

THE EFFECT OF VARYING SUGAR AND CITRIC ACID ADDITIONS ON THE ORGANOLEPTIC CHARACTERISTICS OF READY-TO-EAT SWEET POTATO

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ABSTRACT

This research investigated the influence of different sugar and citric acid additions on the organoleptic properties of ready-to-eat sweet potato. Three formulations were prepared, namely Formulation A (without sugar and citric acid), Formulation B (with sugar), and Formulation C (with sugar and 0.05% citric acid). Sensory evaluation was conducted with 15 panelists using a five-point hedonic scale to assess color, aroma, taste, texture, and overall acceptability. The collected data were analyzed using the Shapiro–Wilk test, followed by the Friedman test and Wilcoxon Signed-Rank test. The findings revealed that the treatments significantly influenced color, texture, and overall acceptability ($p < 0.05$), whereas aroma and taste were not significantly affected ($p > 0.05$). Panelists rated Formulation C highest for color, while Formulation A obtained the highest scores for aroma, taste, and overall acceptance. Overall, Formulation A demonstrated the greatest level of consumer acceptance among the tested formulations.

Keywords: ready-to-eat sweet potato, citric acid, sugar, organoleptic.

INTRODUCTION

Food product innovation plays an important role in increasing the economic value of local agricultural commodities while addressing consumer demand for practical and high-quality food products. The development of innovative food products also supports food diversification and strengthens the competitiveness of the food industry through more effective utilization of locally available raw materials (Hidayah et al., 2023). Among these commodities, sweet potato has considerable potential to be processed into a convenient ready-to-eat product.

Sweet potato (*Ipomoea batatas* L.) is recognized as a nutritious carbohydrate source because it contains dietary fiber, vitamins, minerals, and various antioxidant compounds. These nutritional characteristics make it suitable for development as a functional food. In addition, sweet potato is widely cultivated and commonly consumed by the community, providing strong potential for product development (Amagloh et al., 2021). Nevertheless, its utilization is still largely limited to conventional processed products, highlighting the need for more innovative ready-to-eat alternatives. In the development of ready-to-eat products, organoleptic characteristics—such as color, aroma, taste, and texture—are crucial factors influencing consumer acceptance. The addition of sugar serves to impart sweetness and improve the product's sensory attributes. Meanwhile, citric acid acts as an acidulant, helping to preserve the product's color by inhibiting browning reactions during processing and storage; it can also enhance the product's brightness compared to formulations without it. Therefore, the use of sugar and citric acid must be precisely formulated to achieve sensory characteristics that align with consumer preferences (Putri et al., 2024).

Based on this, this study aims to determine the effect of varying additions of sugar and citric acid on the organoleptic characteristics of ready-to-eat sweet potato, specifically regarding color, aroma, taste, texture, and overall acceptability.

MATERIAL AND METHODS

Materials

The main ingredient used in this study is sweet potato. Additional ingredients include granulated sugar, citric acid, and water. The equipment used includes a knife, digital scale, steamer, oven, vacuum sealer, vacuum bags, and standing pouches.

Product Preparation

The study employed three formulations: Formulation A (without added sugar or citric acid), Formulation B (with 12 g of sugar dissolved in 100 mL of water), and Formulation C (with 12 g of sugar in 100

mL of water and 0.05% citric acid). The sweet potatoes were sorted, washed, peeled, and cut to the desired size. Subsequently, the sweet potatoes for Formulation C were soaked in a 0.05% citric acid solution for 10 minutes, whereas Formulations A and B did not undergo this soaking treatment. All samples were then steamed for 20 minutes. The subsequent heating process involved a combination of oven-drying and steaming: oven-drying at 100°C for 1 hour, followed by steaming for 10 minutes, a second round of oven-drying at the same temperature, and a final 30-minute oven-drying period to achieve the desired product characteristics. After cooling to room temperature, the product was packaged using the vacuum packaging method.

