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Siam orange (*Citrus nobilis* L.) nectar characteristics with variations in stabilizer and sucrose level

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Abstract

The Siam orange (*Citrus nobilis* L.) has low economic value because of its sour taste and unattractive appearance. However, processing the fruit into nectar can increase its value. Nectar production requires the addition of sugar and the appropriate stabilizer for consumer acceptance. This research aimed to study the ideal combination of sucrose and stabilizer in Siam orange nectar production. A factorial completely randomized design was employed with two factors, the concentration of sucrose (10%, 15%, and 20%) and the type of stabilizer (CMC, carrageenan, pectin). As more sucrose was added to the juice, the moisture content decreased and the volume of soluble solids increased. The type of stabilizer only affected nectar pH and viscosity. CMC produced the highest nectar pH, followed by carrageenan and pectin. However, based on the results of the analysis of all parameters using the effectiveness index, carrageenan was the best stabilizer. Orange nectar with 20% sucrose and 0.5% carrageenan contained 24.2% total soluble solids, 76.6% moisture content, 7.9% reducing sugar, 23.5% vitamin C, and 3.38% crude fibre, with a viscosity of 109 cP and pH of 3.7. The product's sensory characteristics were an orange colour, a sweet, citrus aroma, and a slightly thick texture. Additional research on the storage stability of this nectar formulation is necessary.

1. Introduction

There is high potential genetic diversity in Indonesia's citrus fruits, and the country's orange production is substantial, reaching 2,510,442 tons in 2018 (Badan Pusat Statistik, 2020). One variety of orange grown in Indonesia is the Siam orange (*Citrus nobilis* L.), which constitutes approximately 80–85% of citrus production in Indonesia (Hanif and Zamzami, 2012). However, they have a sour taste, and their greenish or yellowish skin colour is unevenly distributed. Currently, consumers tend to prefer sweet oranges (*Citrus sinensis*) for direct consumption, demonstrating less interest in Siam oranges, particularly sour ones (Sadeli and Utami, 2013). The compositions and properties of oranges vary by type (De-Carvalho *et al*., 2020), and orange fruits can be easily damaged, making their shelf life relatively short (Arshad *et al*., 2019). These factors indicate that appropriate technology is needed to increase the economic value of Siam oranges, one method of which is to process the oranges into nectar (Lozano *et al*., 2020).

Nectars are fermented or unfermented products obtained by adding water to fruit juice, concentrated fruit juice, fruit puree, or concentrated fruit puree, or a mixture of these that conform to the specifications and may contain up to 20% added sugar (De Sousa *et al*., 2010). Depending on the fruit type, the minimum fruit content in fruit nectar is approximately 25 to 50% (Krumreich *et al*., 2018), but nectar can be 10–99% fruit pulp or juice (Najafabadi *et al*., 2020). Highly acidic and fibrous fruits are often transformed into nectar. Adding water makes the nectar more drinkable. Nectar production may also involve heating and filtration processes, possibly affecting the concentration of bioactive compounds. Nectar turbidity is associated with colloidal suspensions in varying amounts, and the solid content is usually 5 to 20% (w/w) (Krumreich *et al*., 2018). The same kind of fruit with different compositions require different and precise nectar formulations (Bahlol *et al*., 2018).

The production of fruit nectar has been studied for multiple fruits, such as mango (Lozano *et al*., 2020), soursop (Tran *et al*., 2020), guava (Krumreich *et al*., 2018), peach (Nedić-Tiban *et al*., 2003), and mixed fruits

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(Bahlol *et al*., 2018). Furthermore, Stella *et al*. (2011) investigated the antioxidant activity of commercial orange nectar of *Citrus reticulata*, and Matiashe *et al.* (2014) developed nectar from lemons (*Citrus limon*). However, the production and composition of nectar from Siam orange (*Citrus nobilis* L.) have not been investigated, and this research is necessary to increase the fruit's economic value.

Adding sucrose to nectar increases the sweetness and enhances the flavour (Nedić-Tiban *et al*., 2003). Sucrose is a sweetener that is colourless and soluble in water. It can play an important role in increasing the acceptance of certain foods (Brochier *et al*., 2019), and its addition will help develop a product with the desired properties. For example, working with guava, Khan *et al.* (2014) found that different concentrations of sucrose produced guava bars with different characteristics. Furthermore, Ferrarezi *et al.* (2013) stated that consumers' desire to buy orange juice and nectar is influenced by sensory properties, in addition to price and labelling. Hoffmann *et al*. (2017) developed *Butia* fruit nectar using a xanthan gum stabilizer and variable amounts of added sucrose, and the authors found that samples with 14°Bx sucrose had the best sensory characteristics, including colour, aroma, flavour, sweetness, and overall acceptability.

