Vol. 12, No. 4 (2023) : 1010 - 1021
DOI : http://dx.doi.org/10.23960/jtep-l.v12i4.1010-1021

JURNAL TEKNIK PERTANIAN LAMPUNG

ISSN 2302-559X (print) / 2549-0818 (online)
Journal homepage : https://jurnal.fp.unila.ac.id/index.php/JTP

The Effect of Application of Low-calorie Sugar on Chemical, Physical, and Organoleptic Characteristics of Red Dragon (*Hylocereus polyrhizus*) Fruit Syrup

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Article History :

Received : 10 April 2023
Received in revised form : 1 July 2023
Accepted : 5 July 2023

Keywords :

Low-calorie sugar,
Obesity,
Organoleptic,
Red dragon fruit,
Syrup

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ABSTRACT

Syrup is a thick sugar solution with or without the addition of permitted food additives. Syrup usually uses high calorie cane sugar which can trigger obesity if it is not balanced by physical activity. This study aimed to determine the effect of low-calorie sugar application on chemical characteristics (including pH, vitamin C, reducing sugars, betacyanin), and physical characteristics (total dissolved solids) and organoleptic (including aroma, taste, color) in red dragon fruit syrup. The experiment was designed following randomized block design (RBD) with one-factor treatment, namely the concentration of sugar consisted of 5 treatments (K1: 3%, K2: 6%, K3: 9%, K4: 12%, K5: 15 %). Each treatment was repeated 5 (five) times to obtain 25 experimental units. The results showed that the application of low-calorie sugar significantly affected the syrup's chemical characteristics, namely reducing sugar. They had a significant effect on the physical characteristics of the syrup, namely the total dissolved solids. However, it did not significantly affect pH, vitamin C, and betacyanin levels. From the organoleptic test, the panelists liked red dragon fruit syrup the most, with a concentration of 15% for each organoleptic parameter, including aroma, taste, and color.

1. INTRODUCTION

Red dragon fruit is a popular fruit because it has a sweet taste. It also has attractive shapes and colors. Red dragon fruit contains compounds such as phenols, flavonoids, betacyanin, and vitamin C which have the ability to act as antioxidants (Maleta & Joni, 2018). Betacyanin functions to ward off free radicals or has antioxidant properties (Masyhura *et al*., 2018). The antioxidant activity of red dragon fruit juice tested using the DPPH (1,1-diphenyl-2-picrylhydrazyl) method was 20.7% (Purwanti, 2015).

Red dragon fruit is also rich in potassium (K), where 100 grams of red dragon fruit flesh contains 128 mg of potassium (Kemenkes R.I., 2017). The potassium contained in red dragon fruit is useful for lowering blood pressure (Nisa *et al*., 2019). Red dragon fruit has vitamin C levels of 32.62 mg/100g (Sumaryani & Dharmadewi, 2018). However, behind the nutritional content, red dragon fruit also is easily damaged because it has a high water content, so it cannot be stored for long time. Physiologically ripe red dragon fruit with dark red skin can only be stored at room temperature (25-28 ^{o}C) for 4 days after harvesting (Marlina *et al*., 2020). So red dragon fruit needs to be processed to extend its shelf life and increase added value.

One example of a processed product that can be made from red dragon fruit is syrup. According to SNI No. 01-3544-1994 (BSN, 1994), syrup is defined as a thick sugar solution (saccharose: High Fructose Syrup and/or other reducing sugar) with or without the addition of permitted food additives. Syrup usually uses cane sugar (sucrose), which is a natural sweetener which is known to have a high calorie content, namely 346.0 calories/100 g (Harismah *et al*., 2014). High calorie levels in processed products can trigger obesity if not balanced with physical activity. A lazy or sedentary lifestyle where a person rarely does physical activity can result in excess energy that is not used so that metabolic processes do not occur optimally which results in the accumulation of energy reserves and triggers obesity. (Rizona *et al*., 2020).