Organoleptic Evaluation

Organoleptic testing was done through a hedonic test with 15 panelists—employees from PT Lombok Gandaria who were between 20 and 40 years old. The test looked at color, smell, flavor, how it feels, and how much people liked it overall. They used a scale from 1 to 5, where 1 means really dislike, 2 means dislike, 3 is neutral, 4 is like, and 5 is really like.

Statistical Analysis

The organoleptic test results were checked for normality using the Shapiro–Wilk test. Data that didn't follow a normal distribution were analyzed with the Friedman test to find differences between the different formulations. If the Friedman test results indicated a significant difference ($p < 0.05$), the analysis proceeded with the Wilcoxon Signed-Rank test as a post-hoc test at a 5% significance level.

RESULTS AND DISCUSSION

Product Development of Ready-to-Eat Sweet Potato

The development of ready-to-eat sweet potato was carried out to increase the added value of sweet potato as a local agricultural commodity through product diversification. This product was developed in response to the growing consumer demand for practical, nutritious, and ready-to-eat food products. Several formulation and process optimization stages were conducted to obtain a product with desirable sensory characteristics and commercial potential.

Prior to product formulation, a SWOT analysis was done to figure out the strengths, weaknesses, opportunities, and threats of the product that was created. The analysis served as the basis for determining the appropriate product development strategy. The results of the SWOT analysis are presented in Table 1.

Table 1 SWOT Analysis

Aspect	Analysis Results
Strengths	Utilizing locally grown sweet potatoes, which are abundant, highly nutritious, and convenient to eat, and serving as a means of product diversification for the company.
Weaknesses	The texture can change easily during storage, the shelf life is still limited, and it is not yet widely recognized as a ready-to-eat product.
Opportunities	The growing demand for convenient and healthy food, as well as opportunities for market development of products based on local food ingredients.
Threats	Competition with other ready-to-eat products and changing consumer preferences.

Based on the SWOT analysis, three product formulations were developed to evaluate the effects of sugar and citric acid addition on the quality characteristics of ready-to-eat sweet potato. The composition of each formulation is presented in Table 2.

Table 2 Product Formulations

Formulation	Treatment
A	sweet potato (control)
B	Sweet potatoes + sugar solution
C	Sweet potato + sugar solution + 0.05% citric acid

As shown in Table 2, Formulation A was used as the control without the addition of sugar or citric acid. Formulation B contained sugar solution to enhance sweetness and improve consumer acceptance, whereas Formulation C consisted of sugar solution combined with 0.05% citric acid. The addition of citric acid was intended to reduce enzymatic browning, maintain product color, and improve product stability during storage. These formulations were subsequently evaluated through sensory analysis to determine the most acceptable formulation.

Sensory Evaluation of Ready-to-Eat Sweet Potato

A sensory test was conducted to determine how much people liked the new ready-to-eat sweet potato product. 15 panelists conducted a hedonic test on the sweet potatoes. They used a 5-point scale to rate their liking for each formulation, considering five aspects: color, aroma, taste, texture, and overall opinion. Before performing statistical analysis, the data were tested for normality using the Shapiro–Wilk test. Since the data did not follow a normal distribution ($p < 0.05$), we used nonparametric statistical methods instead. The Friedman test was used to examine whether there were significant differences among the three formulations. Next, the Wilcoxon Signed-Rank test was performed to determine exactly which pairs of formulations showed significant differences in the sensory characteristics that yielded significant results. The results of the Friedman test are presented in Table 3.

Table 3 Friedman Test Results for Sensory Evaluation of Ready-to-Eat Sweet Potato

Sensory Attribute	Mean Rank A	Mean Rank B	Mean Rank C	X ²	p-value	Interpretation
Color	1.97	1.57	2.47	7.787	0.020	Significant
Aroma	2.37	1.87	1.77	4.227	0.121	Not Significant
Taste	2.33	1.77	1.90	4.051	0.132	Not Significant
Texture	2.57	1.87	1.57	12.474	0.002	Significant
Overall Acceptance	2.53	1.83	1.63	11.167	0.004	Significant

Table 3 shows that there were big differences between the three formulas in terms of color, texture, and how well people liked them overall ($p < 0.05$). However, there were no big differences in smell and flavor ($p > 0.05$). These results show that changes in sugar and citric acid levels affected the product's look and feel more than its taste. To find out which specific mixtures caused the big differences, they did pairwise comparisons using the Wilcoxon Signed-Rank test for the sensory qualities that had significant results from the Friedman analysis.

