Physico-Chemical and Sensoric Characteristics of Yogurt Drink- Based on Coconut Sap (CSY-Drink)

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Abstract— Coconut sap-Yogurt (CSY) *drink* is a product based on coconut sap and skim-milk processed through lactic acid fermentation using *Lactobacillus bulgaricus* dan *Streptococcus thermophillus* at certain time and temperature. This research was aimed to assess the effect of varieties/different coconut-sap and skim-milk concentrations on physico-chemical and sensoric characteristics of coconut sap-Yogurt *drink* produced and to assess the treatment combinations which produce the best product. The research conducted using RBD with two factors; coconut-sap concentrations (0%, 10%, 30% and 50%) and skim-milk consentrations (5% and 10%); with four replications, therefore obtained 32 experimental units. Variables observed were; viscosity, total-acid, pH, reduction-sugar, total-sugar, Soluble-protein contents and sensoric/organoleptic-test (color, coconut-sap aroma, yogurt aroma, sweet-taste, sour-taste and hedonic. Data obtained was analised using F test and if significant, analysis continued using *Duncan's Multiple Range Test* (DMRT) at 5% level. Result of the research showed that the best CSY drink preferred by panelist is the CSY drink processed from 50% of coconut sap and 10% skim-milk; with sensoric characteristics; rather-preferred (scale of 2,175), brownish-white in color (scle of 3,413) with taste of rather sweet (scale of 2,4) and rather sour (scale of 2,225), rather strong of yogurt aroma (scale of 2,05) and rather strong of coconut sap aroma (scale of 2,538). The physico-chemical characteristics of the product were as follow; viscosity of 7,375 mPa.s; acidity of 0,219%; pH of 4,975; reducing sugar content of 3,38% wb; total sugar content of 20,056% wb and Soluble protein content of 0,05% wb.

Index Terms— Coconut sap, skim-milk, *Lactobacillus bulgaricus*, *Streptococcus thermophillus*.

1 INTRODUCTION

Coconut sap is a sweet liquid obtained from the tapping of coconut flowers. The sap is vulnerable of microbe deterioration especially when it is left on direct contact with open air after tapping process. Sap contains high sucrose, which is a growth medium of microorganisms such as bacteria *Acetobacter acetic* and yeast cells of the genus *Saccharomyces* [11]. In the naturally fermentation of sap, the yeast of the genus *Saccharomyces* cells will be activated to synthesize sugar (glucose) to produces alcohol and CO_2 (Budiyanto, 2004).

Coconut sap contains sucrose which, when heated to above its melting point (186^oC) will split the molecule into glucose and fructose (Suwardjono, 2001). On the use of coconut sap to produce fermented beverages such as yogurt drink; sucrose in coconut sap can be used as a medium growth of used lactic acid bacteria; *Lactobacillus bulgaricus* and *Streptococcus thermophillus*. These bacteria break down the lactose into glucose and galactose, the glucose entering the glycolytic pathway to form lactic acid and other organic acids. Both bacteria are grow at the optimum temperature of 40-45^oC). Lactic acid bacteria convert lactose into lactic acid which reacts with proteins in the milk, causing them to precipitate at pH 4.6, and make the milk creamier. The lactic acid has a sour taste, which causes a change in flavor of yogurt.

Yogurt is a dairy products fermented by lactic acid bacteria include *Lactobacillus bulgaricus* and *Streptococcus thermophillus*, symbiotize in breaking down lactose to produce lactic acid [4]. Recently, diversification of yogurt products are widely performed resulting in more diverse products. In general, yogurt product diversification moves on reducing the sour taste of yogurt, this is done because consumers want a sweeter flavor yogurt. Therefore, the addition of sugars was conducted, such as addition of honey, sugar and fresh fruit.

Yogurt has a thick texture, but some consumers prefer the "ready to drink" yogurt, therefore yogurt drink is prepared. Yogurt drink is a yogurt that has a watery texture and can be drunk like fresh milk [15].

