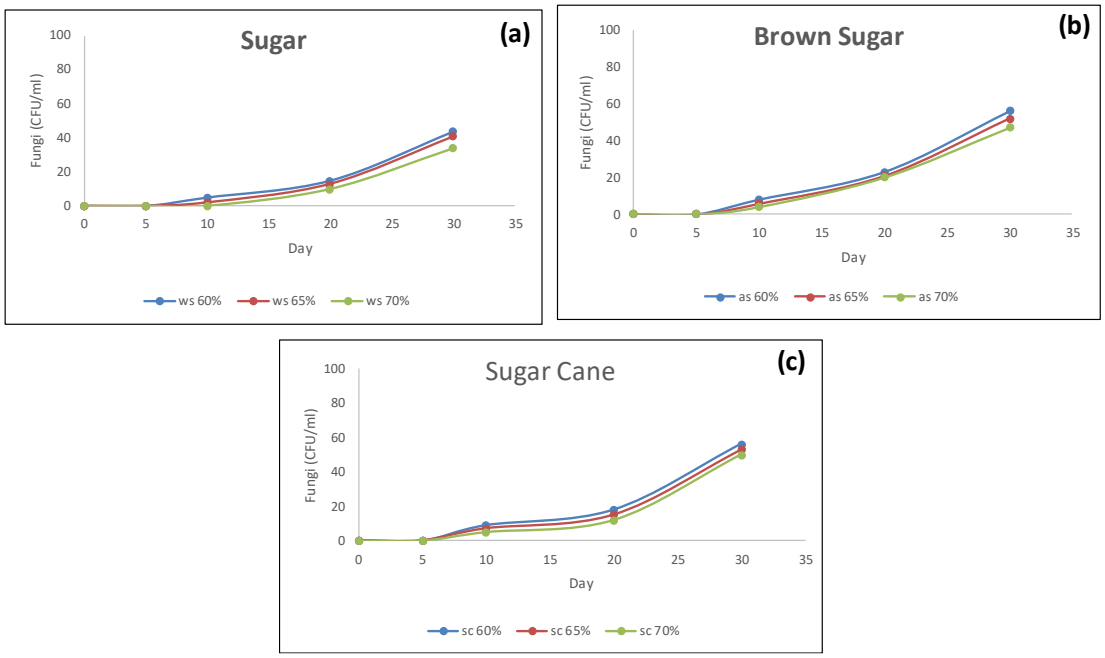

Figure 9. The effects of variation in local sugar sources and their concentration on the growth of fungi in cocoa pulp syrup at 5 ^{0}C temperature.

The same results were also identified for bacterial and *Salmonella* growth tests as shown in Figures 10 and 11 respectively. Then fungi, bacterial and *Salmonella* tests showed that the syrup placed at 5 ^{0}C temperature could be consumed safely only till to the tenth day.