Color

Color is one of the key quality characteristics that influence how customers are attracted to a product and decide to purchase it. The Friedman test revealed a significant difference in color preferences among the three formulations ($p = 0.020$). Therefore, a pairwise comparison was conducted using the Wilcoxon Signed-Rank test, and the results are presented in Table 4.

Comparison	Z-value	P-value	Interpretation
A - B	-1.556	0.119	Not Significant
A - C	-1.846	0.065	Not Significant
B - C	-2.797	0.005	Significant

The Wilcoxon test showed that a significant difference in color preference was only observed between Formulations B and C ($p = 0.005$). In contrast, no significant differences were found between Formulations A and B or between Formulations A and C. These findings suggest that the addition of 0.05% citric acid improved the appearance of the product compared with the sugar-only formulation. Citric acid is known to inhibit enzymatic browning by lowering the pH and chelating metal ions that catalyze the oxidation of phenolic compounds, thereby helping to maintain a brighter and more attractive product color. These findings are in agreement with previous studies, which reported that enzymatic browning can be inhibited through several methods, including heat treatment and the addition of citric acid solution. The application of citric acid reduces browning by suppressing polyphenol oxidase activity and delaying the oxidation of phenolic compounds, thereby maintaining the natural color of food products (Sirait et al., 2020).

Aroma

The Friedman test showed no significant differences in aroma among the three formulations ($p = 0.121$). This result indicates that the addition of sugar and citric acid at the concentrations used did not substantially alter the characteristic aroma of sweet potato. Consequently, all formulations exhibited relatively similar aroma profiles and were similarly accepted by the panelists. The absence of significant differences suggests that the formulation did not markedly affect the release or composition of the volatile compounds responsible for the characteristic aroma of sweet potato. Aroma perception is largely determined by the release of volatile compounds from the food matrix, and interactions between food components and volatile compounds can influence their diffusion and perceived aroma intensity (Fan et al., 2025).

Taste

Similarly, no significant differences were observed in taste among the three formulations ($p = 0.132$). Although sugar contributed to sweetness and citric acid provided slight acidity, these modifications did not significantly influence the overall taste preference of the panelists. Therefore, the three formulations maintained comparable flavor acceptability.

Texture

Texture was significantly affected by formulation, as indicated by the Friedman test ($p = 0.002$). To determine the source of the differences, the Wilcoxon Signed-Rank test was performed, and the results are presented in Table 5.

Table 5 Wilcoxon Signed-Rank Test Results for Texture

Comparison	Z-value	P-value	Interpretation
A - B	-2.373	0.018	Significant
A - C	-2.803	0.005	Significant
B - C	-1.414	0.157	Not Significant

The Wilcoxon analysis revealed significant differences between Formulation A and Formulations B and C, whereas no significant difference was found between Formulations B and C. The incorporation of sugar appeared to improve the texture of the product compared with the control formulation. This improvement may be related to the hygroscopic properties of sucrose, which enable it to bind water through hydrogen bonding and influence the moisture characteristics of food products. Consequently, the presence of sugar may contribute to a more desirable texture during processing. Meanwhile, the addition of citric acid did not significantly modify texture compared with the sugar-only treatment, indicating that its primary function was associated with acidity regulation rather than texture modification (Ridhani et al., 2021).

Overall Acceptance

Overall acceptance represents the combined perception of all sensory attributes evaluated by the panelists. The Friedman test indicated significant differences among formulations ($p = 0.004$). Pairwise comparisons were conducted using the Wilcoxon Signed-Rank test, as shown in Table 6.