Stabilizers increase the nectar's viscosity, physical consistency, and stability (Hoffmann *et al*., 2017). In the production of orange nectar, carboxymethylcellulose (CMC), carrageenan, and pectin can be used, and different stabilizers are appropriate depending on the nectar produced. CMC as sodium carboxymethyl cellulose salt provides good shape, consistency, and texture. It also acts as a water binder, thickener, emulsion stabilizer, and gum texture (Akkarachaneeyakorn and Tinrat, 2015). In the production of soursop and mango nectars, CMC is used as a stabilizer and produces nectar of good viscosity (Tran et *al*., 2020; Lozano *et al*., 2020). Carrageenan is seaweed sap extracted from certain Rhodophyceae species using water or an alkaline solution. It is an emulsifier, thickener, and stabilizer (Nedić-Tiban *et al*., 2003) that was shown to provide greater viscosity than CMC in the production of dragon fruit velva (Basito *et al.*, 2018). Pectin is a type of α-D-galacturonic acid carbohydrate biopolymer that contains methyl ester and can be extracted from fruit flesh and skin with an acidic solvent. It is often used as a stabilizer in foodstuffs, jelly ingredients, and films (Krumreich *et al*., 2018). When preparing guava nectar, pectin has demonstrated good viscosity generation and vitamin C retention during storage.

The objectives of this study were to examine Siam orange nectar's physical, chemical, and sensory properties using different sugar concentrations, determine the physical, chemical, and sensory effects of an added stabilizer and determine the combination of sucrose concentration and stabilizer that produces the best Siam orange nectar.

2. Materials and methods

2.1 Materials

Siam oranges (*Citrus nobilis* L.) were purchased from a local market in Purwokerto, Indonesia. The stabilizers tested were carrageenan (kappa carrageenan, produced by CV Karagen Indonesia), CMC (Butterfly brand, purchased from Intisari, Purwokerto, Indonesia), and powdered pectin (low methoxy pectin, product of PT Chemindo Ekatama).

2.2 Experimental design

The research used a factorial completely randomized design with two factors: sucrose concentration (at 10%, 15%, and 20%) and three types of stabilizers (CMC, carrageenan, and pectin). The treatments were arranged factorially to obtain nine treatment combinations, and each treatment combination was repeated three times to obtain 27 experimental units. The data were analyzed by ANOVA (F-test). If the ANOVA revealed a significant effect, Duncan's multiple range test (α = 5%) was performed.

2.3 Production of nectar

The orange nectar was produced according to Hoffmann *et al.* (2017), with modifications to the ingredient proportions and stabilizer type. The nectar was made by mixing water and pulp (1:4), sucrose, and stabilizer. The amount of sucrose added was 15%, 20%, or 25% (w/v). The stabilizer used was carrageenan, CMC, or pectin. Nectar samples (150 mL) were pasteurized in a 250 mL bottle for three minutes at 100±5°C. The nectar was cooled at 30°C until it reached 28°C, then analyzed.

2.4 Nectar sample analyses

Moisture content, reducing sugar content, soluble solids, crude fibre, vitamin C, viscosity, and pH were determined. Moisture content was determined by the oven method (AOAC, 2005). Soluble solids were measured using a refractometer (AOAC, 2005) and the pH was measured using a pH meter (AOAC, 2005). Reducing sugars were analyzed using the Nelson–Somogyi method, and viscosity was measured according to Steele *et al.* (2014). The crude fibre was analyzed using the gravimetric method (AOAC, 2005).

Total soluble solids (TSS) were measured with a refractometer after calibration. Several drops of each sample were placed on a blue prism and the TSS (°Bx) read. The refractometer was calibrated after each sample.

The reducing sugar was measured in 2 g of sample diluted with distilled water to 100 mL. From the solution, 1 mL was taken and then diluted with distilled water to 10 mL. To 1 mL of this second solution, 1 mL of Nelson's reagent was added. The solution was heated in a water bath for 20 mins. The sample was cooled by holding the flask under running water, 1 mL of arsenomolybdate was added, the sample was shaken using a vortex, and 7 mL of distilled water was added. The absorbance was measured using a spectrophotometer at a wavelength of 540 nm. Reducing sugar content can be measured by converting the absorbance with a standard curve.

Viscosity was measured using a viscometer (Steele *et al.*, 2014). A spindle rod was installed on a viscometer with a number that corresponded to the type of sample. The spindle rod was inserted into the sample in a glass beaker. The viscometer was turned on, and the viscosity was read after 5 mins using the viscometer scale. All values were converted to viscosity according to the speed and spindle used.