Obesity is a health problem that needs to be taken seriously because obesity is a gateway to many non-communicable diseases and is a major factor in COVID-19 complications and death (World Obesity Federation, 2021). One solution to reduce calorie intake for obese sufferers is to make processed syrup products with low-calorie sugar. Low-calorie sugar is sugar that still contains sucrose (cane sugar) with the addition of natural or artificial sweeteners. Natural sweeteners such as stevia (non-calorie) cannot be called low-calorie sugar if sucrose is not added. Some of the basic ingredients that are generally used to make low-calorie sugar are divided into artificial ingredients such as saccharin, aspartame, sucralose, neotame, acesulfame-K, and natural ingredients such as stevia. This ingredient is non-calorie (Dhaka *et al*., 2016). The low-calorie sugar used in this research is based on the non-calorie sweeteners stevia and sucralose and sucrose (cane sugar).

The application of low-calorie sugar in food products has advantages and disadvantages. One example is low-calorie sugar based on stevia, which has advantages including a level of sweetness that is 300 times the sweetness of sucrose, safe for consumption by obesity and diabetes sufferers because it is a non-calorie sweetener (Limanto, 2017). Apart from that, the advantages of stevia are that it is stable at high temperatures of 100 ^{o}C, and does not produce a dark color during cooking (Wuryantoro & Susanto, 2014). Meanwhile, the drawback of low-calorie stevia -based sugar is that it causes a bitter aftertaste (Garnida & Hasnelly, 2018). Sucralose-based low-calorie sugar has the advantage when applied to food products, namely that it is heat-stable so that the aroma of the food product will not be evaporated by heat, for example during the drying process. Besides, sucralose also does not cause a bitter aftertaste. Sucralose also has a sweetness level of 600 times that of sucrose and is non-calorie (Suraya *et al*., 2022). However, sucralose has a weakness, namely that if sucralose is consumed in excess of the recommended daily dose, it will cause a decrease in the number of beneficial microbes in the digestive tract by >50% (Prashant *et al*., 2012).

So far, several studies have been carried out on making syrup using stevia sweetener, however the use of low-calorie sugar based on a combination of stevia, sucralose and sucrose such as in PS 7 (Puteri Satu Tuju) sugar products in syrup has not been widely carried out. Therefore, to obtain chemical and physical characteristics and good organoleptic, research needs to be carried out with different concentrations. In research on beet syrup with a concentration of stevia extract, the results showed that the higher the concentration of stevia extract had a significant influence on the levels of vitamin C and betacyanin in beet syrup (Simarmata *et al*., 2019). Research on grape jelly drinks with varying low-calorie sugar concentrations based on stevia resulted that the total dissolved solids increased along with the stevia sugar concentration (Suryana *et al*., 2022). Celery syrup with sucralose sweetener and different levels of celery concentration show that the addition of sucralose can contribute a sweet taste to celery syrup which has a bitter taste (Silvia & Peppy, 2018). Based on this background, it is necessary to carry out research to determine the effect of the application of low-calorie sugar on chemical characteristics which include pH, vitamin C, reducing sugar, betacyanin, physical characteristics which include total dissolved solids (TDS), as well as organoleptic characteristics which include aroma, taste, and color of red dragon fruit syrup.

2. MATERIALS AND METHODS

The research was conducted from July to December 2022 at the Agricultural Product Processing Technology Laboratory, Department of Agrotechnology, Faculty of Agriculture and Business, Satya Wacana Christian University, Salatiga.

2.1. Tools and Materials

The main tools used in making red dragon fruit syrup are analytical scales (Mettler Toledo AL 204), gas stove, Philips brand blender, pan, basin, 20 mesh plastic filter, metal spoon, thermometer, 250 ml glass bottle, lid. bottle. The tools used in chemical analysis in the research are: UV VIZ spectrophotometry (Shimadzu UV-1280), cuvette, water bath (Memmert), pH meter, 100 ml measuring flask, measuring pipette, glass beaker, dropper pipette, Erlenmeyer, stirring rod, burette and static, vortex (Memmert), funnel, test tube, measuring pipette and filler, filter paper, analytical balance (Mettler Toledo AL 204), while the tool used for physical analysis is a hand refractometer (ATAGO NI)

The materials used in the research were: dragon fruit of the red dragon variety (*Hylocereus polyrhizus*) obtained from Pasar Raya Salatiga, low-calorie sugar of the PS 7 brand obtained from an online shop (shoppe) with a stevia glycoside composition of 0.85%. Other materials included sucralose 98.49%, Iodine 0.01 N, starch 1%, carboxymethyl cellulose (CMC) 0.2%, Nelson's reagent, distilled water, arsenomolybdate reagent, anhydrous glucose, and citrate-phosphate buffer pH 5.