The main ingridient needed in the preparation of yogurt is milk, either fresh milk or skim milk. Skim milk contains all the nutrients of milk except fat and fat-soluble vitamins [2]. Skim milk in yogurt provide a growth medium / nutrient of *Lactobacillus bulgaricus* and *Streptococcus thermophillus* that produce lactic acid, thereby increasing viscosity and acidity of yogurt [17]. Skim milk contains lactose which hydrolyzed to produce lactic acid. Initially, the lactose hydrolyzed by glucose and galactose cultures or galactose - 6 - phosphate. Furthermore, through glycolysis and pyruvate chains, glucose is converted into lactic acid. The lactic acid produced will affect the characteristics of the resulting yogurt therefore the more skim milk used will be directly proportional to the amount of lactic acid produced.

This study aimed to: determine effect of different skim milk and coconut sap concentrations on the physicochemical and organoleptic properties of CSY drink produced, and determine combination of skim milk and coconut sap concentrations of CSY

drink with the best organoleptic and physicochemical properties.

2 MATERIALS AND METHODS

Coconut sap obtained from farmers of Karangtengah Village, Baturaden; skim milk (Indo Prima, Indonesia). Cultures of *Lactobacillus bulgaricus* and *Streptococcus thermophillus* obtained from the Laboratory of Animal Products Technology Faculty of Animal Husbandry, University Jenderal Sudirman, Purwokerto. Cultures of *Lactobacillus bulgaricus* and *Streptococcus thermophillus* prepared using MRSB media (1,044 grams of MRSB powder dissolved in 20 mL of distilled water, sterilized in an autoclave at 121^{o}C for 15 minutes).

The preparation process of CSY drink conducted through 3 stages; 1) rejuvenation of *Lactobacillus bulgaricus* and *Streptococcus thermophillus* cultures, 2) preparation of yogurt starter, and 3) preparation of CSY drink (modification of [6]).

The study was an experimental study using a randomized block design (RBD). Treatment factors consist of: skim milk concentrations (5% and 10%) coconut sap concentrations (0%, 10%, 30%, and 50%); arranged in a factorial treatment and conducted in four (4) replications. Observed variables include; viscosity, acidity, pH, reducing sugar, total sugar, soluble protein contents, and organoleptic tests (color, aroma juice, yogurt aroma, sweet taste, sour taste and preferences). The data analyzed with the F test and if significant followed by Duncan's Multiple Range Test (DMRT) at 5% level. Determination of the best combination treatments based on panelists preferences of the CSY drink.

3. Result and discussions

Effect of coconut sap and skim milk concentrations on physico-chemical characteristics of CSY *drink* produced.

The characteristics of CSYdrink produced due to variation on coconut sap and skim milk concentrations treatments are presented in Table 1 and 2.

Table1.
Effect of coconut sap concentrations treatments on the average value of CSY *drink's* physico-chemical variables observed

No	Variables	Coconut sap conc. (%)			
		0	10	30	50
1	pH	5.40 [a]	5.14 [b]	5.03 [b]	4.93 [b]
2	Acidity (%w/w)	0.16 [b]	0.18 [a]	0.20 [a]	0.19 [a]
3	Viscosity (mPa.s)	6.56	5.24	5.79	5.90
4	Reducing sugar (%w/w)	2.36	2.34	2.81	2.81
5	Total sugar (%w/w)	7.52 [c]	10.01 [c]	14.7 [b]	17.9 [a]
6	Soluble protein (%w/w)	0.053	0.046	0.049	0.043

Data followed by different letter within each column is significantly different according to Duncan multiple range test at $p<0.05$. Data obtained from at least four replicates

Table 2.
Effect of skim milk concentrations treatments on the average value of CSY *drink's* physico-chemical variables observed.