The crude fibre was analyzed by the gravimetric method (AOAC, 2005). To 2 g of sample in a 250 mL Erlenmeyer flask, 50 mL of 1.25% H_2SO_4 solution was added. The sample was heated for 30 mins, and 50 mL of a 3.25% NaOH solution was added. The sample was reheated for 30 mins in an 80°C water bath. The suspension was filtered through filter paper that had been oven-dried and weighed. The residue left in the filter paper was washed with 15 mL of hot 3.25% H_2SO_4 and 15 mL of boiling distilled water, then washed again with 15 mL of hot 96% ethanol. Sample washing was continued until the washing water was not acidic. The filter paper was dried in an oven at 110°C to a constant weight, cooled in a desiccator, and weighed. Crude fibre content was calculated based on the ratio between the dried residue and the initial sample weight.

The pH was measured using a pH meter (model Do700 Extech Instruments, Shanghai, China). Before use, the pH meter was calibrated using buffer solutions of pH 7 and pH 4. Then, the pH meter electrode was dipped into a sample of orange nectar until the value stabilized.

Vitamin C was determined using the titration method based on the reduction of the indicator 2,6-dichlorophenol. The sample (5 g) was added to a 100 mL volumetric flask, and distilled water was added to 100 mL. The filtrate was homogenized, filtered, and 25 mL was added to an Erlenmeyer flask with 1 mL of 1% starch solution. The filtrate was then titrated with a standard 0.01 N iodine solution until a colour change occurred.

The sensory evaluation utilized the Meillgard method (De Sousa *et al.*, 2010). Sensory analysis was performed, using test scores for taste, colour, aroma, thickness, and preference parameters on a scale of 1 to 5. The scales for taste were 1 = bitter and 5 = very sweet; for colour, 1 = light yellow and 5 = very orange; for aroma, 1 = not strong and 5 = very strong; for viscosity, 1 = not thick and 5 = very thick; for personal preferences, 1 = dislike and 5 = like very much. Twenty trained panellists were employed, and the Friedman test was used to analyze the organoleptic results. If there was an effect, a multiple comparison test with α = 5% was conducted. The orange nectar sensory test variables based on a numeric scale can be viewed in Table 1.

3. Results and discussion

3.1 Total soluble solids

The concentration of sucrose significantly affected the TSS of orange nectar. The greater the quantity of sucrose added, the higher the nectar TSS. The highest soluble solid value was 23.4°Bx, with the addition of 20% sucrose (Figure 1). Sucrose contains high TSS. According to Krumreich *et al.* (2018), the solid content of sucrose is 95%, and the more sucrose added, the greater the TSS. This result is consistent with the increase detected in sucrose content as the TSS in orange nectar increased (Stella *et al.*, 2011).

The interaction between the sucrose concentration and the type of stabilizer had a significant effect on TSS (Figure 2). The highest TSS values were found with the addition of 20% sucrose and carrageenan as stabilizers. Carrageenan has higher TSS than CMC and pectin due to its high protein content of 3.4%, while CMC has no protein (Septianti *et al.*, 2019). The 20% sucrose in this study provided higher TSS than the 10% and 15%, and

Table 1. Numeric scale of attribute

Numeric Scale	Colour	Taste	Aroma (citrus flavour)	Viscosity	Preference
1	Light yellow	Not sweet	No citrus flavour	Thin	Dislike
2	Dark yellow	Little sweet	Little	Little thick	Little like
3	Slightly orange	Slightly sweet	Slightly	Slightly thick	Slightly like
4	Orange	Sweet	Citrus flavour	Thick	Like
5	Very orange	Very sweet	Very strong	Very thick	Very like

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in combination with carrageenan as a stabilizer, it produced orange nectar with the highest TSS, at 24.1°Bx. With 10% sucrose added with CMC, carrageenan, and pectin stabilizers, the nectar showed no significant differences in TSS, at 16.3, 16.4, and 16.8°Bx, respectively (Figure 1).

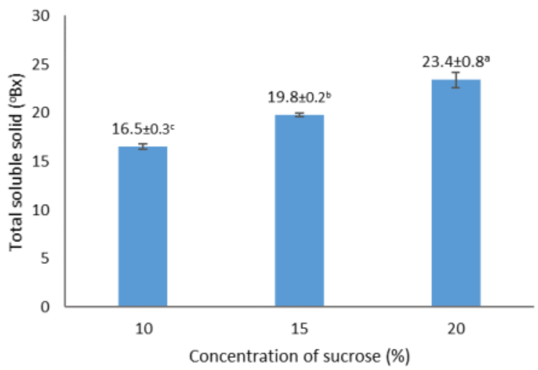

Figure 1. Effect of sucrose levels on the soluble solids of the orange nectar. Values with different superscript are significantly different ($p<0.05$).