2.2. Experimental Design

Five treatments was determined and arranged in a non-factorial randomized block design. The treatment was the addition of low-calorie sugar with different concentrations consisting of K1 (3%), K2 (6%), K3 (9%), K4 (12%), K5 (15%). All measurements were replicated 5 times. No control treatment was used in this study. Experimental data from each treatment was processed using the SAS 9.4 application to carry out analysis of variance (ANOVA). If the treatments were significant, the data was further analyzed by DMRT (Duncan Multiple Range Test) at a level of 5%.

2.3. Research Steps

Red dragon fruit was sorted, washed and then peeled. After peeling, the dragon fruit was cut into pieces and weigh 500 g, then mashed it with a blender and added with 300 ml of clean water. Then filtration was carried out using a 20 mesh Pup brand plastic filter to separate the fruit juice from the dregs. As much as 400 ml of red dragon fruit juice was taken for each treatment. Red dragon fruit juice was added with low-calorie sugar with a composition of 12 grams (3%), 24 grams (6%), 36 grams (9%), 48 grams (12%), 60 grams (15%). Next, the mixture was heated on a stove and 0.2% CMC was added to the syrup during cooking. The syrup was heated until it boils for 5 minutes, then the red dragon fruit syrup was ready for bottling.

2.4. Analysis Methods

2.4.1. pH **(Muchtadi, 2010)**

pH measurements were carried out using a pH meter (Hanna HI 9125). Before measurement, the pH meter was calibrated first using a buffer solution of 7.0 and 4.0. One ml of the syrup sample was pipetted and 3 ml of distilled water was added, stirred until homogeneous. The electrode was inserted into the syrup sample and left a while to get a stable reading and the pH was value recorded.

2.4.2. Vitamin C content **(Iriani *et al*., 2005)**

As much as 10 ml sample of red dragon fruit syrup was pipetted and then transfered it into a 100 ml measuring flask to reach the test limit using distilled water. The sample was then filtered using filter paper with a pore diameter of 15-20 µm, then 10 ml of the filtered results was pipetted and then transferred into an Erlenmeyer flask. The next step was pipetting 2 ml of 1% starch (as an indicator) and adding 20 ml of distilled water. The solution was shaken until it was evenly mixed. Then titration was carried out with I_2 (iodine) until the color of the solution changes to blue. The titration volume was then recorded and the Vitamin C was calculated as the following:
where 0.88 mg is equivalent value of ascorbic acid in 1 ml of iodine.

$$\text{Vitamin C content in 10 ml} = \text{titration volume} \times 0.88 \text{ mg} \tag{1}$$

2.4.3. Reducing Sugar Content **(Iriani *et al*., 2005)**

Preparation of a standard glucose solution according to Sudarmadji *et al*. (1997) was carried out in the following way: 10 mg of anhydrous glucose was dissolved in distilled water in a 100 ml measuring flask. Five dilutions were made from the standard glucose solution to obtain glucose solutions with concentrations of 2, 4, 6, 8 and 10 mg/100 ml. Next, from the standard glucose solution, 1 ml of each pipette was then transferred to a test tube, and one test tube was given 1 ml of distilled water as a blank. The test tubes containing the standard glucose solution were then added to each with 1 ml of Nelson's reagent and heated in a water bath for 20 min. The heated reaction tube was then cooled until the temperature reaches 25 °C. The cooled tube was then given 1 ml of arsenomolybdate reagent and shaken until all the Cu_2O precipitate was dissolved, then added with 7 ml of distilled water and shaken until homogeneous. The optical density (OD) of each tube was measured at a wavelength of 540 nm and then a line equation was determined based on the OD and concentration of the standard solution as follows:

$$Y = a + bX \tag{2}$$

where Y = optical density (OD), and X = reducing sugar content.