Table 6 Wilcoxon Signed-Rank Test Results for Overall Acceptance

Comparison	Z-value	P-value	Interpretation
A - B	-2.310	0.021	Significant
A - C	-2.887	0.004	Significant
B - C	-0.333	0.739	Not Significant

The Wilcoxon test demonstrated that Formulations B and C were significantly more acceptable than the control formulation (A). However, no significant difference was observed between Formulations B and C, indicating that the addition of sugar was sufficient to improve overall consumer acceptance, while the inclusion of citric acid primarily enhanced product quality and appearance without substantially increasing panelist preference. Overall acceptability represents the combined evaluation of all sensory attributes, including color, aroma, taste, and texture, and is therefore considered the most comprehensive indicator of consumer preference. The higher overall acceptance observed in Formulations B and C suggests that improvements in these sensory attributes collectively enhanced the acceptability of the developed product (Binag, 2026).

CONCLUSION

The development of *ready-to-eat sweet potato* demonstrated that formulation modification significantly influenced the sensory quality of the product. Among the evaluated formulations, the addition of sugar and 0.05% citric acid significantly affected color, texture, and overall acceptance, whereas no significant differences were observed in aroma and taste. These results indicate that the incorporation of sugar improved the sensory acceptability of the product, while citric acid contributed to maintaining product appearance without negatively affecting consumer preference.

Furthermore, the developed *ready-to-eat sweet potato* showed potential as a value-added food product with favorable sensory acceptance and feasible production costs. Therefore, this product has promising potential for commercialization as a convenient and nutritious ready-to-eat food. Further studies are recommended to evaluate the physicochemical characteristics, shelf life, and consumer acceptance using a larger number of panelists to support product development and market implementation.

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REFERENCES

- Amagloh, F. C., Yada, B., Tumuhimbise, G. A., Amagloh, F. K., & Kaaya, A. N. (2021). The potential of sweetpotato as a functional food in sub-saharan africa and its implications for health: A review. *Molecules*, 26(10), 1–21. <https://doi.org/10.3390/molecules26102971>
- Binag, I. A. (2026). Sensory evaluation, physicochemical characterization, and consumer acceptability of peanut-quinoa plant-based cheese formulations. *Lwt*, 249(November 2025), 119419. <https://doi.org/10.1016/j.lwt.2026.119419>
- Fan, W., Che, X., Ma, P., Chen, M., & Huang, X. (2025). Aroma Formation, Release, and Perception in Aquatic Products Processing: A Review. *Foods*, 14(15), 1–22. <https://doi.org/10.3390/foods14152651>
- Hidayah, N., Tjandra Bravo, C., & Valentina. (2023). Strategi Pengembangan Produk Baru Pada Usaha Mikro Kecil. *Abdaya: Pengabdian Dan Pemberdayaan Masyarakat*, 3(2), 1–7.

- Putri, N. A., Nurwantoro, & Susanti, S. (2024). Pengaruh Konsentrasi Asam Sitrat Terhadap Karakteristik Kimia, Kecerahan, dan Organoleptik manisan Kering Buah Nanas The Effect of Citric Acid on the Chemical Characteristics, Lightness, and Organoleptic of Dried Sweetmeat Pineapple. *Jurnal Pangan Dan Agroindustri*, 12(3), 175–183.
- Ridhani, M. A., Vidyaningrum, I. P., Akmala, N. N., Fatihatunisa, R., Azzahro, S., & Aini, N. (2021). Potensi Penambahan Berbagai Jenis Gula Terhadap Sifat Sensori Dan Fisikokimia Roti Manis: Review. *Pasundan Food Technology Journal*, 8(3), 61–68. <https://doi.org/10.23969/pftj.v8i3.4106>
- Sirait, V. A. A., Zulkifli, Z., Handayani, T. T., & Lande, M. L. (2020). Pengaruh Penambahan Asam Sitrat Terhadap Proses Non-Enzimatis Browning Jus Buah Pir Yali (*Pyrus bretschneideri* Rehd.). *Jurnal Penelitian Pertanian Terapan*, 18(3), 186. <https://doi.org/10.25181/jppt.v18i3.1505>