As free water was bound by a stabilizer, TSS increased. As more particles bind to stabilizers, the TSS increases, and the precipitate decreases. In the presence of a stabilizer, the suspended particles will be trapped in the system and will not settle under the influence of gravity (Krumreich *et al*., 2018). Prasetijo *et al.* (2017) found that the higher the sucrose concentration in ripe fruit, the higher the total dissolved solids. Sucrose and pectin play a role in increasing the total dissolved solids content.

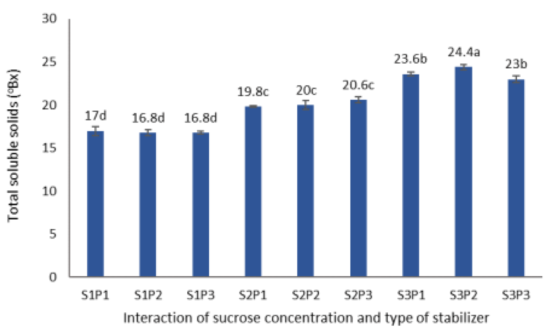

Figure 2. Effect of sucrose content and type of stabilizer on the soluble solids of the orange nectar. Values with different superscript are significantly different ($p<0.05$).

The orange nectar in this study had TSS values of 16.3–24.1°Bx (Figure 2). The TSS of these nectars were higher than those found for lime (13–13.2°Bx), guava (14.1–16.2°Bx), and mango (11.94–12.45°Bx) nectars (Matiashe *et al*., 2014; Krumreich *et al*., 2018; Lozano *et al*., 2020). However, the TSS of orange nectar was lower than mango nectar (72–75.4°Bx) (Khan *et al*., 2014), as mangoes have more total solids than oranges.

3.2 pH

The concentration of sucrose did not affect the pH of the orange nectar significantly. The average pH values of the orange nectars with 10%, 15%, and 20% added sucrose were the same (3.7). This is because sucrose has a neutral pH, so it does not affect the pH when added to orange nectar. These results are consistent with Khan *et al.* (2014), who found that adding sucrose did not affect nectar pH.

The stabilizer type had an impact on the pH of the orange nectar, and nectars with CMC as a stabilizer had the highest pH (3.9), followed by carrageenan (3.7) and pectin (3.6), as shown in Figure 3. As CMC is an alkaline stabilizer, the orange nectar with added CMC will have a higher pH than those with carrageenan and pectin. Khan *et al.* (2014) noted that the pH of guava bars with the addition of CMC was slightly higher than that of those with added pectin. Our results are also consistent with Prasetyo (2014), in which the addition of CMC in the manufacture of red guava fruit drinks had a pH ranging from 5.3 to 5.9. Furthermore, adding 0.5% CMC to cashew syrup resulted in a pH of 5.34 (Manoi 2006). According to Simamomar and Rossi (2017), adding 0.5% pectin in the manufacture of mangrove apple (*Sonneratia caseolaris)* jam resulted in a pH of 3.20. Therefore, applying pectin to citrus fruit nectar will result in a more acidic pH than citrus nectar with CMC or carrageenan.

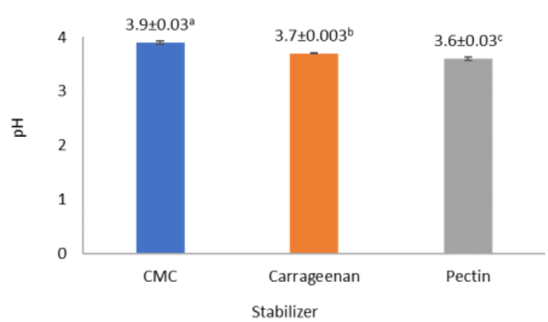

Figure 3. Effect of stabilizer on the pH of the orange nectar. Values with different superscript are significantly different ($p<0.05$).

The addition of CMC will cause the pH to increase because CMC is a salt of a strong base and a weak acid, so the resulting solution will have a high pH (Marchelina *et al*., 2020). In addition, there are large amounts of hydrocolloids in CMC to increase the pH (Malaka *et al*., 2017). The addition of pectin will increase the acidity so that the pH decreases. This process occurs because, during nectar production, pectin is hydrolyzed into pectinate and pectic acid so that the more pectin is added, the higher the acid produced and the lower the pH (Tran *et al*., 2020).