Analysis of reducing sugar content according to Iriani *et al*. (2005) was carried out by pipetting a 10 ml sample of red dragon fruit syrup and transferring it into a 100 ml measuring flask, then added distilled water up to the test level. One ml of fitrate was taken and added with 9 ml of distilled water (100x dilution), then vortexed it. A total of 1 ml of filtrate from a 100x dilution, was then added with 1 ml of Nelson's reagent and then heated for 20 min. One ml of arsenomolybdate solution and 7 ml of distilled water was added. Absorbance at 100x dilution was measured using a spectrophotometer at a wavelength of 540 nm. The reducing sugar content was determined using the standard series regression formula (mg/ml):

$$Y = a + bX \tag{3}$$

$$\text{Reducing sugar content (mg/ml)} = \frac{X \times FP}{mg\ sample} \times 100\% \tag{4}$$

where *Y* is absorbance value, *X* is reducing sugar, *a* and *b* are regression constants, and *FP* is dilution factor.

2.4.4. Total Betacyanin Content **(Khuluq *et al*., 2007)**

Total betacyanin analysis in red dragon fruit syrup samples was conducted without extraction first because the samples were liquid. A sample of 1 ml of red dragon fruit syrup was taken using a measuring pipette and transferred to a test tube, then the sample was diluted with citrate-phosphate buffer pH 5, then transferred to a cuvette with a thickness of 1 cm and the absorbance was measured with a wavelength of 537 nm and 500 nm. The absorbance value was calculated with A = 1.095 (λ537nm-λ500nm). The formula for determining total betacyanin was as follows:

$$\text{Betacyanin content (mg/L)} = \frac{A \times fp \times BM \times 1000}{\varepsilon \times l} \tag{5}$$

where BM is molecule weight of standard betacyanin (550 g/mol), ε is extinction coefficient for standard betacyanin (60000 L mol^{-1} cm^{-1}), *l* is cuvete thickness (1 cm), *FP* is dilution factor for test sample by buffer pH 5 (*FP* = 5)

2.4.5. Total Dissolved Solids **(Mukaromah *et al*., 2010)**

Measurement of total dissolved solids (TDS) used a tool, namely a hand refractometer (ATAGO NI), which was done by dropping a sample of syrup on the sensor glass of the refractometer. Next, the scale reading was carried out by looking at the refractometer binoculars. Total dissolved solids were expressed in percent Brix (°Brix).

2.4.6. Organoleptics **(Rifkowaty & Martanto, 2016)**

Organoleptic testing used the hedonic method to measure the level of panelists' preference. The method referred to (Rifkowaty & Martanto, 2016) with modifications, using 30 untrained panelists. The panelists were students from Satya Wacana Christian University. The assessment method used the five human senses to assess the aroma, taste, and color of red dragon fruit syrup products with different concentrations low-calorie sugar. The assessment employed Likert scale in the form of numbers one to five, where 1: highly disliked, 2: disliked, 3: moderately liked, 4: liked, 5: highly liked. The score to obtain a percentage was based on the assessment criteria for each hedonic test. The score to get the percentage (%) was formulated as follows (Sumartini *et al*., 2020):

$$\% = \frac{n}{N} \times 100\% \quad (6)$$

where % is the percentage score, n is number of the collected score, and N is the ideal score (in this case is highest score x number of panelist = 5 x 30 = 150). The percentage score was interpreted using classification as in Table 1.

Table 1. Classification of hedonic scale

Hedonic Scale	Interval score
Highly disliked	0%-19,99%
Disliked	20%-39,99%
Moderately liked	40%-59,99%
Liked	60%-79,99%
Highly liked	80%-100%

3. RESULTS AND DISCUSSION

Table 2 shows characteristic for low-calorie sugar syrup made from red dragon fruit with different low-calorie sugar concentration treatments. Analysis variance (ANOVA) resulted that treatments are significant for pH, reducing sugar, and TDS of the syrup. The treatments, however, are not significant for vitamin C and betacyanin. Each property of the produced syrup is discussed in the following.