No.	Variables	Skim milk conc. (%)	
		5	10
1	pH	5.02 [b]	5.23 [a]
2	Acidity (%w/w)	0.16 [b]	0.21 [a]
3	Viscosity (mPa.s)	4.33 [b]	7.41 [a]
4	Reducing sugar (%w/w)	2.15 [b]	3.02 [a]
5	Total sugar	10.99 [b]	14.10 [a]

	(%w/w)		
6	Soluble protein (%w/w)	0.044	0.051

Data followed by different letter within each column is significantly different according to Duncan multiple range test at $p<0.05$. Data obtained from at least four replicates

The CSY drink's pH

pH of a food is one of several important factors that determine the survival and growth of microorganisms during processing, storage and distribution. Results of analysis of variance showed that the concentration of coconut sap and skim milk at 5% level significantly affect the decrease in CSY drink's pH but did not affect the interaction between them.

Results of the study showed that the increase in coconut sap concentration decrease the CSY drink's pH. Sugar content in coconut sap may function as energy source for the growth of lactic acid bacteria. *Lactobacillus bulgaricus* and *Streptococcus thermophillus* can utilize coconut sap during fermentation process, they break sucrose into glucose and fructose although not maximized it is known from the resulting pH is still high compared with yogurt drink in general (<4.6). Sucrose fermentation generally passthrough several stages including sucrose breakdown to produce glucose and fructose which will pass through the next stage of fermentation produce acid. Coconut sap contains 12.3 to 17.4% sucrose [5], it is possible initially *Streptococcus thermophillus* utilize the coconut sap's sucrose converted into glucose and fructose; which then *Lactobacillus bulgaricus* utilized the glucose in the subsequent fermentation process to produce acid. The faster growth of *Streptococcus thermophillus* can accelarate the growth of *Lactobacillus bulgaricus* to break lactose from skim milk which accordingly produce lactic acid, and can lower pH of the yogurt drink produced [5]. However, the resulting pH is still high compared with yogurt drink in general (<4.6). Its might both bacteria can not metabolize the available lactose completely by the time of fermentation stopped after 6 hours.

Treatments of skim milk concentration on the pH of CSY drink produced appear that the greater the concentration of skim milk, the higher the pH (Table 2). This due to skim milk is a major source of lactose in yogurt manufacture.

The acidity of CSY drink

The analysis of variance result shows that both coconut sap and skim milk concentrations at 5% level significantly affect the CSYdrink acidity but not affect the interaction between them. However, these products have not met the yogurt drink's Acidity according to ISO standard ISO 2981: 2009. Acidity in yogurt ranged between 0.5-2.0%.

As described previously that initially *Streptococcus thermophillus* utilize the coconut sap's sucrose converted into glucose and fructose; which then *Lactobacillus bulgaricus* utilized the glucose in the subsequent fermentation process to produce acid. The more coconut sap the more sucrose contained, so the more acid can be produced from the fermentation

Acidity is inversely proportional to the pH of the resulting wherein the pH value increases with the increase of skim milk concentration. Coconut sap concentration of 10-50% is responsible for the decrease in pH compared with skim milk, but not in terms of generating lactic acid as shown that the total lactic acid concentration on the single factor of 10% skim milk can result in higher total lactic acid 5% skim milk. Lactose in skim milk is converted into glucose and galactose to produce lactic acid which the skim milk plays a role in the metabolism of lactic acid [13].

The viscosity of CSY drink

Results of analysis of variance CSY drink showed that the concentration of skim milk at 5% level significantly affect the viscosity of the product while the concentration of coconut sap and their combination treatment did not affect the viscosity of CSY drink produced .

The greater the concentration of skim milk, the greater the viscosity. This is consistent with research Kuntarso (2007) which states that the more the concentration of skim milk yogurt added, the viscosity will increase. Skim milk can increase the total solids of yogurt and increase the nutritional value of yogurt drink [7].

