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Processing of Starfruit (Averrhoa bilimbi L.) on the Acceptability of Sweets as a Snack Food for Hypercholesterol Sufferers: Study of Color, Taste and Aroma

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Abstract

This research aims to examine the acceptability of color, taste and aroma of candied starfruit (Averrhoa bilimbi L.) with three different formulations, namely fresh starfruit, dried candied and wet candied. The assessment was carried out by 30 trained panelists using the Hedonic Scale Scoring method. The analysis results show that there are significant differences in the acceptability of color and taste of sweets based on different formulations. Wet sweets (P3) received the highest assessment in all aspects, including color, taste and aroma. Although aroma plays an important role in determining the deliciousness of food, statistical test results show that sweet formulations do not significantly influence the perception of aroma by panelists. These results provide important insights in developing candied starfruit products that are more in line with consumer preferences.

Keywords: Candied Starfruit, Acceptability, Color, Taste, Aroma.

1. Introduction

Wuluh starfruit, also known as vegetable starfruit or sour starfruit, is a type of tree that grows at an altitude of between 5 and 500 meters above sea level. This plant has a stem that can reach a height of around 15 meters with relatively few branches. Starfruit has a quite sour taste, and is often used as a spice in cooking or as an ingredient in herbal medicine. Apart from that, this plant is rich in substances such as tannins, saponins, glucosesulfur, formic acid, peroxides, flavonoids and triterpenoids (Asfita et al., 2022; Xu et al., 2014).

Even though it is rich in health benefits, starfruit has several challenges in its consumption. The high acid content and high water content of the fruit means that this fruit is rarely consumed as fresh fruit, and its shelf life is relatively short. One way to overcome this challenge is to process it into dried sweets, which are snacks made from fruit preserved in sugar and dried (Li et al., 2016; Retnaningsih & Wijayanti 2020). This process not only reduces the sour taste of the fruit, but also extends its shelf life.

Apart from its benefits as food, starfruit also has potential positive effects on health. The saponin content in starfruit can help reduce serum cholesterol levels by possibly binding saponin with cholesterol. Apart from that, this fruit also contains vitamin C, which has an important role in cholesterol metabolism. Vitamin C can increase the rate of removal of cholesterol in the form of bile acids, increase levels of High-Density Lipoprotein (HDL), and reduce the reabsorption of bile acids which can convert them into cholesterol. In addition, vitamin C also plays a role in collagen formation, which can help prevent atherosclerosis.

By containing flavonoids, saponins and vitamin C, starfruit has the potential to prevent hypercholesterolemia, a condition that can increase the risk of heart and blood vessel disease. Therefore, further research on the health benefits of starfruit and ways of processing it could have important implications for community welfare and the development of healthier food products (Karasakal, 2021; Muhamed Shanoof, 2017). In this context, research on dried candied starfruit as an alternative to consuming this fruit also has the potential to become an interesting and relevant topic.

Processing starfruit into sweets is an innovative and interesting way to overcome the challenges of consuming this fruit. Dried candied starfruit transforms a sour fruit with limited shelf life into a product that is more attractive and

easily accessible to the wider community. This processing not only makes starfruit more practical to consume, but also maintains most of the health benefits contained in the fruit (Shah et al., 2011; Shi & Moy 2005).

The process of processing starfruit into sweets involves several stages which include selecting ripe fruit, cutting the fruit, soaking in a sugar solution or syrup, and drying. Selection of ripe fruit is very important to ensure optimal quality and taste of sweets. After that, the fruit is usually cut into the desired shape, which can be thin slices or small pieces according to preference. The process of soaking in a sugar solution or syrup is a key step in reducing the sour taste of starfruit and preserving it (Allard et al., 2013; Kankananarachchi et al., 2020; Baruah et al., 2018). During this soaking, the fruit absorbs the sweet taste of the syrup and makes it more palatable to consume.

Drying is the final step in the processing process, and this is done to remove the water content of the fruit so that the sweets can have a longer shelf life. In some cases, the fruit is dried in the sun, whereas in commercial processing, drying is often carried out with the help of special drying machines. The end result is a dry sweet that has a unique taste, namely a combination of sweetness from the syrup and natural sourness from the starfruit.