3.1. pH

The red dragon fruit used in this research has a pH of 4.35 which is categorized as acidic. Meanwhile, the pH of the resulting syrup has a higher pH than the initial pH of dragon fruit, which is between 4.820 (medium acid) to 5.448 (low acid). This can happen because in this study the low-calorie sugar used was based on stevia and sucralose which have a higher pH than red dragon fruit, namely 7.2, so the pH of the syrup produced was higher than the initial pH of red dragon fruit. This is supported by the statement of Saepudin *et al.* (2014) that syrup preparations sweetened with sucralose produce a neutral pH, namely 6 because sucralose has a stable pH. Meanwhile, the pH of stevia is in the range of 5-6 (Simarmata *et al.*, 2019), so that giving low-calorie sugar causes the pH of the syrup to be higher than the initial pH of the fruit. In Table 2, it can be seen that the treatment with the addition of low-calorie sugar had a significant effect on the pH of the syrup. The addition of low-calorie sugar at a concentration of 9% (K3) produces a syrup pH that is significantly greater than the pH of syrup with a low-calorie sugar concentration of 9% (K3). This is in accordance with the statement of Noormala *et al.*, (2022) where the higher the sugar concentration, the higher the pH of the soursop syrup produced. However, the effect of increasing the concentration of low-calorie sugar on the pH of dragon fruit syrup is not consistent. This can be seen in the pH of dragon fruit syrup with a higher concentration of low-calorie sugar (12-15%) which results in a syrup pH higher than K1 but not statistically significant. This may be caused by the unstable cooking temperature factor because the cooking temperature cannot be controlled, causing the pH parameters of the syrup to be inconsistent. This is supported by Hadiwijaya (2013) who states that temperature and cooking time are factors that influence pH.

Table 2. Effect of low calorie sugar application on chemical (pH, vitamin C, reducing sugar, betacyanin) and physical (total dissolved solids) characteristics of red dragon fruit syrup

Syrup characteristic	Treatment				
	K1 (3%)	K2 (6%)	K3 (9%)	K4 (12%)	K5 (15%)
pH	4.82 b	5.098 ab	5.448 a	5.036 ab	5.036 ab
Vitamin C (mg/10ml)	0.6512 a	0.6160 a	0.5632 a	0.6636 a	0.8096 a
Reducing suger (mg/ml)	1.6164 e	2.0286 d	2.3254 c	2.5932 b	3.1118 a
Betacyanin (mg/L)	61.613 a	67.770 a	63.186 a	66.214 a	65.143 a
TDS (^{o}Brix)	10.86 e	13.66 d	16.38 c	19.06 b	21.88 a

Note: Numbers followed by the same letter in the same row are not significantly different in the DMRT test at the 5%

3.2. Vitamin C content

The DMRT test results at the 5% level showed that the addition of low-calorie sugar did not have a real effect on the vitamin C content of red dragon fruit syrup. This could happen because the low-calorie sugar in this study is thought to not be able to play a role in increasing vitamin C in syrup. This is because the low-calorie sugar used in this research is based on sucralose, stevia glycosides and sucrose, all of which do not contain vitamin C. Apart from that, the addition of low-calorie sugar can actually help dissolve vitamin C in water, so that the dissolved vitamin C in the water during the heating process will evaporate and become damaged. This is supported by the statement of Asmawati *et al*. (2018) that the addition of higher levels of sugar causes vitamin C which is already dissolved in water to be bound by sugar so that during the heating process evaporation occurs and vitamin C is lost.

3.3. Reducing Sugar Content

The results of the DMRT test at a level of 5% showed that there was a significant effect of low-calorie sugar concentration treatment on reducing sugar levels. The highest reducing sugar content was obtained with the addition of 15% low-calorie sugar, namely 3.1118 mg/ml and the lowest reducing sugar content of red dragon fruit syrup was obtained with the addition of 3% sugar, namely 1.6164 mg/ml. This can happen because the more low-calorie sugar that is added means that more sugar is dissolved in a solution so that the level of reducing sugar will also increase. This is in accordance with the statement of Asmawati *et al*. (2018) that the higher the sugar concentration added, the higher the reducing sugar content in the red dragon fruit syrup obtained. Apart from that, the sucrose decomposition process is also influenced by pH. Sucrose will decompose into reducing sugar (glucose) in an acidic environment, and in this study the pH of the syrup was in the range of 4-5 which is considered acidic and can contribute to the process of decomposing sucrose into reducing sugar in red dragon fruit syrup. This is also supported by Winarno's (2007) statement that the sucrose inversion process occurs in an acidic atmosphere, where the higher the heating temperature, the greater the percentage of the formed invert sugar.