The results of analysis of variance at 5% level showed that coconut sap concentration treatment does not significantly affect the viscosity of CSY drink, although the average viscosity was shown to have different values. CSY drink with coconut coconut sap concentrations of 0% (no coconut sap) gave the highest average is 6.563 mPa.s which shows that coconut sap can not be fully utilized by *Lactobacillus bulgaricus* and *Streptococcus thermophillus* in the coagulants formation on the CSY drink. It is related to the low protein content in the coconut sap, therefore in acidic conditions only protein content of skim milk that can be coagulated. Tramer [16], found that the growth of *Lactobacillus bulgaricus* inhibited with increasing concentrations of sugar, however it's not affect the growth of *Streptococcus thermophilus.* Analysis of variance at 5% level stated that the interaction of skim milk and coconut sap concentrations did not significantly affect the viscosity of CSY dink, but the treatment of 10% skim milk without coconut sap gave the highest viscosity values of 9.75 mPa .s.

The reducing sugar of CSY drink

Results of analysis of variance at 5% level showed that skim milk concentrations treatment significantly affect the reducing sugar-content. Lactose as an energy source for the *Lactobacillus bulgaricus* and *Streptococcus thermophillus* growth broke down into glucose and galactose, which all are reducing sugars; therefore, the higher skim milk concentration the higher reducing sugar produced.

The analysis of variance result at 5% level stated that coconut sap and skim milk concentrations treatments and their combination treatments does not affect the reducing sugar of CSY dink. The highest levels of reducing sugar of 3.38 % wb, obtained at a combination of 10% skim milk and 50% coconut sap concentrations.

Total sugar of CSY drink

Analysis of variance at 5% level shows that coconut sap and skim milk concentration treatments both significantly affect the total sugar of CSY drink produced. Coconut sap contains sucrose; therefore, the higher of coconut sap concentration used, the higher the total sugar content of CSY drink produced Skim milk contains lactose as the main sugar that is converted into glucose and galactose by lactic acid fermentation by *Lactobacillus bulgaricus* and *Streptococcus thermophillus*. The more the amount of skim milk used, the higher the total sugar content.

Levels of total sugar produced is still high indicating that not all of the sugars contained in the coconut sap and skim milk completely utilized as an energy source / substrate for the growth and development of *Lactobacillus bulgaricus* and *Streptococcus thermophillus.* Azizah *et al.*, [1], reported on their research that the LAB (lactic acid bacterias) allegedly not utilize simple sugars that exist in jackfruit extracts characterized by the concentration of the extract had no significant effect on the pH value jackfruit generated.

Soluble protein of CSY drink

Based on the analysis of variance result at 5% level; skim milk and coconut sap as well as the interaction between them not significantly affect the levels of soluble protein content even though the average levels of the protein obtained has a different value. Soluble protein content decreased even the concentration of coconut sap 30% had higher levels of soluble protein concentrations higher than 10%. Soluble protein is a protein that is soluble in water, coconut sap contains a high water content, so the more concentration of coconut sap the more the water content of the yogurt drink produced.

Effect of coconut sap and skim milk concentrations on sensoric characteristic of CSY *drink* produced

The sensoric characteristics of CSYdrink produced due to variation on coconut sap and skim milk concentrations treatments are presented in Figure 1 and 2.

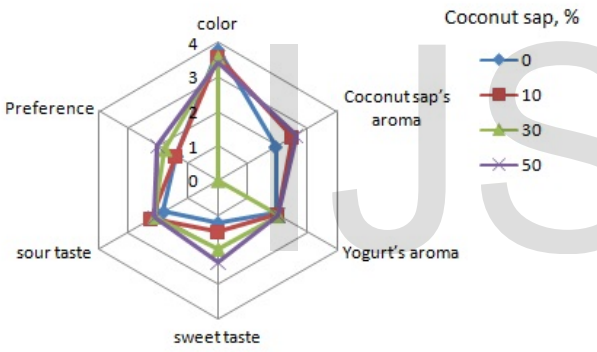

Figure 1. Effect of coconut sap concentrations treatments on the average value of CSY *drink's* s variables sensoric observed.