The interaction between the stabilizer type and sucrose concentration did not significantly affect the pH of the nectar. The pH of the citrus nectar in this study was 3.6–3.9, which was lower than the 4.2 found by Matiashe *et al*. (2014), who studied lime nectar production.

The pH of a food product is extremely important, as it limits the growth of disease and spoilage bacteria. According to Xiang-Ng and Kuppusamy (2019), heat treatment also promotes the stability of ascorbic acid because this vitamin is more stable at acidic pH. There is no pH standard for orange nectar, although the standard range for orange juice, according to the FDA Center for Food Safety and Applied Nutrition (2008), is 3.3 to 4.19. Based on this FDA standard, the pH of orange nectar from 3.6–3.9 would meet FDA standards.

3.3 Viscosity

The type of stabilizer had a significant impact on the viscosity of the orange nectar (Figure 4). CMC produced the highest viscosity (195 cP), followed by carrageen (119 cP) and pectin (26 cP). The high viscosity of orange nectar with added CMC is due to the dispersal of CMC in the fluid phase, which binds large amounts of water and forms a gel framework, preventing the free movement of water molecules (Akkarachaneeyakorn and Tinrat, 2015). According to Utomo *et al*. (2014), the viscosity of many water molecules is increased because the crosslinks formed by the helical arrangement and their interactions are trapped within the three-dimensional structure. The water previously free to move outside the granules can no longer do so because it is absorbed and bound to the CMC granules, increasing viscosity (Siskawardhani *et al*., 2013).

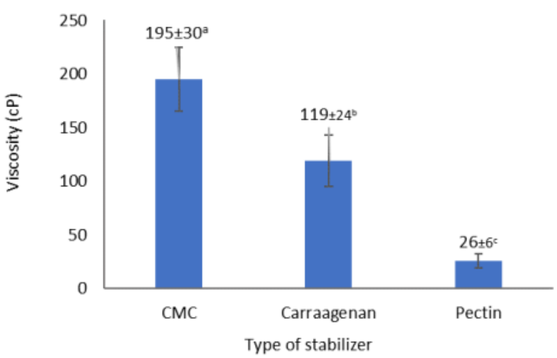

Figure 4. Effect of stabilizer on the viscosity of the orange nectar. Values with different superscript are significantly different ($p<0.05$).

The addition of carrageenan will cause decreased stability, especially at high temperatures. Carrageenan is capable of forming a gel of polymer chains that form a three-dimensional mesh. This network captures or mobilizes water therein and forms a strong and rigid structure (Sharma *et al*., 2017). However, the tissue formed by carrageenan is weaker than CMC, so the viscosity of nectar added with carrageenan was lower than the viscosity of nectar added with CMC. According to Penjumras *et al.* (2019), adding more CMC rather than carrageenan to the dough will increase its viscosity.

Compared to other stabilizers, pectin produced the lowest orange nectar viscosity. Khushbu and Sunil (2018) stated that mayonnaise had a lower viscosity with added pectin than CMC. Similarly, Tran et *al.* (2020) found that adding pectin in low concentrations resulted in a reduction in soursop nectar viscosity.

The interaction between sucrose concentration and stabilizer type did not significantly influence the viscosity of the orange nectar. According to the guidelines of the National Dysphagia Diet (Steele *et al*. 2014), the viscosity of orange nectar should be 51–350 cP. The viscosity of orange nectar produced in this study was 21.7–221.7 cP (Figure 5). Orange nectar with pectin stabilizer does not fulfil these requirements, as its viscosity is less than 50 cP, while orange nectar with carrageenan and CMC stabilizers fulfilled the dysphagia diet criterion.

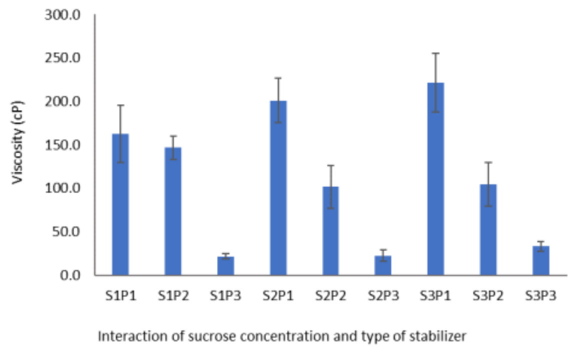

Figure 5. Effect of stabilizers and sucrose levels on the viscosity of the orange nectar

3.4 Reducing sugar content

Sucrose concentration and stabilizer type, and the interaction between them, did not affect sugar reduction significantly. Figure 6 shows that the reducing sugar content was 5.7–11.1%. No studies have investigated the reducing sugar levels of nectar, but Nuraeni *et al.* (2019) found an 8–10% lower sugar content for fruit juice. Sugar reduction in citrus nectar is similar to that in guava bars, at 839–1138 (Khan *et al*., 2014).