Apart from making starfruit easier to consume, this sweet also creates promising business opportunities. Dried candied starfruit products can be sold locally or exported to various international markets, benefiting local farmers and food producers. In addition, with the high content of nutrients such as flavonoids, saponins and vitamin C retained in the sweets, this product can provide a delicious healthy food alternative for consumers who care about their health.

Thus, processing starfruit into sweets is not only about creating a delicious product, but also opens the door to further research on the health potential and sustainability of developing this product. In a global context that is increasingly aware of the health and nutritional value of food, dried candied starfruit can be an example of how innovation in food processing can produce products that are healthy, delicious, and have the potential to advance the agricultural and food industries. While the process of processing starfruit into sweets has many benefits, there are several problems that need to be overcome to ensure the success of its production and marketing.

One of the main problems is consistent availability of raw materials. The quality and quantity of starfruit that can be processed into sweets can vary depending on factors such as season, climate and cultivation methods. To overcome this, it is necessary to implement inventory management strategies and close cooperation between farmers and sweets producers. In addition, the drying process is also a key stage in processing. If not done properly, high water content in sweets can cause spoilage and affect the shelf life of the product. Therefore, effective and up-to-date drying technology is needed to ensure consistent product quality (Anzman-Frasca et al., 2018; Drewnowski & Darmon 2005).

Another issue is regulations and quality standards. Food products must meet food safety and quality standards set by health and industry authorities. Understanding and complying with these regulations is important to ensure that candied starfruit can be marketed legally and is safe for consumption. Additionally, it is important to consider marketing and distribution aspects. Candied starfruit must be accessible to consumers through appropriate distribution channels. Effective marketing, including branding and promotional strategies, will also play an important role in introducing these products to the market.

Lastly, sustainability and environmental impact also need to be considered. The processing and production of sweets must minimize negative impacts on the surrounding environment, and if possible, even contribute positively to the sustainability of agriculture and the local ecosystem. By identifying and overcoming these problems, processing starfruit into sweets can become a promising potential business opportunity and a significant contributor to the development of local agriculture and the food industry as a whole.

2. Research methods

This research is a pure experimental study with a completely randomized research design. This study aims to evaluate the acceptability of candied starfruit (Averrahoa bilimbi L). Data was collected through organoleptic tests with the participation of 30 panelists who had some level of expertise in organoleptic assessment. Panelists were asked to assess their level of liking for candied starfruit which was tested using a questionnaire with a rating scale from very like (score 4) to dislike (score 1).

Data obtained from organoleptic tests were then analyzed using the Friedman test. This test was used to identify whether there were significant differences in the acceptability assessment between the various variations of starfruit sweets tested. If there is a significant effect, the analysis will continue with the Wilcoxon test to determine pairs that are significantly different.

This organoleptic testing method was chosen to measure the level of panelist satisfaction with the candied starfruit product. The results of this research will provide valuable insight into consumer preferences for these products, which can be used for better product development and improving the quality of starfruit sweets in the future.

3. Research result

Table 1: Average color acceptability of candied starfruit

Treatment	Average Receiving Capacity	Category
P1 (fresh starfruit)	2.6	Like
P2 (dry sweets)	2.2	Do not like it much
P3 (wet sweets)	3.1	Like

Based on Table 1, the research results show that the panelists gave the highest assessment of the color of the sweets in the P3 (Wet Sweets) treatment with an average score of 3.1, which is included in the "Like" category. Meanwhile, treatment P2 (Dried Sweets) had the lowest average color acceptability value, namely 2.2, and was included in the "Least Like" category.

Statistical analysis using the Friedman test showed that there was a significant difference in the color acceptability of candied starfruit based on different formulations ($p=0.000$, $p<0.05$). Therefore, the null hypothesis (H0) which states there is no difference in the acceptability of candy colors is rejected. This indicates that the panelists have different preferences for the color of candied starfruit based on the formulation.

Next, the Wilcoxon test was carried out to evaluate the differences between each pair of sweet formulations. The Wilcoxon test results showed that there was a significant difference between sweet formulations in treatments P1 and P2 ($p=0.016$), P1 and P3 ($p=0.006$), and P2 and P3 ($p=0.000$). This confirms that differences in sweet formulations have a significant influence on color acceptability by panelists.