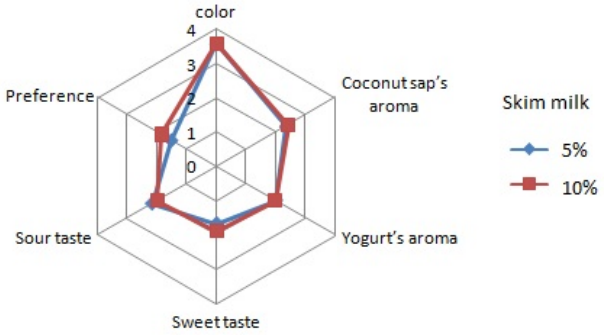

Figure 2. Effect of skim milk concentrations treatments on the average value of CSY *drink's* s variables sensoric observed.

Color

Analysis of variance results at 5% level appeared that the concentration of coconut sap significantly affect the color of CSYdrink produced (Fig.1).

Brown color is a result of Maillard reaction occurs during the initial treatment of coconut sap heated to boil for 20 minutes. Maillard reaction is formed by the interaction between amino acids with reducing sugars resulting in brown color of the product. Maillard reaction in general is influenced by the temperature where the greater the temperature the Maillard reaction will occur faster; as a result the color of product turn to brown faster [8].

Furthermore, analysis variance's resulted at 5% level showed that skim milk concentrations not significantly affect the color of CSY drink. Overall, based on assessment of the 20 panelists, the highest score of 3.28 (brownish white) obtained from treatment of coconut sap and skim milk at concentration of 50% and 10%; respectively (Fig.2)..

Coconut sap aroma

The variance analysis at 5% level is resulted that the concentration of coconut sap is significantly affect the aroma of CSY drink produced (Fig.1). The greater the concentration of coconut sap produce stronger aroma; while the concentration of skim milk did not significantly affect the aroma of CSY drink produced.

The coconut sap aroma is formed from Maillard reaction and caramelization on the cooking process [12]. Caramelization reactions contribute to the aroma, not only produce a brown color but also produce maltol and isomaltol compounds that have a strong caramel aroma and sweet taste [12]. The coconut sap aroma is very

strong and has a distinctive aroma during fermentation resulted in lasting scent of coconut sap which can still be detected on the CSY drink produced.

Results of analysis variance at 5% level showed that skim milk treatment not significantly affect the aroma of CSY drink produced (Fig.2).. Combination treatments of skim milk and coconut sap concentrations also not significantly affect the aroma of CSY drink produced; but panelists assessed the highest score of 2.7 (rather strong) obtained from treatment of coconut sap and skim milk at concentration of 50% and 5% ; respectively.

Yogurt's aroma

The analysis of variance result at 5% level showed that either coconut sap concentration or skim milk treatment not significantly affect the yogurt's aroma of CSY drink produced. Moreover, combination treatment of coconut sap and skim milk concentrations also not significantly affect the CSY drink produced yogurt's aroma.

Typical yogurt's aroma is formed due to the presence of lactic acid as a result of lactic acid fermentation by *Lactobacillus bulgaricus* and *Streptococcus thermophillus*. Aroma acid in the yogurt will be stronger when the lactic acid produced more and more and low pH products. However, in this study, the pH of CSY drink produced is quite high compared with yogurt drink in general.

Sweet taste

The sweet taste of CSY drink produced is contributed by coconut sap which high sucrose content (Fig.1). As the analysis variance result at 5% level showed that concentration treatment of coconut sap significantly affect sweetness on CSY drink produced. The higher concentration of coconut sap produced the more sweet CSY drink. *Lactobacillus bulgaricus* and *Streptococcus thermophillus* was unable to use the entire content of sucrose in coconut sap to convert it into lactic acid; resulting the sweet taste of CSYt drink produced is still strong. The use of coconut sap as an ingredient for preparation of CSY drink is capable to reduce the sour taste of the product.

However, the skim milk concentration treatments not significantly affect the sweet taste of CSYproduced. For the combination treatment between coconut sap and skim milk concentration; gave the highest score of 2.4 (rather sweet) obtained from concentration of 10% skim milk and 50% of coconut sap.