3.5 Vitamin C content

Sugar concentration and type of stabilizer had no significant effect on the orange nectar ascorbic acid levels, which were 21.1–28.2 mg/100 mL (Figure 7).

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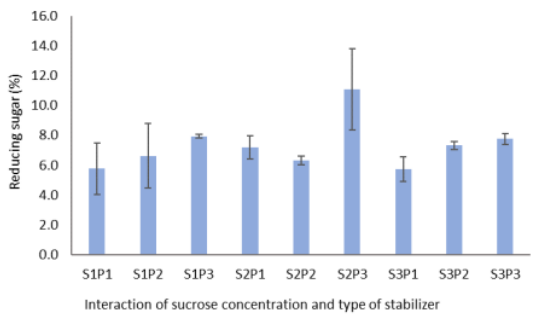

Figure 6. Effect of stabilizers and sucrose levels on the reducing sugar of the orange nectar

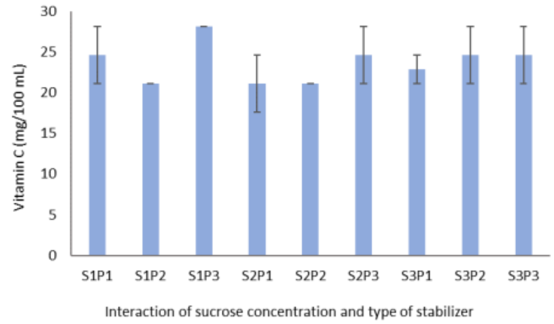

Figure 7. Effect of stabilizers and sucrose levels on the vitamin C of the orange nectar

According to Wariyah (2010), Siam oranges contain 20–60 mg/100 mL of vitamin C. The proportion of juice to the water in the manufacture of orange nectar is the same (4:1), so the levels of vitamin C could be compared.

Krumreich *et al.* (2018) found that ascorbic acid was higher in guava nectar (5.2%), and Kumalasari (2015) found that it was 9.7% in papaya-pineapple juice. Khan *et al*. (2014) also stated that the type of stabilizer did not affect ascorbic acid levels.

3.6 Crude fibre content

The analysis of variance showed that the type of stabilizer had a significant effect on the crude fibre content of citrus nectar. Moreover, the sucrose concentration and the interaction between sucrose and stabilizer had no significant effect on the crude fibre content of citrus nectar.

The crude fibre content of orange nectar with added pectin was 3.27%, carrageenan 3.17%, and CMC 2.57%. The differences are due to the different characteristics of each type of stabilizer. These results are consistent with Herlina (2020) that adding 0.5% carrageenan to fruit leather of *Chrysophyllum cainito* resulted in higher fibre content (6.81%) than adding 0.5% CMC (5.16%). Mangrove apple jam with 0.5% pectin had a crude fibre content of 2.08%, according to Simamomar and Rossi (2017).

Fibre is composed of carbohydrates that cannot be hydrolyzed by strong acids or bases under controlled conditions (Palafox-Carlos *et al*., 2011). Anderson *et al.* (2009) reported that there are two fibre classes, namely water-soluble fibre and insoluble fibre. Soluble fibre includes pectin, gum, and carrageenan. Meanwhile, the fibres that are not soluble in water are cellulose, hemicellulose, and lignin. *Penjumras et al.* (2019) stated that CMC contains water-soluble fibre, which will increase the fibre content in the product. However, the total dietary fibre content of CMC is 74 g/100 g, which is less than that of carrageenan (83.62 g/100 g) (Muzaifa 2006). In this study, the product with the highest crude fibre content was the product with added pectin. Pectin is a soluble dietary fibre that the higher the concentration of pectin added, the higher the soluble fibre content (Dickinson 2009).

3.7 Sensory evaluation

Sensory testing of six products was performed on those nectar products with added CMC and carrageenan. Nectar with pectin as a stabilizer was not tested because it did not comply with viscosity standards.

Colour is an important element that helps to determine the acceptance level of a specific food. If a product has good nutritional value, good taste, and attractive colour, it will interest the public (Akkarachaneeyakorn and Tinrat, 2015). In this case, the orange nectar colour scored 3.84–4.24, which means the nectar had a yellow colour, and the difference between treatments was not significant. The colour of oranges results from the presence of beta carotene.