3.4. Betacyanin

Red dragon fruit is a plant that is rich in betacyanin. Betacyanin is a flavonoid pigment that is bound to sugar so it is polar and a nitrogenous pigment (Andersen & Markham, 2006). Betacyanin is a red-violet pigment. Betacyanin acts as an antioxidant which is beneficial for health (Maleta & Joni, 2018).

Red dragon fruit syrup without low-calorie sugar has a betacyanin level of 62.651 mg/L, which is not much different from red dragon fruit syrup given low-calorie sugar, the betacyanin level is in the range of 61-67 mg/L. The results of further DMRT tests with a level of 5% showed that low-calorie sugar concentrations did not have a real effect on the betacyanin levels of red dragon fruit syrup. This shows that the addition of low-calorie sugar in this study could not increase the betacyanin levels of red dragon fruit syrup. The low-calorie sugar used in this study is based on stevia and sucralose, and sucrose, where the low-calorie sugar in this study does not contain betacyanin, so the addition of low-calorie sugar cannot increase the betacyanin levels of red dragon fruit syrup. In addition, the stability of betacyanin is influenced by pH and temperature. The pH obtained in this study ranged from 4-5, which is still in the optimum pH range for betacyanin stability, however the temperature used in the process of cooking red dragon fruit syrup was unstable because the cooking temperature was not controlled. This can cause unstable betacyanin levels so that there is no real difference in the betacyanin levels of red dragon fruit syrup. This is supported by the statement by Asra *et al*. (2019) that the stability of betacyanin pigment is influenced by temperature and pH. Betacyanin is stable at temperatures below 40 ^{o}C and pH 4-6. At high temperatures and critical pH, a hydrolysis reaction occurs which causes betacyanin to change to betalamic acid (yellow). The results of our research, however, differ from the results of research by Simarmata *et al*. (2019) on making beetroot syrup where increasing the concentration of stevia caused a significant increase in betacyanin levels.

3.5. Total Dissolved Solids (TDS)

The results of the DMRT test showed that the low-calorie sugar concentration had a significant effect on the total dissolved solids of red dragon fruit syrup at 5% level. The higher the sugar concentration causes the TDS to increase (Table 2) because the more low-calorie sugar is added, which means that the more solid fraction is added, the higher TDS increases. This is supported by Kinanti & Julfi (2023) that the higher the concentration of sucralose added, the higher the TDS of the green okra functional drink. Breemer *et al*. (2021) also reported that the increase in TDS is caused by the nature of sugar which dissolves easily in water so that the more sugar concentration added, the more TDS from the Gandaria fruit syrup produced.

3.6. Organoleptic

Table 3 shows the percentage of average scores for the level of liking regarding the aroma, taste and color of red dragon fruit syrup with the addition of low-calorie sugar obtained from a hedonic test with 30 untrained panelists.

Table 3. Preference level of panelis on the red dragon fruit syrup added with low-calori sugar

Hedonic parameter	Treatment				
	K1 (3%)	**K2 (6%)**	**K3 (9%)**	**K4 (12%)**	**K5 (15%)**
Aroma	52% (CS)	55% (CS)	60% (S)	63% (S)	68% (S)
Taste	57% (CS)	68% (S)	81% (SS)	73% (S)	81% (SS)
Color	75% (S)	76% (S)	81% (SS)	81% (SS)	81% (SS)

Note: SS = highly liked, S = liked, CS = moderately liked.