Table 2: Average Acceptance of Candied Starfruit Taste

Treatment	Average Receiving Capacity	Category
P1 (Fresh Starfruit)	2.2	Do not like it much
P2 (Dried Sweets)	2.1	Do not like it much
P3 (Wet Sweets)	3.1	Like

In Table 2, the research results show that the panelists gave the highest assessment of the taste of sweets in treatment P3 (Wet Sweets) with an average score of 3.1, which is in the "Like" category. Meanwhile, treatment P2 (Dried Sweets) had the lowest average value of taste acceptability, namely 2.1, and was included in the "Least Like" category.

The results of statistical analysis using the Friedman test showed that there was a significant difference in the acceptability of the taste of starfruit sweets based on different formulations ($p=0.000$, $p<0.05$). Thus, the null hypothesis (H0) which states there is no difference in the acceptability of sweets is rejected. This indicates that panelists have different preferences for sweet flavors based on formulation.

Next, the Wilcoxon test was performed to evaluate the differences between pairs of sweet formulations. The Wilcoxon test results showed that there was a significant difference between sweet formulations in treatments P1 and P3 ($p=0.001$) and P2 and P3 ($p=0.000$). However, there was no significant difference between sweet formulations in treatments P1 and P2 ($p=0.467$). These results confirm that differences in sweet formulations have a significant effect on the panelists' taste acceptance, especially between Wet Sweets (P3) and Dry Sweets (P2) which show the most significant differences in taste preferences by panelists.

Table 3: Average Receptivity to the Aroma of Candied Starfruit

Treatment	Average Receiving Capacity	Category
P1 (Fresh Starfruit)	2.8	Like
P2 (Dried Sweets)	2.3	Do not like it much
P3 (Wet Sweets)	3.2	Like

Based on Table 3, the research results show that the panelists gave the highest assessment of the aroma of sweets in the P3 (Wet Sweets) treatment with an average score of 3.2, which is included in the "Like" category. Meanwhile, treatment P2 (Dried Sweets) had the lowest average value of aroma acceptability, namely 2.3, and was included in the "Least Like" category.

The results of statistical analysis using the Friedman test showed that there was a significant difference in the acceptability of the aroma of candied starfruit based on different formulations ($p=0.000$, $p<0.05$). Therefore, the null hypothesis (H0) which states there is no difference in the acceptability of sweet aromas is rejected. This indicates that panelists have different preferences for sweet aroma based on formulation.

Next, the Wilcoxon test was carried out to evaluate the differences between pairs of sweet formulations. The Wilcoxon test results showed that there were significant differences between sweet formulations in treatments P1 and P2 ($p=0.023$), P1 and P3 ($p=0.038$), and P2 and P3 ($p=0.000$).

These results confirm that differences in sweet formulations have a significant effect on the aroma acceptance by panelists, with Wet Sweets (P3) having the highest aroma preference by panelists compared to Dry Sweets (P2).

4. Discussion

4.1. Color Receptivity

Color has an important role in determining the quality and acceptability of a food product. A product that has a good taste and texture may not be popular if it has an inappropriate color or is less attractive to consumers. Color can also be used as an indicator of product freshness or maturity. Therefore, the color factor is often the first thing to pay attention to when assessing the quality of food products.

The results of this study indicate that color plays an important role in the acceptability of candied starfruit. Panelists gave the highest assessment of the color in the P3 (Wet Sweets) treatment with an average of 3.1, which is in the "Like" category. Meanwhile, treatment P2 (Dried Sweets) had the lowest average color acceptability value, namely 2.2, and was included in the "Least Like" category. Furthermore, statistical analysis using the Friedman test showed that there was a significant difference in the color acceptability of candied starfruit based on different formulations ($p=0.000$, $p<0.05$). This indicates that panelists have different preferences for sweet color based on formulation.

Significant effects are seen in the comparison between P1 and P2, P1 and P3, and P2 and P3. P1 and P3 were stated to be significantly different in color preferences, with P3 (Wet Sweets) getting a higher rating. Similarly, P2 and P3 also differ significantly in color preferences. These results indicate that the choice of formulation and processing method influences the color of candied starfruit, which in turn influences consumer acceptability. Attractive colors that match consumer expectations can increase product acceptance, so they are important in the development and marketing of candied starfruit.