Taste is a major parameter in consumer food selection since it is a quality attribute capable of determining the level of consumer acceptance of products (Chakraborty *et al*., 2020). Different perceptions of food products are also determined by taste. The taste of the orange nectar had a score of 3.24 (slightly sweet)–4.4 (sweet), which was influenced by the combination of stabilizer type and sucrose concentration. As shown in Figure 8, the highest taste score was for the nectar with the addition of 20% sucrose and carrageenan stabilizer. The addition of a high amount of sucrose and carrageenan increased the sweetness. Similarly, Marzelly *et al*. (2018) found that adding sugar and carrageenan increased the sweetness of fruit leather.

Aroma is one of the sensory parameters used by consumers when selecting food (Tuan-Azlan *et al*., 2020). Most people will first smell the product before tasting it. There was no significant difference in the aroma of the orange nectar between the treatments, with scores of 2.60–3.24, indicating a mild citrus aroma. Marzelly *et al*. (2018) proposed that sugar and carrageenan form a network of matrixes that traps and produces the characteristic citrus aroma.

Sensory texture tests were performed on the product viscosity. Texture considerably influences the images of foods and is sometimes more important than flavour (Chakraborty *et al*., 2020). The sensory score for the viscosity of the orange nectar was 2.00–3.56, differing significantly by treatment effect. The highest viscosity (3.56) was in the nectar with the addition of 20% sucrose and CMC stabilizer . The sensory viscosity test results are consistent with viscometer results. The high viscosity of orange nectar with CMC was due to the dispersed CMC during the fluid phase, which binds large quantities of water and creates a gel-frame, preventing water molecules from moving freely (Akkarachaneeyakorn and Tinrat, 2015).

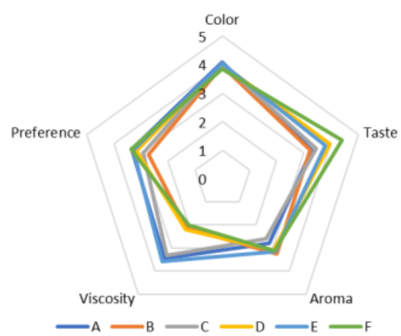

Figure 8. Sensory properties of orange nectar on various stabilizers and sucrose levels (A: 10% sucrose and CMC; B: 10% sucrose and carrageenan; C: 15% sucrose and CMC; D: 15% sucrose and carrageenan; E: 20% sucrose and CMC; F: 20% sucrose and carrageenan).

The panellists' overall taste verdict was the final evaluation, combining the parameters of colour, aroma, taste, and texture. The preference score for citrus nectar was 2.72–3.36, influenced by the sucrose concentration and the type of stabilizer. The highest preference (3.36) was for the orange nectar with 20% saccharose and carrageenan stabilizer (Figure 8).

4. Conclusion

Squeezed oranges can be processed into nectar with the addition of sucrose and a stabilizer. The more sucrose added to the nectar, the lower the moisture content and the more soluble solids produced. The type of stabilizer had a major impact on the pH and viscosity of orange nectar, and the best stabilizer was found to be carrageenan. The preferred citrus nectar was made with the addition of 20% sucrose and carrageenan. The favoured product had the sweetest taste, an orange colour was slightly dense, and had a slightly orange aroma. The preferred nectar had a moisture content of 76.6%, total dissolved solids of 24.2%, pH of 3.7, a viscosity of 109 cP, vitamin C of 23.5%, reducing sugar of 7.9%, and crude fibre of 3.38%. Squeezed oranges of low economic value can be made into orange nectar by adding 20% sucrose and 1% carrageenan. The processing of squeezed oranges into citrus nectar is expected to increase its shelf -life and economic value. More research on its stability during storage is needed.

Conflict of interest

The authors declare no conflict of interest.

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FINAL GRADE

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GENERAL COMMENTS

Instructor

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CLAIM

Take an arguable position on the scientific topic and develop the essay around that stance.

ADVANCED	The essay introduces a precise, knowledgable, qualitative and/or quantitative claim based on the scientific topic or text(s), regarding the relationship between dependent and independent variables, and establishes the significance of the claim. The essay develops the claim and counterclaim fairly and thoroughly, distinguishing the claim from alternate or opposing claims.
PROFICIENT	The essay introduces a precise, qualitative and/or quantitative claim based on the scientific topic or text(s), regarding the relationship between dependent and independent variables. The essay develops the claim and counterclaim fairly, distinguishing the claim from alternate or opposing claims.
DEVELOPING	The essay introduces a qualitative and/or quantitative claim based on the scientific topic or text(s), regarding the relationship between dependent and independent variables, but it may be somewhat unclear. The essay may not present the claim and counterclaim evenly or objectively, failing to adequately distinguish the claim from alternate or opposing claims.
EMERGING	The essay does not clearly make a qualitative and/or quantitative claim based on the scientific topic or text(s), or the claim is overly simplistic or vague. The essay does not address counterclaims.