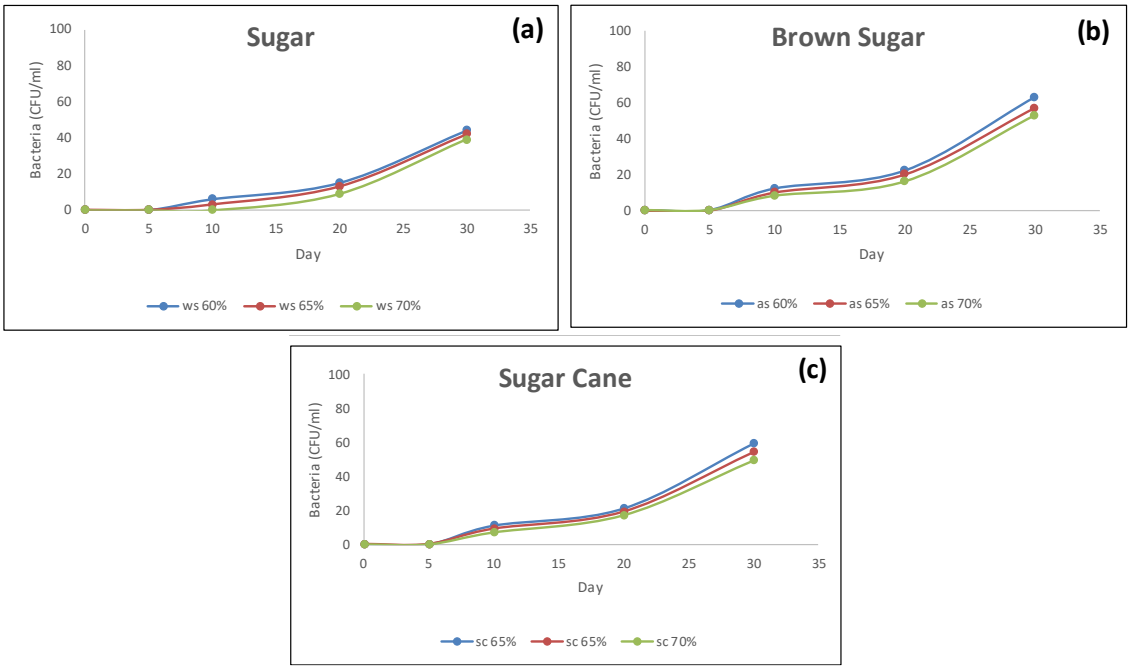

Figure 10. The effects of variation in local sugar sources and their concentration on the growth of bacteria in cocoa pulp syrup at 5 ^{0}C temperature.

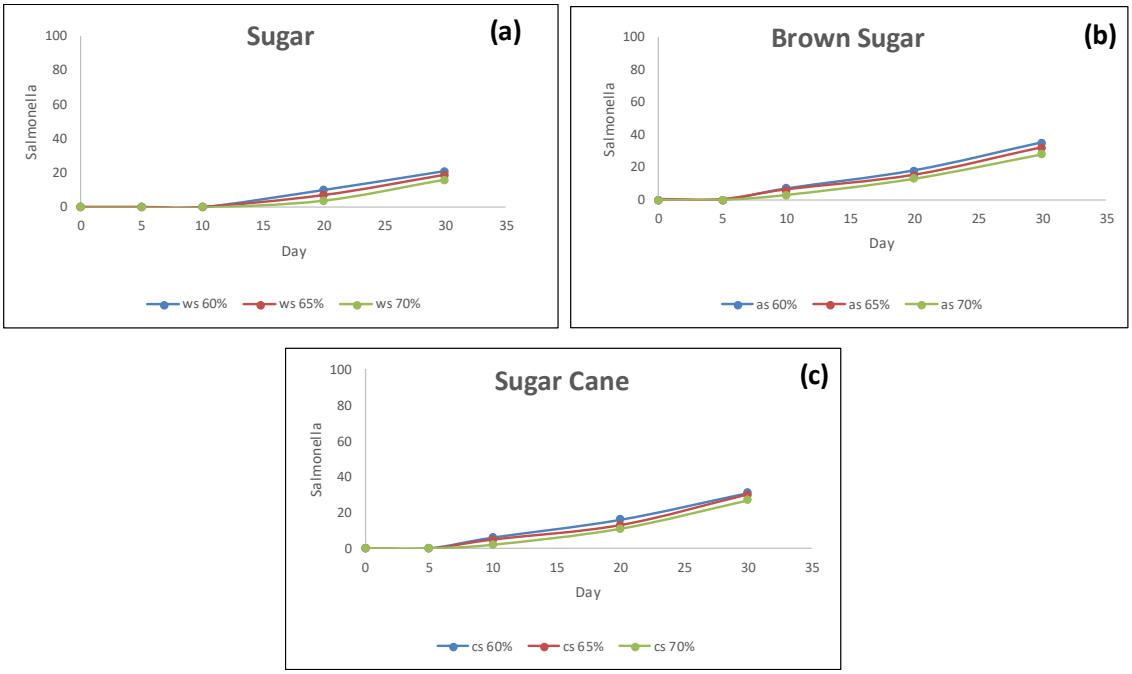

Figure 11. The effects of variation in local sugar sources and their concentration on the growth of bacteria *Salmonella* in cocoa pulp syrup at 5 ^{0}C temperature.

Those findings related to the microbe growth were also reported by L Mizzi *et al.* (2020). They reported the capacity of different sugar against the pathogen. It showed that at a low

concentration of sugar, it appears to act as a substrate for microbe nutrition. Otherwise at relatively high concentrations, exhibits significant antimicrobial effects.

4. Conclusions

The utilization of cocoa pulp as raw material for fruit syrup production is possible to be developed. Organoleptic tests by hedonic evaluation showed that most respondents preferred cocoa pulp syrup with white sugar to palm sugar and sugarcane caramel. Fungi, bacterial, and salmonella tests showed that the syrup placed at 5 ^{0}C temperature could be consumed safely only till to the fifth day for white sugar and less than five days for palm sugar and sugarcane while placed syrup at room temperature in a sealed glass bottle. Based on the result, cocoa pulp syrup with variation local sugars meets the standard of SNI. Further study should be performed in terms of quality, safety, and optimizing the fermentation condition.

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