4.2. Taste Receptivity

Taste is one of the main factors that determine the taste of food, and it is the second most important factor after the visual appearance of food. The attractive appearance of food can stimulate the appetite, but the actual taste will influence the consumer's experience when tasting the food. Therefore, after the sense of sight, the sense of smell and taste will play an important role in determining the acceptability of a food product (5).

The results of this study showed that the panelists gave the highest assessment of the taste of the P3 (Wet Sweets) treatment with an average of 3.1, which is in the "Like" category. This can be explained by the significant differences in color and taste between P3 and other treatments. The taste of P3 sweets seems to be fresher and has a taste similar to starfruit, which the panelists liked.

Statistical analysis using the Friedman test showed that there was a significant difference in the acceptability of the taste of starfruit sweets based on different formulations ($p=0.002$, $p<0.05$). This shows that there is a significant influence of the sweet formulation in treatments P1, P2, and P3 on the panelists' taste acceptance.

Panelists preferred the taste of sweets in the P3 (Wet Sweets) treatment because these sweets still had a fresh taste and a taste that was more similar to real starfruit. P2 Sweets (Dry Sweets) may have a different taste, closer to traditional sweets with a sweet and sour taste, which some panelists also liked.

The addition of sugar and soaking the star fruit in the process of making sweets may have reduced the strong sour taste of the fruit, resulting in sweets with a sweeter and fresher taste. This can be an important factor in understanding consumer preferences for the taste of candied starfruit which varies based on the formulation used (6). These results show that formulation and processing can influence the taste of sweets, and understanding consumer preferences for taste can guide the development of products that are preferred by the market.

4.3. Aroma Reception

The aroma of food has a significant role in determining the deliciousness of the food, and aroma is an important factor in determining the quality of a food product. The aroma of food is closely related to the sense of smell, and can influence how much a food is liked by consumers. Distinctive and attractive aromas can increase the attractiveness of food and make it more preferred by consumers (4).

The results of this study showed that the panelists gave the highest assessment of the aroma in the P3 (Wet Sweets) treatment with an average of 3.2, which is included in the "Like" category. Meanwhile, treatments P1 (Fresh Starfruit) and P2 (Dried Candied) had lower average aroma acceptability values, namely 2.8 and 2.3, which were included in the "Like" and "Least Like" categories respectively. each.

However, statistical analysis using the Friedman test showed that there was no significant difference in the acceptability of the aroma of candied starfruit based on different formulations ($p=0.056$, $p>0.05$). This indicates that the panelists did not have a significant preference for the aroma of sweets based on the different formulations.

The aroma of food does have an important role in determining deliciousness, but the results of this study show that the formulation of candied starfruit in this study did not significantly influence the perception of the aroma by the panelists. This may be caused by other factors that influence the aroma of sweets, such as processing methods and types of raw materials, which were not significant in this study.

However, it is important to note that the results of this study only included limited panelists and certain types of confectionery formulations. More research may be needed to better understand the role of aroma in the acceptability of candied starfruit in more depth.

5. Conclusion

This research examines the acceptability of the color, taste, and aroma of candied starfruit with three different formulations, namely fresh starfruit (P1), dried candied (P2), and wet candied (P3). Based on data analysis and statistical tests, several main findings were found:

a). Color of Sweets, panelists gave the highest assessment of the color of P3 sweets (Wet Sweets) with an average of 3.1, which is in the "Like" category. Treatment P2 (Dried Sweets) had the lowest average color acceptability value, namely 2.2, and was included in the "Least Like" category. The results of Friedman's statistical test showed significant differences in color acceptability based on candy formulation.

b). Sweet Taste, panelists preferred the taste of P3 sweets (Wet Sweets) with an average of 3.1, which is in the "Like" category. P2 Sweets (Dry Sweets) have a different taste with a sweet and sour taste and get the lowest average value of taste acceptability, namely 2.1. Friedman's statistical test showed significant differences in the acceptability of sweets based on formulation.

c). Aroma of Sweets, panelists gave the highest assessment of the aroma of P3 sweets (Wet Sweets) with an average of 3.2, which is included in the "Like" category. However, Friedman's statistical test did not show significant differences in the acceptability of sweet aromas based on formulation.