a. Aroma

Factors that influence the quality of a food include color, taste, aroma and nutritional content. The aroma factor influences the quality of red dragon fruit syrup because aroma plays a role in making consumers interested in a food product. The results of the aroma assessment showed that it was liked enough by the panelists. The red dragon fruit syrup in this study had a normal aroma and no strange aroma or odor. Panelists liked the aroma of red dragon fruit syrup with the addition of low-calorie sugar ranging from a concentration of 9% to 15%, and the highest score was obtained at a concentration of 15% with a liking index value of 68% (like). The aroma of the syrup comes from red dragon fruit, while red dragon fruit itself does not have a distinctive aroma like durian or jackfruit. Yanti *et al*. (2015) stated that the aroma of dragon fruit is fruity or the typical aroma of fruit in general, and is different from white dragon fruit which has a dominant sweet aroma. Therefore, red dragon fruit has an aroma that is not as strong as white dragon fruit. Apart from that, the addition of low-calorie sugar based on stevia and sucralose in this study also did not play a role in bringing out the aroma in red dragon fruit syrup. This is in line with Amalia's (2016) research where the concentration of stevia sugar did not affect the aroma of the drink. This is because stevia sugar does not have a distinctive aroma like palm sugar or other types of sugar. Apart from that, sucralose also does not contribute a distinctive aroma to the syrup. The aroma produced from red dragon fruit syrup at each concentration can also be categorized as normal, because the aroma that arises is the aroma of red dragon fruit as in general, so the aroma of red dragon fruit syrup in this study meets SNI 3544 (BSN, 2013) where the good syrup give normal aroma and do not strange odor.

b. Taste

In food products, taste is generally a determining factor whether a product is liked or not by consumers. The results of the assessment of the taste of red dragon fruit syrup in Table 3 show that the low-calorie sugar concentration of 3% is the least preferred because it has a bland taste. The higher the sugar concentration, the sweeter the syrup will be. This is because the low-calorie sugar used in this study is based on stevia and sucralose which produces a higher level of sweetness than sucrose. Stevia has a sweetness level of 300 times that of sucrose (Limanto, 2017), while sucralose has a sweetness level of 600 times that of sucrose (Suraya *et al*., 2022). The highest scores for the taste parameters of red dragon fruit syrup were at concentrations of 9% and 15% with an index value of 81% in the highly preferred (SS) category. Panelists who don't like sweets tend to choose red dragon fruit syrup with a low-calorie sugar concentration of 9%, while panelists who like sweets prefer a concentration of 15%. Based on the standards set by SNI 3544 regarding syrup (BSN, 2013), the taste of good syrup does not contain any strange tastes, so it can be said to be normal. The taste produced from red dragon fruit syrup in this study was categorized as normal because there was no foreign taste, so it met the SNI.

c. Color

Color is also an important factor in whether a product is liked by consumers because the first thing consumers see before knowing the taste is the visual aspect first. A beautiful color will give the impression that the food or drink tastes good compared to a product that has an unattractive color even though the composition is the same. Food or drinks that are less attractive are often assumed to have an unpleasant taste (Isnaini & Khamidah, 2011). The results of the organoleptic assessment for color generally panelists liked the color of red dragon fruit syrup starting from a low-calorie sugar concentration of 3% and 6% with an index value of 75-76% which was included in the (like) category, while the highest index value was at a sugar concentration of 9%. 12% and 15% with a score of 81% in the (highly liked) category. Panelists preferred the color of syrup at a concentration of 9% to 15% compared to concentrations of 3% and

6%, this shows that the more low-calorie sugar added, the more attractive the color of the red dragon fruit syrup produced. This can happen because the more low-calorie sugar is added and the syrup heating process will produce a deeper color due to the caramelization process of the sucrose contained in low-calorie sugar. The addition of low-calorie sugar at a concentration of 9-15% produces a deep purplish red color and is preferred by panelists. Fitriyono (2010) reports that if sugar is continuously heated until its temperature exceeds its melting point, a caramelization process will occur. This caramel formation can improve the taste and color of food.

4. CONCLUSION

Based on the results and disccusion, it can be inferred that the application of low-calorie sugar has a significantly different effects on the chemical characteristics of the syrup, namely pH and reducing sugar. The treatment was also statistically significant for physical characteristics of the syrup, namely total dissolved solids. The low-calorie sugar concentration, however, did not significantly affect vitamin C and betacyanin levels. From the organoleptic test, the panelists liked red dragon fruit syrup the most with a low-calorie sugar concentration of 15% for all hedonic parameters including aroma, taste, and color. The best low-calorie sugar concentration is 15% because it produces the highest levels of reduced sugar and total soluble solids, and produces the syrup most liked by the panelists.

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