EVIDENCE

Include relevant facts, definitions, and examples to back up the claim.

ADVANCED	The essay supplies the most relevant and appropriate qualitative and/or quantitative data and evidence related to the scientific topic or text(s) to support its claim and counterclaim.
PROFICIENT	The essay supplies sufficient qualitative and/or quantitative data and evidence related to the scientific topic or text(s) to support its claim and counterclaim.
DEVELOPING	The essay supplies some qualitative and/or quantitative data and evidence, but it may not be closely related to the scientific topic or text(s), thereby not effectively supporting the essay's claim and counterclaim.
EMERGING	The essay supplies very little or no qualitative and/or quantitative data and evidence to support its claim and counterclaim.

REASONING

Explain how or why each piece of evidence supports the claim.

ADVANCED	The essay applies scientific ideas and principles in order to thoroughly explain how or why the cited evidence supports the claim. The essay demonstrates consistently logical reasoning and full understanding of the scientific topic and/or text(s), comprehensively stating the strengths and limitations of both the claim

and counterclaim. The essay's explanations effectively anticipate the audience's knowledge level, concerns, values, and potential biases about this scientific topic.

PROFICIENT	The essay applies scientific ideas and principles in order to explain how or why the cited evidence supports the claim. The essay demonstrates some logical reasoning and understanding of the scientific topic and/or text(s) and states the strengths and limitations of both the claim and counterclaim. The essay's explanations anticipate the audience's knowledge level and concerns about this scientific topic.
DEVELOPING	The essay includes some reasoning and understanding of the scientific topic and/or text(s), but it does not effectively apply scientific ideas and principles to explain how or why the evidence supports the claim. The strengths and limitations of the claim and counterclaim may be unclear.
EMERGING	The essay does not demonstrate clear or relevant reasoning to support the claim or to demonstrate an understanding of the scientific topic and/or text(s).

FOCUS

Focus your writing on the purpose and task.

ADVANCED	The essay maintains strong focus on the purpose and task, using the whole essay to support and develop the claim and counterclaims fairly while thoroughly addressing the demands of the prompt.
PROFICIENT	The essay maintains focus on the purpose and task, using most of the essay to support and develop the claim and counterclaims while thoroughly addressing the demands of the prompt.
DEVELOPING	The essay may not fully address the demands of the prompt or stay focused on the purpose and task. The writing may stray off topic at times.
EMERGING	The essay does not maintain focus on purpose or task.

ORGANIZATION

Organize your writing in a logical sequence.

ADVANCED	The essay incorporates an effective organizational structure throughout that logically sequences the claim(s), counterclaims, reasons, and evidence. It also includes an effective introduction and a conclusion which follows from and supports the arguments presented. Transitional words and phrases are included to enhance the relationships between and among ideas (i.e. claim and reasons, reasons and evidence, claim and counterclaim) and to create cohesion and clarity throughout.
PROFICIENT	The essay incorporates an adequate organizational structure and transitional phrases throughout that establish clear relationships between and among the claim(s), counterclaims, reasons, and evidence, including an introduction and concluding statement or section.

DEVELOPING	The essay uses a basic organizational structure but relationships between and among ideas are not consistently clear. The essay moves from beginning to end; however, an introduction and/or conclusion may be overly formulaic, repetitious, or missing.
EMERGING	The essay does not have a clear organizational structure. An introduction and conclusion are not evident.

LANGUAGE

Pay close attention to your tone, style, word choice, and sentence structure when writing.

ADVANCED	The essay effectively establishes and maintains a formal style and objective tone and incorporates language that anticipates the reader's knowledge level, concerns, values, and potential biases. The essay demonstrates a clear command of conventions, while also consistently employing discipline-specific word choices and varied sentence structure.
PROFICIENT	The essay generally establishes and maintains a formal style and somewhat objective tone with few possible exceptions and incorporates language that anticipates the reader's knowledge level and concerns. The essay demonstrates a general command of conventions, while also employing discipline-specific word choices and some variety in sentence structure.
DEVELOPING	The essay attempts a formal style and objective tone, and language inconsistently shows an awareness of the reader's knowledge or concerns. The essay may contain errors in conventions that interfere with meaning. Some attempts at discipline-specific word choices are made, and sentence structure may not vary.
EMERGING	The essay is not formal in style or objective in tone and employs language that does not anticipate the reader's knowledge or concerns. The essay may contain pervasive errors in conventions that interfere with meaning. Word choice is not discipline-specific, and sentence structures are simplistic and unvaried.