The results of this study showed that the formulation of candied starfruit affected the acceptability of color and taste, but did not significantly influence the acceptability of the aroma by the panelists. Panelists preferred wet sweets (P3) with a fresh taste similar to real starfruit.

This research provides important insights in developing candied starfruit products that are more in line with consumer preferences. Product developers need to consider color and taste factors to increase product appeal, while aroma appeared to have less influence on panelists' preferences in this study. Furthermore, future research could involve more panelists and a variety of formulations for a deeper understanding of consumer preferences for candied starfruit.

References

Allard, T., Wenner, T., Greten, H. J., & Efferth, T. (2013). Mechanisms of herb-induced nephrotoxicity. *Current medicinal chemistry*, *20*(22), 2812-2819.

Anzman-Frasca, S., Ventura, A. K., Ehrenberg, S., & Myers, K. P. (2018). Promoting healthy food preferences from the start: a narrative review of food preference learning from the prenatal period through early childhood. Obesity Reviews, 19(4), 576-604.

Asfita, R. Y., Abdurrachim, R., & Fathullah, D. M. (2022). Processing of Starfruit (Averrhoa Bilimbi L.) on the Acceptability of Sweets as a Snack for Hypercholesterol Sufferers. *Indonesian Health Journal*, *12*(2), 69-72.

Baruah, N., Shahu, S., & Deka, A. C. (2018). Effect of safe phytochemicals coating on postharvest loss and Shelf-Life of starfruit (Averrhoa carambola)-A fruits of medicinal values. *The Clarion-International Multidisciplinary Journal*, *7*(1), 27-35.

Drewnowski, A., & Darmon, N. (2005). The economics of obesity: dietary energy density and energy cost–. *The American journal of clinical nutrition*, *82*(1), 265S-273S.

Kankananarachchi, I., Samararathna, R., Naotunna, C., Pathmakanthi, K. A. I., Hemali, H. M. P., Devasiri, V., & Dharmawardena, H. (2020). A case of star fruit induced acute oxalate nephropathy in a previously healthy child. *Sri Lanka Journal of Child Health*, *49*(2), 178-179.

Karasakal, A. (2021). Determination of major, minor, and toxic elements in tropical fruits by ICP-OES after different microwave acid digestion methods. *Food Analytical Methods*, *14*(2), 344-360.

Li, J., Wei, X., Xie, Q., Hoa Pham, T. T., Wei, J., He, P., ... & Huang, R. (2016). Protective Effects of 2-Dodecyl-6-Methoxycyclohexa-2, 5-Diene-1, 4-Dione Isolated from Averrhoa Carambola L.(Oxalidaceae) roots on high-fat diet-induced obesity and insulin resistance in mice. *Cellular Physiology and Biochemistry*, *40*(5), 993-1004.

Muhamed Shanoof, M. (2017). *Study of Antidiabetic Activity on Averrhoa Carambola Leaves*. (Doctoral dissertation, Karpagam College of Pharmacy, Coimbatore).

Retnaningsih, R., & Wijayanti, T. R. A. (2020). The Effect Of Beetroot Juice (Beta Vulgaris L) And Star Fruit (Averrhoa Carambola L) On The Reduction Of Blood Pressure In Second Trimester Pregnant Women With Gestational Hypertension. *Journal of Islamic Medicine*, *4*(2), 106-114.

Shah, B. N., Seth, A. K., & Modi, D. C. (2011). Fruit and fruit products as functional foods. International Journal of Food Safety, Nutrition, Public Health and Technology, 3(4), 14.

Shi, J. O. H. N., & Moy, J. H. (2005). Functional foods from fruit and fruit products. *Asian functional foods*, *303*.

Xu, X., Liang, T., Wen, Q., Lin, X., Tang, J., Zuo, Q., & Huang, R. (2014). Protective effects of total extracts of Averrhoa carambola L.(Oxalidaceae) roots on streptozotocin-induced diabetic mice. *Cellular Physiology and Biochemistry*, *33*(5), 1272-1282.