Sour taste

Results of analysis variance at 5% level showed that the concentration of coconut sap significantly affect the sour taste of CSY drink produced. Coconut sap plays a role in the pH decline of CSYdrink. The *Lactobacillus bulgaricus* and *Streptococcus thermophillus* are capable to break sucrose into glucose and fructose although not maximum provide the resulting pH is still high compared with yogurt drink in general (< 4.6) . It has an impact on the sour taste of CSY drink, of which 20 panelists gave the highest score of 2.388 (slightly acid) in the treatment of 10% skim milk and 30% coconut sap concentrations; respectively.

Furthermore, skim milk treatment resulted not significantly affect the sour taste of sour CSY drink produced. Also the combination treatment of coconut sap and skim milk not significantly affect the sour taste CSY drink, but the 20 panelists gave the highest assessment scores of 2,39 (slightly acid) at treatment of 10% skim milk and 30% coconut sap concentrations.

Preference

Panelist's preference is a conclusion of the overall organoleptic parameters; color, coconut sap's aroma, yogurt's aroma, sweet taste and sour taste. Harjiyanti *et al.*,[6], states that a consumer 's preference affected by several factors such as color, flavor and the appearance that attract consumers, benefits to consumers as well as the nutritional value of the product.

Results of analysis variance at 5% level showed that the concentration of coconut sap significantly affect panelist preference to CSYdrink produced.

Analysis variance at 5% level resulting that skim milk concentrations treatment significantly affect on a panelist preference on CSY drink produced. Based on the assessment of the panelists tend to prefer the CSYproduct with a concentration of 10%, 30% and 50% of coconut sap.

Based on the results of the study showed that the combination treatment of 10% skim milk and 50% coconut sap concentrations has the highest score of 2,18 (rather like). The panelist preference on a product describe that the product has gained good response and acceptable by the sensory panelists. Therefore, determining the best treatment based on the panelists acceptance representing consumer acceptance of the new products presented

Treatment of 10% skim milk concentration and 50% of coconut sap concentrations produced CSY drink wirh sensoric characteristics including brownish white, yogurt's aroma rather strong but also a rather strong of coconut sap's aroma, taste slightly sweet and slightly sour. The physic-chemical characteristics of the product are; pH of 4,975, acidity content of 0.219%. According to ISO 2981: 2009, acidity in yogurt ranged between 0.5-2.0%, therefore this product not meet the ISO standard ISO.

Reducing sugar is sugar which has the ability to reduce due to the free aldehyde or ketone group [9]. Reducing sugar content in the treatment 10% skim milk concentration and 50% of coconut sap concentrations produced CSY drink at 3.38%; is the highest reducing sugar levels compared with other treatments. The amount of reducing sugar contained indicates that there is still a lot of glucose, fructose and sukrose which can not be utilized by the bacteria *Lactobacillus bulgaricus* and *Streptococcus thermophillus* to produce lactic acid. This is influenced by the amount of coconut sap and skim milk used in the preparation of the CSY drink not comparable with the amount of lactic acid bacteria added.

Viscosity can be regarded as the main characteristic that distinguishes between yogurt and yogurt drink. Yogurt drink has a thinner texture than yogurt because the yogurt drink has higher water content than yogurt in general. Skim milk concentration is suspected contributed to CSY drink viscosity. The higher skim milk concentrations will increase the viscosity of the yogurt produced and add to the total solids of yogurt. This is consistent with research Kuntarso [10], which states that the more the concentration of skim milk added, the viscosity will increase. Skim milk can increase the total solids of yogurt and increase the nutritional value of yogurt drink [7].

4. Conclusion

Treatment of coconut sap concentrations affect sensoric characteristics in color, coconut sap's aroma, sweetness and sour taste, and panelist preference; physic-chemical characteristics in pH, acidity and total sugar of the CSY drink produced. While treatment of skim milk concentrations affect sensoric characteristic of panelist preference; physico-chemical characteristics in pH, acidity, total sugar, reducing sugar, and viscosity of the CSY drink produced. Overal, combination treatment of coconut sap and skim milk concentrations not affect either sensoric or physico-chemical characteristics of the CSY drink produced.

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